NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)
HEADQUARTERS
SCIENCE MISSION DIRECTORATE

RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES – 2020 (ROSES-2020)

NASA RESEARCH ANNOUNCEMENT (NRA)
SOLICITING BASIC AND APPLIED SCIENCE RESEARCH AND TECHNOLOGY DEVELOPMENT
ANNOUNCEMENT NUMBER: NNH20ZDA001N

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ISSUED: FEBRUARY 14, 2020

NOTICE: July 6, 2020. In Section V(c)iv the points of contact for the International Space Station Program's Research Office have been updated.

Clarified June 23, 2020. The 2020 Guidebook for Proposers Responding to a NASA Notice of Funding Opportunity has been posted at https://www.hq.nasa.gov/office/procurement/nraguidebook/ with an "effective date" of June 23, 2020. It is not anticipated that this version of the Guidebook will change the content of proposals to ROSES but, just to give everyone time to review it, the 2020 Guidebook will only apply to ROSES proposals with due dates after September 25, 2020.

Clarified May 22, 2020. If an acronym used in the page limited Scientific/Technical/Management (S/T/M) section needs to be defined, it must be defined within the S/T/M section the first time it is used. Proposers may not define acronyms solely in a list outside of the page-limited S/T/M section. If and only if acronyms are defined within the S/T/M section may an acronym list also be provided outside of the S/T/M section for the convenience of reviewers.

KEY DATES
FULL (STEP-2) PROPOSALS DUE
NO EARLIER THAN MAY 14, 2020
THROUGH NO LATER THAN MAY 13, 2021

RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES (ROSES)–2020
EXECUTIVE SUMMARY

This National Aeronautics and Space Administration (NASA) Research Announcement (NRA), Research Opportunities in Space and Earth Sciences (ROSES) – 2020, solicits basic and applied research in support of NASA's Science Mission Directorate (SMD). ROSES is an omnibus NRA, with many individual program elements, each with its own due dates and topics. All together these cover the wide range of basic and applied research and technology in space and Earth sciences supported by SMD. Awards to non-governmental organizations will be made primarily as grants or cooperative agreements and only occasionally as contracts as the nature of the work and/or program requirements dictate, see Section II(a). Awards to government labs will be made as inter- or intra-agency transfers. The typical period of performance for an award is three years, but some programs may allow up to five years and others specify shorter periods. Organizations of every type, domestic and foreign, Government and private, for profit and not-for-profit, may submit proposals without restriction on teaming arrangements. Note that it is NASA policy that all research involving non-U.S. organizations will be conducted on the basis of no exchange of funds.

This ROSES-2020 omnibus NRA will be available electronically as PDF files, at http://solicitation.nasaprs.com/ROSES2020. Tables 2 and 3 of this NRA, which will be posted at http://solicitation.nasaprs.com/ROSES2020table2 and http://solicitation.nasaprs.com/ROSES2020table3, respectively, provide proposal due dates and hypertext links to descriptions of the solicited program elements in the Appendices of this NRA. To learn of additional new program elements or amendments to this NRA through February 2021, at which time release of a subsequent ROSES NRA is planned, proposers are encouraged to subscribe to:

(1) The SMD mailing lists (by logging in at http://nspires.nasaprs.com/ and checking the appropriate boxes under "Account Management" and "Email Subscriptions"),
(2) The ROSES-2020 Blog for amendments, clarifications, and corrections at http://science.nasa.gov/researchers/sara/grant-solicitations/ROSES-2020/, and
(3) The ROSES-2020 due date Google calendars. Instructions are at https://science.nasa.gov/researchers/sara/library-and-useful-links.

Potential proposers may find Frequently Asked Questions (FAQ) that span multiple years of ROSES funding announcements at http://science.nasa.gov/researchers/sara/faqs/ and should refer to the *Guidebook for Proposers Responding to a NASA Funding Announcement* (hereafter referred to as the *NASA Guidebook for Proposers* or simply the *Guidebook*).

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Any amendments to the program elements will be indicated as bold and red in Table 2 and Table 3 of this NRA. Potential proposers may receive notification of amendments to ROSES-2020 by signing up for the SMD NSPIRES mailing list and/or by signing up for the ROSES-2020 Blog at https://science.nasa.gov/researchers/sara/grant-solicitations/roses-2020/.

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RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES (ROSES)–2020

SUMMARY OF SOLICITATION

I. FUNDING OPPORTUNITY DESCRIPTION

(a) Strategic Objectives of NASA and the Science Mission Directorate

The National Aeronautics and Space Administration (NASA) is chartered in the National Aeronautics and Space Act [51 U.S.C. § 20101 et seq.] with, among other objectives, the expansion of human knowledge of the Earth and of phenomena in the atmosphere and space. Working from this Congressional authorization, U.S. National Space Policy directs NASA to advance fundamental scientific knowledge of our Earth system, Solar System, and the Universe. This direction is manifest in the 2018 NASA Strategic Plan, which includes Strategic Objective 1.1 to understand the Sun, Earth, Solar System, and Universe. Further insight into the Strategic Goals and Objectives of the Science Mission Directorate, from the *2018 NASA Strategic Plan* and the current version of *Science 2019-2024: A Vision for Scientific Excellence* (formerly known as the Science Plan), are given in the documents at http://science.nasa.gov/about-us/science-strategy/. All program elements in this NASA Research Announcement (NRA) are relevant to NASA's Strategic Goals and Objectives. Each proposal to this NRA demonstrates the relevance of its proposed research to NASA by demonstrating relevance to the particular program element to which it was submitted. Further instructions concerning relevance and the other evaluation criteria are provided in Section VI(a) below.

(b) Research Programs of NASA's Science Mission Directorate

The NASA Science Mission Directorate (SMD) pursues NASA's strategic objectives using a wide variety of space flight programs that enable the execution of both remote sensing and *in situ* investigations. These investigations are carried out through the flight of space missions in Earth orbit, as well as to or even beyond objects in the Solar System, and also through ground-based research activities that directly support these space missions. This ROSES NASA Research Announcement (NRA) solicits proposals for both flight investigations, using suborbital-class platforms (including aircraft, balloons, sounding rockets, CubeSats, commercial suborbital reusable launch vehicles, and small International Space Station payloads), and all kinds of ground-based supporting research and technology (SR&T) investigations that seek to understand naturally occurring space and Earth phenomena, human-induced changes in the Earth system, and Earth and space science-related technologies and to support the national goals for further robotic and human exploration of space. These ground-based investigations include, but are not limited to: theory, modeling, and analysis of SMD science data, (together with data from SMD's international and/or interagency partners) development of concepts, techniques and advanced technologies suitable for future SMD space missions; development of methods for laboratory analysis of both extraterrestrial samples returned by spacecraft and terrestrial samples that support or otherwise help verify observations from missions; determination of atomic and composition parameters needed to analyze space data, as well as returned samples from the Earth or space; Earth surface observations and field campaigns that support SMD science missions; development of integrated Earth system models; development

of systems for applying Earth science research data to societal needs; and development of applied information systems applicable to SMD objectives and data.

Proposals in response to this NRA should be submitted to the most relevant science program elements described in Appendices A, B, C, D, and E. Table 2 lists these program elements in the order of their calendar deadlines for the submission of proposals, while Table 3 lists them in the order in which they appear in the appendices of this NRA. Direct questions about each specific program element to the Program Officer(s) identified in the Summary of Key Information section that concludes each program element description.

In order to pursue NASA's strategic objectives, SMD research and technology development activities are organized into four Programs:

- The Earth Science Research and Applied Sciences Program sponsors integrative research to advance knowledge of and to explore interactions among the major components of the Earth system — continents, oceans, atmosphere, ice, and life — to distinguish natural from human-induced causes of change and to understand and predict the consequences of change.
- The Heliophysics Research Program sponsors research to understand the Sun and its interactions with the Earth and the Solar System, including space weather.
- The Planetary Science Research Program sponsors research to explore the Solar System to study its origins and evolution, including the origins of life within it.
- The Astrophysics Research Program sponsors research to explore the Universe beyond, from the search for planets to the origin, evolution, structure, and destiny of the Universe itself.

Appendices A, B, C, and D describe program elements of these four science research programs, respectively. Additionally, Appendix E describes cross-division program elements relevant to two or more of these science research programs. Each of these appendices is prefaced with Division Overview (A.1, B.1, C.1…) that introduces the research program content of that division and lays out important rules that apply to all program elements within that Appendix if not superseded by individual program elements. See Section I(g) regarding order the precedence of these rules.

(c) Significant Changes from Recent ROSES

(i) Proposers should be aware of the following changes from last year:

- This year SMD will pilot a "dual-anonymous peer review" (DAPR) for the evaluation of proposals submitted to select program elements. Proposals to those program elements must be prepared consistent with guidelines for preparation of anonymous proposals, see Section IV(b)i, and DAPR processes are described in Section VI(b).
- Starting in ROSES-2020, unless the program element states otherwise, the sufficiency of the data management plan will be evaluated and will have a bearing on whether or not the proposal is selected, see Section II(c).
- This year, SMD will initiate a multi-year stepwise transition to implement the National Academy's recommendations in their report "*Best Practices for a Future Open Code Policy for NASA*". This includes both:

- Two new cross division program elements to enable public access: E.7 Support for Open Source Software Tools, Frameworks, and Libraries and E.8 Supplemental Open Source Software Awards and
- SMD has made uniform across all of ROSES the expectations regarding data and software, both to emphasize its importance and to simplify life for proposers as unified data policies better enable cross-disciplinary proposals. Text describing the now uniform ROSES approach on data and software may be found in the Division Overviews (i.e., A.1, B.1, C.1…).

- This year SMD will collect information from proposers and reviewers to assess (intellectual) risk and impact of ROSES proposals and the Associate Administrator will assemble a special panel to take a second look at select high-risk high-impact proposals that were not selected for funding through the normal review process. For more information see Section VI(b).

There have been a number of changes to the program elements within ROSES (see the lists of Program Element Appendices above). A non-exhaustive list of examples include:

- In Appendix A (Earth Science) a new call for members of a science team for the Global Ecosystem Dynamics Investigation (GEDI) instrument on the International Space Station (ISS) will be solicited as program element A.8. Moreover, A.30 The Earth Science U.S. Participating Investigator program will evaluate proposals using "dual-anonymous peer review", see Section VI(b). The Ecological Forecasting call has returned (having not been solicited since 2016) as A.39. Please note that this element is unique in requiring cost sharing. Finally, more program elements than ever before in Appendix A are requiring that proposers use the Earth Science standard templates for the Table of Work Effort and Current and Pending Support, please see Section IV(b)iii and the "SARA" web page where these templates maybe downloaded.
- In Appendix B (Heliophysics) new opportunities for GOLD/ICON Guest Investigators and Parker Solar Probe Guest Investigators will be solicited as program elements B.15 and B.16, respectively. In addition, H-FORT has been split into three separate program elements for improved clarity: Low Cost Access to Space (B.9), Flight Opportunities Studies (B.10), and the remaining SmallSats and Rideshare Opportunities (B.11) that retains the name H-FORT. Finally, program element B.4, Heliophysics Guest Investigators-Open will evaluate proposals using "dual-anonymous peer review", see Section VI(b).
- In Appendix C (Planetary Science) new participating scientist programs for the Double Asteroid Redirection Test (DART) Mission and the MOMA instrument on the ExoMars rover will be solicited as program elements C.21 and C.25, respectively. A program element for Radioisotope Power Systems Technology is planned for C.22, and what was Near-Earth Objects has been renamed Yearly Opportunities for Research in Planetary Defense (C.24).
- In Appendix D (Astrophysics) a new program element for Guest Scientists for the X-Ray Imaging and Spectroscopy Mission (XRISM) is planned for this year in D.12, Astrophysics Explorers U.S. Participating Investigators returns in D.13 and Theoretical and Computational Astrophysics Networks returns in D.14. Finally, all Astrophysics GO/GI programs and D.2 Astrophysics Data Analysis will evaluate proposals using "dual-anonymous peer review", see Section VI(b).

- To Appendix E (Cross Division) three new opportunities will be added this year: E.6, the Science Activation Program Integration, E.7 Support for Open Source Software Tools, Frameworks, and Libraries and E.8 Supplemental Open Source Software Awards. The graduate student research program Future Investigators in NASA Earth and Space Science and Technology (FINESST), that was added to ROSES last year continues as program element E.5. Finally, Habitable Worlds (E.4) will evaluate proposals using "dual-anonymous peer review", see Section VI(b).
- As always, small changes have been made throughout this document and to program elements, so please read carefully. Other changes will occur after this initial release, announced by Amendments, corrections, and clarifications. Subscribe to the NSPIRES mailing lists and the ROSES-2020 Blog for such updates.
- **The 2020 version of the *Guidebook for Proposers* has been posted at https://www.hq.nasa.gov/office/procurement/nraguidebook/ with an "effective date" of June 23, 2020. To give proposers adequate time to review it, the 2020 Guidebook will only apply to ROSES proposals with due dates after September 25, 2020. Until then proposers should continue to refer to the prior (2018) version of the Guidebook. [Clarified June 23, 2020]**

(ii) Those who have not proposed to ROSES recently should note the following changes made in recent years:

- Awards deriving from ROSES now require that as-accepted manuscript versions of peer-reviewed publications be uploaded into NASA's part of the PubMed Central (PMC) repository called NASA PubSpace, as described in Section II.(c). Manuscripts are to be deposited within one year, and failure to do so may delay or prevent awarding of funds.
- In Section IV(b)iii in the description of the summary table of work effort it is noted that, unless otherwise stated in an individual program element, person time listed in the table of work effort that is offered at no cost by the proposing organization is assumed to be an estimate of anticipated additional effort that may be provided to the project as needed and is considered voluntary uncommitted effort.
- Section VI.(b) defines the programmatic considerations that may be considered by the selection official.
- Section VIII now includes a link to information on filing a complaint through the NASA Office of Diversity and Equal Opportunity.
- Although, in general, Notices of Intent (NOIs) are optional, they are mandatory in a few cases (e.g., D.3 APRA and D.7 SAT). Grants.gov does not include an option to submit a Notice of Intent. For more information on NOIs see Section IV(b)vi.

(d) NASA-Provided High-End Computing (HEC) Resources

SMD provides a specialized computational infrastructure to support its research community, managed on its behalf by NASA's High-End Computing (HEC) program (see the HEC website at https://www.hec.nasa.gov/). Two major computing facilities are offered: the NASA Center for Climate Simulation (NCCS) at the Goddard Space Flight Center (GSFC), and the NASA Advanced Supercomputing (NAS) facility at the Ames Research Center (ARC).

The HEC program facilities maintain a range of computing systems with significant data storage resources. These offerings are summarized at https://www.hec.nasa.gov/about/overview.html. Augmentation and refreshment of these central systems occur periodically but the resources continue to be highly constrained. The HEC program also provides assistance in code porting, performance tuning, scientific data visualization, and data transfer.

Any need for computing time and other HEC program resources for the proposed research responding to a ROSES solicitation must be explicitly justified by completing an allocation request form for inclusion with your ROSES proposal (see sections i and ii below). If your proposal is selected, it is eligible for an allocation of HEC resources.

(i) Request HEC Resources

The purpose of this step is to inform science review panels and program managers of your computational needs, and if your ROSES proposal is selected, establish eligibility to use HEC resources. Complete and submit a request in the HEC Request Management System (RMS) at https://request.hec.nasa.gov. The form includes a written justification of how the computational resources would support the investigation as well as a multi-year resource-phasing plan, in annual increments, identifying the computing time and data storage requirements covering the duration of the proposed award period. You should use the “planning date for start of investigation” from the Summary of Key Information for your program element as the start date for your computational project.

Computing time must be described in the request using Standard Billing Units (SBUs), a common unit of measurement employed by the HEC program for allocating and tracking computing usage across its various architectures. The RMS system has a built-in calculator to help convert processor (CPU) hours to SBUs. SBU Conversion Factors are also available at https://www.hec.nasa.gov/user/policies/sbus.html, or proposers may contact HEC support staff for further assistance calculating SBUs; contact information can be found at https://www.nas.nasa.gov/hecc/support/user_support.html for NAS User Support, and https://www.nccs.nasa.gov for NCCS User Services Group.

(ii) Upload Request for HEC Resources

Save a PDF copy of your request after submitting it using the button provided in RMS. During your proposal submission in the NSPIRES system:

- Upload the PDF version of your computing time request as a separate file from your proposal; select "Appendix" as the document type when uploading;
- On the NSPIRES Cover Page
  - Check the box indicating that a request for HEC resources is included in the proposal; and
  - Enter the HEC Request Number (specified on the PDF).

For proposals submitted via Grants.gov, the resource request should be attached as an appendix to any appropriate location. This requirement for a separate document supersedes the general rule that proposals are made up of only two PDF files: the proposal and the Total Budget.

As they review the proposed investigation, science peer review panels will be asked to consider whether the computing time requested is an appropriate use of the highly constrained resources dedicated to each program element under this NRA.

Selection of your ROSES proposal does not guarantee that your HEC request will be fully allocated; it means that your HEC request is eligible to progress to the next step for evaluation by the HEC program (see section iii below). While you are guaranteed some HEC time, it may differ from your request given resource constraints.

(iii) Allocation of HEC Resources

If your proposal is selected for funding, your HEC request will be evaluated by the HEC Allocation Authority. The HEC program will then issue letters identifying yearly allocations of HEC resources for the duration of the project, which again, may differ from your request due to limited availability of resources. However, PIs may submit requests to increase or decrease allocations of HEC resources if there are unexpected changes to computational needs. Requests for modifications must be submitted via RMS. Allocation in full cannot be guaranteed, but SMD will make every attempt to satisfy the needs in the context of the overall set of requirements, resource constraints, and science priorities.

To expedite initiation of new projects where PIs and/or users are foreign nationals (whose accounts will require additional documentation and longer processing), the HEC program will consider providing a minimal allocation to such projects which have been notified of pending funding soon after the PI submits an allocation request in RMS.

For further information or questions about NASA provided High-End Computing resources please contact Tsengdar Lee at Tsengdar.J.Lee@nasa.gov or 202-358-0860.

(e) Availability of Funds for Awards

Prospective proposers to this NRA are advised that funds are not available for new awards for all of its solicited program elements at the time of its release. The Government's obligation to make awards is contingent upon the availability of sufficient appropriated funds from which payment can be made and the receipt of proposals that NASA determines are acceptable for award under this NRA.

(f) Successor, Renewal, Resubmitted, Multiple and Duplicate Proposals

PIs holding awards from any program element of any prior NRA are welcome to submit "successor" or "renewal" proposals that seek to continue a previously funded line of research if in scope of the current NRA. However, as described in the *NASA Guidebook for Proposers*, such successor proposals will be considered with neither advantage nor disadvantage along with new proposals that are submitted for that same program.

Proposers are welcome to resubmit proposals (or tasks) that were not funded under a prior program element or solicitation. Such submissions will be peer reviewed and considered with neither advantage nor disadvantage along with new proposals that are received by NASA. However, some Appendices and/or program elements in ROSES limit submissions in several ways:

The first limitation on submission bars "multiple" proposals to a given program element. Some program elements in Appendix B (Heliophysics), e.g., B.2 H-SR, will not allow a

particular individual to be the PI on more than one proposal to those program elements. In such cases, the first proposal identifying a particular PI will be evaluated, but any subsequent proposal to the same program element that identifies the same PI will not be evaluated or considered.

The second limitation bars concurrent submission of what are called "duplicate" proposals, in B.1, the Heliophysics Research Program Overview, C.1, the Planetary Science Research Program Overview, and D.1 the Astrophysics Research Program Overview where they are described as "the same or essentially the same" proposals. See Section 1.4 of B.1, Section 3.2 of C.1 and Section 2 of D.1 for more information.

In either case, the order of receipt of the proposals will be determined by the time stamp generated automatically by the proposal submission system. The first proposal submitted will be evaluated but subsequent duplicate proposals will be returned without review.

(g) Order of Precedence: The *Guidebook* vs. *ROSES Summary of Solicitation* vs. program elements

ROSES is an omnibus solicitation, meaning that this *Summary of Solicitation* (SoS) presents required information that applies to all program elements within it (like the OMB Approval Number 2700-0092 and the CFDA Number 43.001) that is not repeated within each program element. Similarly, this *Summary of Solicitation* sets out the default rules that apply to every ROSES program element unless otherwise stated, but any program element may supersede the SoS.

Grants and cooperative agreements will be subject to the policies and provisions identified in the regulations at 2 CFR (Code of Federal Regulations) 200 and 1800, 14 CFR 1274 (for cooperative agreements awarded to commercial organizations), the *NASA Grants and Cooperative Agreements Manual* (GCAM), and the *NASA Guidebook for Proposers*. In the case of any conflict, the order of precedence is as follows:

1. Statutes and regulations
2. The NASA GCAM
3. Program elements
4. Division Research Program Overviews (e.g., A.1, B.1…)
5. The *Summary of Solicitation* of the ROSES NRA (i.e., this document)
6. *Guidebook for Proposers Responding to a NASA Funding Announcement*

An example where individual program element may supersede the *Guidebook* is "letters of affirmation" (sometimes called letters of endorsement). The *Guidebook* states that letters that endorse the value or merit of a proposal will not be considered in the evaluation of the proposal, but a few individual program elements in ROSES (e.g., C.17 PMEF, for facility instruments, and E.2 TWSC) do allow such letters of affirmation.

Moreover, this *Summary of Solicitation* may include instructions that are more specific or detailed than the *Guidebook*, and program elements often include instructions that are more specific or detailed than this *Summary of Solicitation* or the *Guidebook*.
An example of a case where individual program element differs from this *Summary of Solicitation* is in how Relevance is evaluated. Section VI(a) lays out a general approach to evaluating relevance, but a few individual program elements in Appendix C (e.g., C.3-

C.5) require explicit statements of relevance through mandatory text boxes on the NSPIRES cover pages.

Answers to questions may appear in a Frequently Asked Questions (FAQ). The FAQ for the ROSES NRA appears at http://science.nasa.gov/researchers/sara/faqs/. Any FAQs for individual program elements will appear under "other documents" on the NSPIRES web page for the program element. FAQs merely clarify, they do not contradict instructions in the *Guidebook*, *ROSES Summary of Solicitation* or program elements.

Questions about differences between *ROSES Summary of Solicitation* and the *Guidebook* should be directed to sara@nasa.gov. Questions about a difference between either of those and an individual program element, should be directed to the point of contact for the particular program element and cc sara@nasa.gov.

(h) Access to NASA Facilities/Systems

To access NASA facilities and/or systems, award recipients must work with NASA to ensure proper credentialing. For example, for access to High-End Computing (HEC) Resources (see Section I(d) above) and for physical access to a NASA facility one would work with the badging office at that NASA center. Authors of proposals that would involve Foreign National access to NASA facilities/systems should refer to the *Foreign National Access Management (FNAM) Operations Manual*.

(i) Citizen science

Citizen science is a form of open collaboration in which individuals or organizations participate voluntarily in the scientific process. Proposers to any ROSES program element are invited to incorporate citizen science and crowdsourcing methodologies into their submissions, where such methodologies will advance the objectives of the proposed investigation. The current SMD Policy on citizen science describes standards for evaluating proposed and funded SMD citizen science projects. For more information see Section 3 H.R.6414 - Crowdsourcing and Citizen Science Act of 2016, which authorizes federal agencies to utilize crowdsourcing and citizen science and the https://science.nasa.gov/citizenscience webpage, that provides information about existing SMD-funded projects, including how to sign up for the NASA-SOLVE email listserve.

(j) Science Activation

NASA Science recognizes the importance our content and experts play in advancing human knowledge. SMD created a new program to activate learners of all ages to become more scientifically-literate and create a life-long love of learning. By leveraging community-based organizations across the U.S. and online, we can provide new opportunities. See the Science Activation program element in this ROSES solicitation under Section E.6.If you are a subject matter expert and would like to learn more - visit https://science.nasa.gov/learners. To volunteer as a subject matter expert in this program, submit an application at https://science.nasa.gov/learners/sme-map.

Questions about the program may be submitted to https://science.nasa.gov/contact-science-activation.

II. AWARD INFORMATION

(a) Funding and Award Policies

NASA may support an award as outlined in the proposal budget, or may offer to fund only selected parts, or all or part for a shorter duration (e.g., a one-year pilot study), or a combination. Awards may depend on acceptable revised budgets, statements of work, data management plans, or other elements of proposals described in ROSES or in the *NASA Guidebook for Proposers*. Moreover, even after an award letter has been sent or an award has begun, NASA has the authority to suspend or terminate a grant in whole or in part in accordance with 2 CFR 200.338 through 200.340.

The amount of funds expected to be available for the first year of new awards for proposals submitted in response to this NRA is given in the Summary Table of Key Information at the end of each program element in the appendices. An estimate of the number of awards that might be made for each program element is also given in this Table, contingent on budget allocation to that program element and availability of funding and presuming the submission of sufficient highly rated proposals.

ROSES-2020 will receive ~5000 proposals across all program elements and will select/award ~1250 totaling ~$600 million over the lifetime of the awards. Individual award sizes will vary based on scope from ~$5,000 to multi-year awards in the millions of dollars.

NASA's goal is to initiate new awards as rapidly as possible after the selection of proposals is announced. However, the workload experienced by NASA, the availability of appropriated funds, and any necessary post-selection negotiations with the proposing organization(s) needed for the award(s) in question can all cause delays. Regarding this last item, every proposer is especially encouraged to submit full and detailed explanations of the requested budget to help expedite the processing of the award, should their proposal be selected.

The ROSES NRA is structured to allow NASA to make the full range of award types: grants, cooperative agreements, contracts, and intra- (within NASA) or interagency transfers. NASA has provided guidance to the award giving offices about how to decide what award type is appropriate in Sections 3.3 and 3.4 of the GCAM. By default, ROSES proposals to non-governmental organizations will result in grants (or cooperative agreements) rather than contracts which would not be appropriate for the public purpose of what is solicited. Unless otherwise stated in a program element, contracts will not be awarded. If a prospective proposer to a program element that excludes contracts thinks that their work should be a contract, they should communicate with the point of contact for that program element and cc sara@nasa.gov.

In general, ROSES proposals submitted by non-governmental organizations result in grants. When ROSES proposals result in cooperative agreements (to non-governmental organizations) there is substantial involvement of NASA facilities or staff in the conduct of the proposed research (e.g., when the PI is at a NASA Center and a funded Co-I is at non-governmental organization).

The budget narrative need not state the type of award instrument that is anticipated. A NASA awards officer will determine the appropriate award instrument for the selections

resulting from this solicitation. Contract awards will be subject to the provisions of the Federal Acquisition Regulations (FAR) and the NASA FAR Supplement.

(b) Award Period of Performance

The period of performance (duration) for new awards for proposals submitted in response to this NRA is given in the Summary of Key Information that concludes each program element description in the appendices. The period of performance ranges from one year for activities of limited scope to five years for extensive, comprehensive studies. Award durations may be longer in special cases, such as teams of long-duration space missions. Whatever the proposed period of performance it must be justified in the proposal. The appropriateness of the proposed period of performance will be evaluated by peer review. NASA may offer to support an award of shorter duration than was proposed. Award start and end dates will vary by program element, but award start dates are rarely less than 6 months from the proposal due date.

(c) Increasing Access to the Results of Federally Funded Research

In keeping with the NASA approach for Increasing Access to Results of Federally Funded Research, most proposals to ROSES will be required to provide a data management plan (DMP) or an explanation of why one is not necessary given the nature of the work proposed. Starting in ROSES-2020, in a change from prior years, the default presumption is that when a DMP is required, the sufficiency of the data management plan will be evaluated as part of the proposal's intrinsic merit and will have a bearing on whether or not the proposal is selected. Unless otherwise stated, the data management plan will be placed in a 2-page section in the proposal PDF immediately following the references and citations for the Scientific/Technical/Management (S/T/M) portion of the proposal and does not count against the page limit for the S/T/M Section.

The exceptions that don't follow this default will say so explicitly and they are: First, for some proposals the nature of the work is inexorably linked to the handling of data so DMP is part of the page-limited S/T/M section of the proposal. Examples include (but are not necessarily limited to) proposals to program elements A.8 GEDI Science Team, B.7 Space Weather Science Applications, B.12 Heliophysics Data Environment Emphasis, C.4 Planetary Data Archiving, Restoration, and Tools, D.2 Astrophysics Data Analysis, D.13 Astrophysics USPI, D.14 Theoretical and Computational Astrophysics Networks, and E.3 The Exoplanets Research Program. Some elements, like A.9 Physical Oceanography and A.14 Ocean Surface Topography Science Team require a separate Software Development Plan. Second, instrument development and technology development programs are generally exempted from providing a DMP at all, under the presumption that no significant research data will be generated. However, even if a DMP is not required with the proposal, if peer-reviewed publications result from the award then any data behind figures or tables must be available electronically at the time of release, ideally in supplementary material with the article and code developed should be made publicly available when it is practical and feasible to do so, and when there is scientific utility in doing so.

Some program elements provide templates for the data management plan. The template for the program elements in Appendix B (Heliophysics) may be found here and

the template for the program elements in Appendix C (planetary Science) may be found here. Please read the program elements carefully.

Whether in the separate 2-page section or in the page-limited S/T/M portion of the proposal, proposals that include a plan to archive data should allocate suitable time and resources for this activity. The appendices or individual program elements of ROSES may specify preferred archives and may require more than is outlined in this *Summary of Solicitation* for all proposers or just those that generate certain kinds of data. For more information on data management plans see the SARA FAQs on this subject. For information about data rights, and other aspects of intellectual property such as invention rights resulting from awards see the file entitled "*Award and Intellectual Property Information*" under the section called "Grant and Cooperative Agreement Guidance" at https://prod.nais.nasa.gov/pub/pub_library/srba/.

In keeping with the NASA Plan for Increasing Access to Results of Federally Funded Research, awards deriving from ROSES include terms and conditions requiring that as accepted manuscript versions of peer-reviewed publications (hereinafter "manuscripts") that result from ROSES awards be uploaded into NASA's part of the PubMed Central (PMC) repository called NASA PubSpace. The Federal Register notice on this subject specifies that manuscripts are to be deposited within one year of completion of the (manuscript) peer review process. Please note that the NASA research access FAQ says that not doing so "may delay or prevent awarding of funds". This applies only to peer reviewed manuscripts. Patents, publications that contain material governed by personal privacy, export control, proprietary restrictions, or national security law or regulations will not be covered by this requirement. For more details on public access to scientific publications and digital scientific data resulting from NASA-funded research, please see: https://www.nasa.gov/open/researchaccess.

(d) Rephasing of Award Budgets, Family or Medical Leave and No-Cost Time Extensions

Occasionally the schedule for a research project changes, and this will change the phasing of the funding requirement. "Rephasing" funding may be initiated either at the request of the PI or NASA.

In keeping with NASA's policy (in 2 CFR 1800.903), SMD will accommodate all reasonable requests from the PI or Authorized Organization Representative (AOR) to rephase ROSES awards to accommodate a PI's need to care for family and health (e.g., for family or medical leave). In the case of contracts, rephasing will be performed as long as it does not compromise previously agreed upon project goals, timelines, or deliverables associated with a NASA requirement described in the contract.

NASA policy allows grantee-initiated, first time no-cost extensions (NCEs) of up to 12 months. Grantees can use the form at https://www.nssc.nasa.gov/nocostextension to request NCEs. PIs at Government labs should contact their program officer directly.

SMD program officers may engage in active grant management to diminish carrying forward unobligated funds from one fiscal year to the next fiscal year (carryover). Program Officers may invite PIs to rephase their funding requirement where funds for a year or more are being carried forward. In this way, the awarding of future year funds

can more closely align with the timing of project activities. The total funds disbursed over the period of performance will not change, only the fiscal year (FY) in which they arrive.

SMD policy is that rephasing should not cause work on continuing awards to be deferred because of a delay in receipt of funds. PIs should communicate clearly to NASA if a rephase would interfere with the planned schedule for the grant. If an award is rephased, NASA will make every reasonable effort to provide the next fiscal year funding in a timely manner. Honoring commitments and ensuring the continuation of existing projects is a high priority of SMD.

III. Eligibility Information

(a) Eligibility of Applicants

Prospective investigators from any category of organizations or institutions, U.S or non-U.S., are welcome to respond to this solicitation. Specific categories of organizations and institutions that are welcome to respond include, but are not limited to, educational, industrial, and not-for-profit organizations, Federally Funded Research and Development Centers (FFRDCs), University Affiliated Research Centers (UARCs), NASA Centers, the Jet Propulsion Laboratory (JPL), and other Government agencies. Historically Black Colleges and Universities (HBCUs), Hispanic-Serving Institutions, Tribal Colleges, and Other Minority Universities (OMUs), small disadvantaged businesses (SDBs), veteran-owned small businesses, service-disabled veteran-owned small businesses, HUBZone small businesses, and women-owned small businesses (WOSBs) are encouraged to apply.

NASA recognizes and supports the benefits of having diverse and inclusive scientific, engineering, and technology communities and fully expects that such values will be reflected in the composition of all panels and teams including peer review panels (science, engineering, and technology), proposal teams, science definition teams, and mission and instrument teams.

(b) Number of Proposals and Teaming Arrangements

There is no general restriction on the number of proposals that an organization may submit to this solicitation, or on the teaming arrangements for any one proposal, including teaming with employees of NASA's Centers and the Jet Propulsion Laboratory. However, some Appendices or program elements limit the number of proposals that may be submitted on behalf of an individual PI to a program element or bar duplicate proposals, see Section I(f). Moreover, unless otherwise stated in the program element, each proposal must be a single separate, stand-alone, complete PDF document for evaluation purposes, other than the Total Budget, (optional) HEC request, and, if relevant, documentation associated with the Dual-Anonymous Peer Review process.

(c) Foreign Participation Including Restrictions Involving China

(i) Foreign Participation in General

Participation in ROSES-funded research by non-U.S. organizations in this program is welcome on a "no exchange of funds" basis. It is NASA policy that each international partner, its sponsoring agency, or its funding/sponsoring institution, covers its own research contributions (further information on foreign participation is provided in ROSES FAQ #14 on this topic and the *NASA Guidebook for Proposers*).

Normally, NASA does not fund research efforts at foreign organizations, whether proposed directly by a foreign organization, or as part of proposals submitted by U.S. organizations. Unless otherwise stated in the program overview or program element, for any research efforts that derive from this NRA, NASA will provide the support for selected U.S. organizations and the sponsoring foreign agency or institution must do the same for their selected organizations.

If a proposal with a non-U.S. partner is selected, NASA will determine whether such participation should be covered by and implemented through an international agreement between NASA and the sponsoring foreign agency or funding/sponsoring institution under which the parties agree to each bear the cost of discharging their respective responsibilities.

NASA funding may not be used for subcontracted foreign research efforts, including travel. The direct purchase of supplies and/or services, which do not constitute research, from non-U.S. sources by U.S. award recipients is permitted.

(ii) Restrictions Involving China

In accordance with restrictions in Appropriation Acts, NASA is prohibited from funding any work that involves the bilateral participation, collaboration, or coordination with China or any Chinese-owned company or entity, whether funded or performed under a no exchange of funds arrangement.

Proposals involving bilateral participation, collaboration, or coordination in any way with China or any Chinese-owned company, whether funded or performed under a no exchange of funds arrangement, may be ineligible for award.

For more information please see the ROSES FAQ on the SARA web page at http://science.nasa.gov/researchers/sara/faqs/prc-faq-roses/

As stated in 2 CFR 1800 Appendix A, NASA requires Certifications, Assurances, and Representations, including Certifications and Assurances to implement restrictions in Appropriation Acts, that are applicable to all awards. By submission of a proposal, proposers are certifying that the proposing organization has read and is in compliance with all the Certifications, Assurances, and Representations, including that they are not China or a Chinese-owned company, and that they will not participate, collaborate, or coordinate bilaterally with China or any Chinese-owned company, at the prime recipient level or at any subrecipient level, whether the bilateral involvement is funded or performed under a no exchange of funds arrangement.

An Assurance of Compliance with restrictions in Appropriation Acts herein after referred to as "the Acts" whereas:

(1) NASA is restricted from using funds appropriated in the Acts to enter into or fund any grant or cooperative agreement of any kind to participate, collaborate, or coordinate bilaterally with China or any Chinese-owned company, at the prime recipient level and at all subrecipient levels, whether the bilateral involvement is funded or performed under a no exchange of funds arrangement.
(2) Definition: "China or Chinese-owned Company" means the People's Republic of China, any company owned by the People's Republic of China, or any company incorporated under the laws of the People's Republic of China.
(3) The restrictions in the Acts do not apply to commercial items of supply needed to perform a grant or cooperative agreement.
(4) By submission of its proposal, the proposer represents that the proposer is not China or a Chinese-owned company, and that the proposer will not participate, collaborate, or coordinate bilaterally with China or any Chinese-owned company, at the prime recipient level or at any subrecipient level, whether the bilateral involvement is funded or performed under a no exchange of funds arrangement.

(d) Cost Sharing or Matching

Unless otherwise specified (e.g., in A.39 Ecological Forecasting), cost sharing is not required for an institution of higher education or other not-for-profit organization to receive a grant or cooperative agreement, although NASA may accept cost sharing if it is voluntarily offered (see 2 CFR 200.306, 2 CFR 1800.306, *Grants and Cooperative Agreement Manual (GCAM)* 5.6 Funding).

For a commercial organization to receive a cooperative agreement, cost sharing (equal to 50% of the total) is required if the project has commercial applications and profit generating potential. Proposals from commercial organizations for cooperative agreements that do not include cost sharing must demonstrate that potential commercially marketable products are not expected to result from the project. (see references in parenthesis above and 14 CFR §1274.102 (c) 4 and 14 CFR §1274.204, "Costs and Payments" (b) Cost sharing).

Each proposal must include a Table of Personnel and Work Effort with names and planned work of all personnel necessary to perform the proposed effort, regardless of whether that work effort requires funding or not. As this is outside of the budget section, any work planned listed in this table that is not to be funded by NASA as a result of this proposal is not considered cost sharing as defined in 2 CFR § 200.29. Level of effort estimates for unfunded team members are not intended to represent voluntary committed cost sharing. Collaborators should be listed on the table, but their level of effort may be simply given as "de minimis." See Section IV(b)iii for an example.

IV. Proposal and Submission Information

(a) Proposal Instructions and Requirements

All information needed to apply to this solicitation is contained in this ROSES NRA and in the companion document, the *NASA Guidebook for Proposers*, located at http://www.hq.nasa.gov/office/procurement/nraguidebook. By reference, the latest edition of the *NASA Guidebook for Proposers* is incorporated into this NRA. We also include 48 CFR 1852.235-72 by reference and it appears in the *NASA Guidebook for*

Proposers. Proposers are responsible for understanding and complying with its procedures for the successful, timely preparation and submission of their proposals. Proposals that do not conform to its standards may be declared noncompliant and returned without review.

Questions regarding a program element should be directed to the program officer identified in the Summary Table of Key Information at the end of each program element or on the list of program officers on the SARA web page. Any clarifications or questions and answers that are published will be posted on the relevant program element's index page in NSPIRES.

The introductory material, as well as the appendices, of the *NASA Guidebook for Proposers* provides additional information about the entire NRA process, including NASA policies for the solicitation of proposals, guidelines for writing complete and effective proposals, and NASA's general policies and procedures for the review and selection of proposals and for issuing and managing the awards to the institutions that submitted selected proposals. A group of Frequently Asked Questions (FAQs) provides additional miscellaneous information about a variety of the NASA proposal and award processes, policies, and procedures.

NASA has implemented a process to collect demographic data from proposers via NSPIRES for the purpose of analyzing demographic differences associated with its award processes. Information collected will include name, gender, race, ethnicity, and disability status. Submission of this information is strictly voluntary, is not communicated to program officers, and is neither any part of the evaluation or selection process nor a precondition of award.

(b) Content and Form of the Proposal Submission

(i) Electronic Proposal Submission

All proposals submitted in response to this ROSES NRA must be submitted electronically by one of the officials at the PI's organization who is authorized to make such a submission; electronic submission by the authorized organization representative (AOR) serves as the required original signature of the proposing organization. No hard copy of the proposal is permitted.

Proposers may opt to submit proposals in response to this ROSES NRA via either of two different electronic proposal submission systems: the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) at http://nspires.nasaprs.com; see Section IV(b)(iv) below, or Grants.gov at http://www.grants.gov; see Section IV(b)(v) below. The only exceptions are occasional joint calls with other Agencies that use the other Agency submission system and the Astrophysics Guest Investigator (GI) and Guest Observer (GO) programs. See Section IV(b)viii on the two-phase process and those program elements for details.

Note carefully the following requirements for submission of an electronic proposal, regardless of the intent to submit via NSPIRES or Grants.gov:

- Every organization that intends to submit a proposal to NASA in response to this NRA, including educational institutions, industry, not-for-profit institutions, the Jet Propulsion Laboratory, NASA Centers, and other U.S. Government agencies, must

be registered in NSPIRES. This applies equally for proposals submitted via Grants.gov, as well as for proposals submitted via NSPIRES. Every organization that intends to submit a proposal through Grants.gov must also be registered in Grants.gov, as well as in NSPIRES. Registration for either proposal data system must be performed by an organization's electronic business point-of-contact (EBPOC) in the System for Award Management (https://www.sam.gov/SAM/). A Data Universal Number (DUNS) is required to obtain a SAM registration, and applicants are required to maintain an active SAM registration, with current information loaded, at all times while competing for a federal award, and, if applicable, during the period of performance of the award. A DUNS can be obtained here.

- Any organization requesting NASA funds through the proposed investigation must be listed on the Proposal Cover Page. NASA will not fund organizations that do not appear on the Proposal Cover Page.
- Each individual team member (e.g., PI, Co-Investigators, etc.), including all personnel named on the proposal's electronic cover page, must be individually registered in NSPIRES. This applies equally for proposals submitted via Grants.gov, as well as for proposals submitted via NSPIRES.
- Unless specifically allowed by an individual program element, Co-PIs are not permitted. The use of other team member roles in NSPIRES (described in the *NASA Guidebook for Proposers*) including Co-I/Science PI, Co-I/Institutional PI, and Co-I/Co-PI (only from a non-U.S. organization under specific circumstances), are permitted. Any role with "PI" in the title is subject to the rules, requirements, page limits, etc. laid out for the PI. For more information on rules and expectations regarding the Co-I/Science PI please see SARA FAQ #9.
- Each individual team member (e.g., PI, Co-investigators, etc.), including all personnel named on the proposal's electronic cover page, must confirm their participation on that proposal (indicating team member role) and specify an organizational affiliation. For proposals submitted via NSPIRES, this confirmation is via NSPIRES (see Section IV(b)(iv), below). For proposals submitted via Grants.gov, this confirmation is via "Letters of Commitment" included within the proposal. The organizational affiliation specified on the cover page must be the organization through which the team member would work and receive funding while participating in the proposed investigation. If the individual has multiple affiliations, then this organization may be different from the individual's primary employer or preferred mailing address. Team members are asked to ensure that their contact information in NSPIRES is up to date. Changes can be made using the "Account Management" link on the "NSPIRES Options" page.

Typically, an electronic proposal consists of electronic forms (i.e., the NSPIRES cover pages) and two or more attachments. The electronic forms contain data that will appear on a proposal's cover pages and will be stored with the proposal in the NSPIRES database. A proposal submitted in response to this NRA must have two attachments: the main proposal PDF and the Total Budget PDF. The main proposal PDF contains all ten sections of the proposal listed in Table 1, including the Table of Contents, main Science/Technical/Management section, References, Biographical sketches/CVs, Table of Personnel and Work Effort, Current and Pending Support, any Statements of

Commitment or Letters, Budget Justification, Facilities and Equipment, and Detailed Budget (excluding any salary, fringe or overhead). The separately uploaded Total Budget PDF contains the full and complete budget, including salary, fringe and overhead (see Section IV(b)iii). If there is an accompanying HEC request (see Section I(d) above) then a HEC Appendix is uploaded as a separate, third PDF.

The only exception to the general rule above is for the case of proposals submitted to those programs that use a dual-anonymous peer review (DAPR) process in which, not only are proposers unaware of the identity of the members on the review panel, but the reviewers are not told the identity of the proposers until after the review of the merit, relevance and cost reasonableness of the proposal. In ROSES this year the programs evaluating proposals using DAPR are:

- A.28 The Earth Science U.S. Participating Investigator program,
- B.4, Heliophysics Guest Investigators-Open,
- D.2 Astrophysics Data Analysis,
- Astrophysics Guest Investigator/Observer/Scientist Calls (D.5, D.6, D.9-D.12)
- E.4 Habitable Worlds.

Proposers to these programs must provide an anonymized version of the proposal for peer review, and a separate non-anonymized document that contains elements of the proposal that would reveal the identities and affiliations of participating researchers, such as expertise, facilities and resources. Any program element that is using DAPR (and thus has these special requirements) will 1) include a notification indicating that this is the case, 2) contain a special section with detailed instructions about how to prepare proposals, 3) link to a special web FAQ on this subject, and 4) the NSPIRES page of any program using DAPR will host "Guidelines for Anonymous Proposals" under "Other documents". As always, a separate (not anonymized) Total Budget file will also be required. DAPR processes are described in Section VI(b).

Submission of proposals via either NSPIRES or Grants.gov is a two-part process. When the PI has completed entry of the data requested in the required electronic forms and attachment of the allowed PDF attachments, including the Science/Technical/ Management section, an official at the PI's organization who is authorized to make such a submission, referred to as the Authorized Organizational Representative (AOR), must submit the electronic proposal (forms plus attachments). Coordination between the PI and his/her AOR on the final editing and submission of the proposal materials is facilitated through their respective accounts in NSPIRES and/or Grants.gov.

(ii) Proposal Format and Contents

All proposals submitted in response to this NRA must include responses to any questions and/or electronic forms required by NSPIRES or Grants.gov. For example, submission requires online input of a 4000-character Proposal Summary, Business Data (such as dates and fiscal years), Other Project Information (such as Environmental Impact), Budget information, Program Specific Data (such as government participation) and online confirmation of team members.

The Science/Technical/Management (S/T/M) section and other required sections of the proposal must be submitted as a single, searchable, unlocked PDF file that is attached

to the electronic submission using one of the proposal submission systems. Proposers must comply with all format requirements specified in this NRA (see below and Table 1 for a summary) and in the *NASA Guidebook for Proposers*. The S/T/M section is page limited and only the parts specified in Table 1 are permitted. Proposals that exceed page limits, violate formatting rules, or contain extra sections or appendices that are not specifically requested or allowed by this NRA or a program element may be declared noncompliant returned without review or rejected after review, no matter what their rating. The *NASA Guidebook for Proposers* provides default Agency-wide discussions of the content and organization of proposals, as well as the default page limits of a proposal's constituent parts. Those apply by default unless superseded by instructions detailed in ROSES, see Section I(g).

Note that some of the program element descriptions in Appendices A through E of this NRA may specify different page limits for the Science/Technical/Management section of the proposal; if so, these page limits will be prominently given in the Summary of Key Information subsection that concludes each program element description. In the event the information in this NRA is different from or contradictory to the information in the *NASA Guidebook for Proposers*, the information in this NRA takes precedence.

Unless otherwise stated in the Appendix or program element, proposals submitted in response to ROSES must follow these rules for formatting: The body text and captions may not, on average across a solid block of text, exceed 15 characters per horizontal inch, including spaces, though text within figures and tables may be smaller if still judged by the reviewers to be readable. Easily read sans serif fonts (e.g., Arial, Helvetica, Verdana) are encouraged but not required. Proposals may not have more than 5.5 lines per vertical inch of text, must have at least one-inch margins, be set for US letter size (8.5x11) paper, and expository text necessary for the proposal may not be located solely in figures, tables, or their captions. Moving images are not allowed unless explicitly permitted by the program element. Pages must be numbered.

Important note on creating PDF files for upload: It is essential that all PDF files generated and submitted meet NASA requirements. This will ensure that the submitted files can be ingested by NSPIRES regardless of whether the proposal is submitted via NSPIRES or Grants.gov. At a minimum, it is the responsibility of the proposer to: (1) ensure that all PDF files are unlocked and that edit permission is enabled – this is necessary to allow NSPIRES to concatenate submitted files into a single PDF document; and (2) ensure that all fonts are embedded in the PDF file and that only Type 1 or TrueType fonts are used. TeX and LaTeX users are strongly cautioned to ensure that their settings conform with the paper size, font size, margins etc., listed above. Do not include any digital signatures in the proposal document, NSPIRES cannot concatenate these PDF files with the cover page, total budget, etc. For more information on creating NSPIRES compliant PDF documents see http://nspires.nasaprs.com/tutorials/PDF_Guidelines.pdf. PDF files that do not meet NASA requirements cannot be ingested by the NSPIRES system; such files may be declared noncompliant and not submitted to peer review for evaluation.

There is a 20 MB size limit for proposals. **Added May 22, 2020: Proposers may not define acronyms in the S/T/M Section solely in a list outside of the page-limited S/T/M section. Acronyms must first be defined in the S/T/M Section.**

(iii) Table of Work Effort and Redaction of Salary, Fringe and Overhead Costs

Peer reviewers need to see the individual effort that will be spent on the project, whether at the proposing organization or not, whether NASA would be paying for it as a result of this proposal or not. Thus, every proposal must include a Table of Personnel and Work Effort that simply lists all of the planned work commitment, by person or role without any technical details. Note, this table is outside of and is distinct from the budget and the page-limited main part of the proposal and thus, unless otherwise stated in an individual program element, any person time listed in the table of work effort that is

Example Table of Personnel and Work Effort

Person and/or Role	Time charged to this proposal	Time not charged to this proposal	Total Time per person/year
PI, Rick Sanchez	3 months/year	N/A	3 months/year
Co-I, Morticia Smith	4 months/year	N/A	4 months/year
Co-I, Revolio Clockberg Jr.*	N/A	1.5 months/year	1.5 months/year
Collaborator, Daniella Harmon	N/A	*de minimis*	*de minimis*
Grad Student, Justin Roiland[o]	N/A	12 months/year	12 months/year

* A letter of support is provided from the foreign organization Herpson Polytecknic Universität for Prof. Revolio Clockberg Jr. participating at no cost to this proposal.

[o] The Graduate student from the Citadel is funded by a FINESST award and thus participating at no cost to this proposal.

offered at no cost by the proposing organization is assumed to be an estimate of anticipated additional effort that may be provided to the project as needed and is considered voluntary uncommitted effort. Descriptions of the work that each team member would be performing must be included in the main part of the proposal, not in this table. The example table shown above presumes a simple case for which all investigators are working the same amount of time on the project each year. The reality is often more complicated, and your table should reflect the best estimate of the amount of time each participant will spend on the project. Planetary Science Division Templates have been provided for those proposing to Appendix C, and Earth Science Division Templates for the Table of Work Effort (and Current and Pending Support) are now required for an increasing number of program elements in Appendix A. For example, as of the time of release of ROSES: A.7, A.8, A.14, A.17 A.26, A.38, and A.39.

Peer reviewers do not need to know salaries or overhead rates to evaluate the cost reasonableness of ROSES proposals. Thus, proposals should not include costs of salary, fringe, or overhead anywhere in the uploaded proposal PDF, including the budget detail or justification sections in the main proposal, which will be seen by peer reviewers. Unless otherwise specified by the program element, all proposers must include all costs, including salary, fringe and overhead of NASA civil servants, all subawards, and any separate Co-I awards in two places outside of the uploaded proposal PDF: the NSPIRES web page budgets and the separately uploaded "Total Budget" PDF file, see below and the walkthrough on this subject. Exceptions to this rule

include Phase-2 proposals for the astrophysics observing programs e.g., Neil Gehrels Swift Observatory Guest Investigator (D.5), Fermi Guest Investigator (D.6), NuSTAR Guest Observer (D.9), TESS Guest Investigator (D.10), and NICER Guest Observer (D.11) because those are cost-only proposals (essentially just budgets) that are not peer reviewed. See Section IV(b)(viii).

However, peer reviewers certainly do need to see the costs of everything other than salary, fringe, and overhead. Although quotes are not required, proposers are strongly encouraged to include both adequate budget detail and justification for the peer reviewers to evaluate whether costs of things (other than team members) are reasonable. For example, if a TDS3054C Tektronix Digital Oscilloscope that costs ~$17K is needed then the proposal must give this price in the detailed budget and, in the budget justification, explain why such an expensive oscilloscope is needed, when a simple one like a TBS1000 series can be purchased for one tenth the price.

In the budget justification in the main proposal PDF, proposers may refer to the time, but not costs, for a subaward that involves salary, fringe or overhead, e.g., "4 months/year are allocated for Co-I Morticia Smith, as can be seen in the Table of Personnel and Work Effort. Dr. Smith will be funded via a subaward to the Citadel. The total cost for that subaward is given in the NSPIRES cover page budget in Section F line 5 and is included in the separately uploaded Total Budget PDF file but is not included here in the proposal."

Almost all ROSES program elements are set up to allow proposers to fill out the NSPIRES web page budgets. These NSPIRES web page budgets are not required for Step-1 proposals. Unless otherwise specified in the ROSES program element, these NSPIRES web page budgets should include all costs, including salary, fringe and overhead of all participants. The full NSPIRES web page budgets will not be seen by peer reviewers. Where more than one organization is involved, the total cost for the Co-I organization is simply given as a single number in row 5, 8, or 9 of Section F (of the NSPIRES cover page budget). When funds are going to Co-I organizations funded directly by NASA, such as NASA centers and other government labs, then lines 8 or 9 should be used and customized. Row 10 in Section F is reserved for reporting any subaward that does not have any salary component. Proposers are strongly encouraged to read the FAQs with a walkthrough on this subject.

Almost all ROSES program elements are set up to allow Step-2 (full) proposers to separately upload a "Total Budget" PDF along with their proposal. Unless otherwise specified in the ROSES program element, all proposers are required to include this separate Total Budget PDF. The Total Budget should simply include the full and complete budget from your proposing organization and that of your Co-Is (in whatever is the standard form used by your organizations). This means that proposers need to get this information from their Co-Investigators whether or not they are Civil Servants. Budgets are generally laid out by project year but since NASA Civil Servant salaries must be charged to present fiscal year dollars, proposals that include NASA Civil Servant salaries may need to phase the funds for NASA Centers by fiscal year. The Total Budget PDF must lay out clearly how much is going to each organization, indicating whether the funds are passing through the proposing organization and which are not. Where the funds are passing through the proposing organization to a Co-I

organization, the Total Budget PDF must specify any overhead charged on funds passing through. Such charges never apply to funds sent directly to Co-I organizations such as NASA centers and other government labs. The Total Budget PDF is uploaded in exactly the same way that the proposal PDF is uploaded, but by choosing document type "Total Budget". This Total Budget file will not be seen by peer reviewers. These budget files are not required for Step-1 proposals.

NASA Civil Servant time must be included in the summary table of work effort and all costs for NASA civil servant investigators must be included in the budgets just as it would be for any other team member. In general, it is not anticipated that directed work to NASA Centers will overlap with work proposed via ROSES. However, any questions about whether NASA Civil Servant participation on a ROSES proposal is already covered by directed work and how to present this in a proposal budget should be directed to the appropriate Headquarters SMD division R&A Lead, a list of which may be found at https://science.nasa.gov/researchers/sara/program-officers-list/.

Proposers from JPL should not include the JPL award fee in the funds requested via ROSES, nor should the budgets of JPL Co-Investigators on proposals from other institutions include the JPL award fee in their budgets. JPL award fees are paid for and accounted for by a different mechanism than that used to fund awards from ROSES.

(iv) Submission of Proposals via NSPIRES, the NASA Proposal Data System

Proposals may be submitted electronically via NASA's Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES). In order to submit a proposal via NSPIRES, this NRA requires that the proposer register key data concerning the intended submission with NSPIRES at http://nspires.nasaprs.com. Potential applicants are urged to access this site well in advance of the Notice of Intent (NOI) and proposal due dates of interest to familiarize themselves with its structure and enter the requested identifier information. Potential PIs should ensure that their organization is also registered in NSPIRES, as it is only an official from the PI's registered organization, not the PI, who can submit a proposal.

It is especially important to note that every individual named on the proposal's electronic Cover Page form (see below) as a proposing team member in any role, including Co-investigators and collaborators, must be individually registered in NSPIRES and that such individuals must perform this registration themselves; no one may register a second party, even the PI of a proposal in which that person is committed to participate. It is also important to note that every named individual must be identified with the organization through which they are participating in the proposal, regardless of their place of permanent employment or preferred mailing address. This data site is secure and all information entered is strictly for NASA's use only.

Every individual identified on the NSPIRES proposal cover page as a team member must indicate their commitment to the proposed investigation through NSPIRES prior to proposal cover page submission. Team members must additionally confirm the organization through which they are participating on this proposal. A team member will receive an email from NSPIRES indicating that he/she has been added to the proposal and should log in to NSPIRES.

- Once logged in, the team member should follow the link in the "Reminders and Notifications" section of his NSPIRES homepage, titled "Need <role> confirmation for proposal <title> for Solicitation <<solicitation number>>". On the "Team Member Participation Confirmation" page, the proposal team member should read language about the Organizational Relationship, then click the "Continue" button.
- If the contact information then displayed on the "Team Member Profile" screen is out of date, the proposal team member should update this information later using the "Account Mgmt" link in the NSPIRES navigation bar across the top. Prior to making that update, however, the team member should follow the on-screen prompts to identify the organization through which he/she is participating on this proposal. Click the "Link Relationship" button to the right side of the "Organizational Relationship" banner. Select the organization from the "Link Proposal to an Association" part of the page. If the correct organization is not displayed here, try using the "Add Association" button to add the organization to this list. Then click the "Save" button at the bottom of the page. If the team member cannot find the organization when searching in the "Add Association" area (i.e., the organization is not registered), type in the formal name in the space provided (or select "Self," if appropriate). Once the organization is selected and the "Save" button is clicked, there is a confirmation page that allows the team member to edit that relationship if it was chosen incorrectly. Click "Continue".
- Note that the organization through which the proposal team member is participating in the proposal might not be the proposal team member's primary employer or primary mailing address. If the address information is accurate (or once it has been edited to be accurate), the proposal team member may log out of NSPIRES.
- NSPIRES will send an email to both the team member and the PI confirming that the commitment was made and the organization was identified. The PI may additionally monitor the status of proposal team member commitments by examining the "Relationship Confirmed" column on the Team Member page of the NSPIRES proposal cover page record. Note that the proposal cannot be submitted until all identified team members have confirmed their participating organizations.

All proposals submitted via NSPIRES in response to this NRA must include a required electronic Cover Page form that is accessed at http://nspires.nasaprs.com/. This form is composed of several distinct sections: a Cover Page that contains the identifier information for the proposing institution and personnel; a Proposal Summary that provides an overview of the proposed investigation that is suitable for release through a publicly accessible archive should the proposal be selected; Business Data that provides the proposed start and end dates, as well as other proposal characteristics; a Budget form that contains a budget summary of the proposed research effort; Program Specific Data that includes required questions specific to ROSES and that particular program element; and Proposal Team that provides the Co-Investigators and other participants in the proposal. This Cover Page form is available for access and submission well in advance of the proposal due dates given in Tables 2 and 3 of this NRA and remains open until the proposal due date for each program element. Unless specified in the program element description itself, no other forms are required for proposal submission via NSPIRES.

The proposer is responsible for assembling the complete proposal document for peer review. The required elements of any proposal submitted in response to this NRA must be submitted as a single, searchable, unlocked PDF document that contains the complete proposal, including the Science/Technical/Management section and budget justification, assembled in the order provided in Table 1 and uploaded as a single attachment. Unless otherwise specified in the program element the only permitted separate attachments are the HEC request, if any, see Section I(d), and the Total Budget file, see Section IV(b)(iii). Documents such as team member biographical sketches, letters of commitment, and current and pending support, as well as the proposal abstract (proposal summary) should not be uploaded to NSPIRES as separate files.

NSPIRES generates error and warning messages as part of the element check concerning possibly missing data. An error (designated by a red X) will preclude proposal submission to NASA by the AOR. A warning, indicated by an exclamation mark (!) on a yellow diamond, is an indication that data may be missing; a warning can be ignored after verifying that the material is included in the single attachment containing the complete proposal. Any actions taken because of warnings are at the PI's discretion.

Please do not download the Proposal Cover Page and incorporate it into the Proposal Document. NSPIRES automatically routes the parts of the proposal (Cover Page form, proposal document, and any HEC appendix, but not the Total Budget file) to the reviewers.

Proposers are encouraged to begin their submission process early. Tutorials and other NSPIRES help topics may be accessed through the NSPIRES online help site at http://nspires.nasaprs.com/external/help.do. For any questions that cannot be resolved with the available online help menus, requests for assistance may be directed by email to nspires-help@nasaprs.com or by telephone to (202) 479-9376, Monday through Friday, , excluding Federal Holidays, 8:00 a.m. – 6:00 p.m. Eastern Time.

(v) Submission of Proposals via Grants.gov

Grants.gov may be used in place of NSPIRES to submit proposals in response to almost all program elements this ROSES NRA. Grants.gov is now using the Workspace environment. Grants.gov requires that the PI use Workspace for either online completion of forms or downloading of forms for completion offline, in addition to downloading an instruction package from Grants.gov. Identifying the appropriate application package requires the funding opportunity number for that program element; the Grants.gov funding opportunity number may be found in the Summary of Key Information table at the end of each program element. That number will be of the form NNH20ZDA001N-XXXX where the "XXXX" will be an abbreviation for that program, e.g., NNH20ZDA001N-HSR for Heliophysics Supporting Research. Proposals submitted via Grants.gov must be submitted by the AOR.

Submitting a proposal via Grants.gov requires at least the following:

a. Grant researchers (PIs) do not need to register with Grants.gov. However, every individual named in the proposal as a proposing team member in any role, including PI, Co-Investigators, and collaborators, as well as the PI’s organization,

must be registered in NSPIRES (http://nspires.nasaprs.com) and such individuals must perform this registration themselves; no one may register a second party, even the PI of a proposal in which that person is committed to participate. This NSPIRES site is secure and all information entered is strictly for NASA's use only.

b. Follow Grants.gov instructions provided at the website to download any software tools or applications required to submit via Grants.gov.
c. Preview the application package from Grants.gov for either online completion or downloading for completion offline by selecting "Preview" under "Package" for the specific Funding Opportunity at http://www.grants.gov. Each program element described in an appendix of ROSES requires a different application package and has a different Funding Opportunity Number; the Funding Opportunity Number may be found in the Summary of Key Information at the end of the program element description in each appendix of ROSES. Enter the appropriate Funding Opportunity Number to retrieve the desired application package. All ROSES application packages may be found by searching on CFDA Number 43.001.
d. Note that Grants.gov proposers must additionally download the "Instructions" zip file, as this includes a proposal summary form and the Program Specific Data form that contains the mandatory data management plan as well as important questions about, for example, China and ITAR.
e. When ready to apply, click "Apply" to create, complete, and submit a Workspace. Completing a workspace allows proposers to complete all the required forms online or download PDF versions to be uploaded later.
f. Complete the required Grants.gov forms, including the Standard Form 424 Application for Federal Assistance, research and research-related (R&R) Other Project Information, R&R Senior/Key Person Profile, and R&R Budget. Every named individual must be identified with the organization through which they are participating in the proposal, regardless of their place of permanent employment or preferred mailing address.
g. Complete the required NASA specific forms including NASA Other Project Information, NASA PI and Authorized Representative Supplemental Data Sheet, and NASA Senior/Key Person Supplemental Data Sheet (this form is only required if there are Senior/Key Persons other than the PI).
h. Complete any NASA program-specific form that is required for the specific program element. This form, which is usually required for all ROSES program element submissions, is included as a PDF form within the proposal instruction package downloaded from Grants.gov. The form, once completed, is attached to the NASA Other Project Information form.
i. Create a proposal in PDF, including the Science/Technical/Management section and all other required proposal sections (see the *NASA Guidebook for Proposers*). Attach sections as separate PDF documents as prompted by Grants.gov. Do not duplicate materials; if a document must be provided as a separate attachment, do not also include it as part of the proposal narrative PDF file. Even though Grants.gov permits the attachment of non-PDF documents, NASA requires that all attached documents be PDF files, which conform to the specifications outlined in Section IV (b)(ii) above. Be sure to include a separate "Total Budget" PDF file and, if relevant, a separate "HEC Request" PDF file.

j. Because Grants.gov does not support the electronic commitment of team members, statements of commitment from all team members must be provided as letters attached to the proposal application at the place(s) specified by Grants.gov. This statement must include confirmation of both the team member role in the proposed effort (e.g., Co-Investigator, collaborator) and the identification of the organization through which the team member will be participating.

k. Here is an example of a statement of commitment: "I acknowledge that I am identified by name as <<role>> to the investigation, entitled <<name of proposal>>, that is submitted by <<name of Principal Investigator>> to the NASA Research Announcement <<alpha-numeric identifier>>, and that I intend to carry out all responsibilities identified for me in this proposal. I understand that the extent and justification of my participation as stated in this proposal will be considered during peer review in determining in part the merits of this proposal. I have read the entire proposal, including the management plan and budget, and I agree that the proposal correctly describes my commitment to the proposed investigation. For the purposes of conducting work for this investigation, my participating organization is <<insert name of organization>>."

l. Submit the proposal via the Authorized Organization Representative (AOR); the PI may not submit the application to Grants.gov unless he/she is an AOR.

m. Within a few days of submitting the proposal to Grants.gov, the PI and AOR should receive an email verifying submission of the proposal to the NSPIRES system, for review. Any proposer not receiving such a verification should contact the NSPIRES Help Desk.

Potential applicants are urged to access Grants.gov site well in advance of the proposal due date(s) of interest to familiarize themselves with its structure and download the appropriate application packages and tools.

Potential applicants considering employing Grants.gov should pay special attention to program elements that require a Notice of Intent, as Grants.gov does not provide the capability to submit an NOI. See Section IV(b)vi, below.

Additional instructions for formatting and submitting proposals via Grants.gov may be found in the *NASA Guidebook for Proposers*. Instructions for the use of Grants.gov may be found at https://www.grants.gov/web/grants/applicants/workspace-overview.html. Instructions for NASA-specific forms and NASA program-specific forms may be found in the application instructions package. For any questions that cannot be resolved with the available online help menus and documentation, requests for assistance may be directed by email to support@grants.gov or by telephone to (800) 518-4726 twenty-four hours a day, seven days a week, except Federal holidays when the support center is closed.

(vi) Notice of Intent to Propose

The Notice of Intent (NOI) to propose is a brief summary of the planned work by the prospective PI. Such statements are of used to identify expertise needed for the review panel and to avoid inviting panelists who are planning to propose. Where NOIs are used - most of the program elements in Earth Science (Appendix A) and Astrophysics (Appendix D) - they are usually requested, but not required, for the submission of

proposals. However, for some program elements an NOI is not requested e.g., Neil Gehrels Swift, Fermi and TESS Guest Investigator programs and those with rolling submissions such as Rapid Response and Novel Research in Earth Science, and Topical Workshops, Symposia, and Conferences. For other programs, e.g., D.3 APRA, and D.7 SAT, an NOI is a required prerequisite for submission of a full proposal. For those program elements where the NOI is mandatory, this will be stated clearly in the program element and NOI due dates will be marked "mandatory" in the Tables of due dates. NOIs may be submitted via NSPIRES directly by the PI by 11:59 p.m. Eastern Time on the due date given in Tables 2 and 3 of this NRA; no action by an organization's AOR is required to submit an NOI.

Grants.gov does not provide NOI capability; therefore, when required (or requested) by a program element, NOIs must (or should) be submitted via NSPIRES, whether or not the proposal will be submitted via NSPIRES or Grants.gov. Interested proposers must register with NSPIRES before it can be accessed for use. NSPIRES is open for the submission of NOIs for typically 30 days, starting about 90 days in advance of the due date for the proposals themselves. When NOIs are requested but not required, late NOIs may be submitted by email to the main point of contact given in the Summary Table of Key Information at the end of the individual program element.

(vii) The Two-Step Proposal Process

Some ROSES program elements require that proposals be submitted using a two-step process in which the NOI is replaced by a required Step-1 proposal. This Step-1 proposal is an abbreviated presentation of the intended research and, as a proposal, it must be submitted by the Step-1 due date given in Tables 2 and 3 of this NRA by the organization Authorized Organizational Representative (AOR). The Step-1 proposal is a prerequisite for submission of a full Step-2 proposal, but it does not obligate the offerors to submit a Step-2 (full) proposal later.

For some program elements, the purpose of the Step-1 proposal is simply to avoid conflicts in the assembly of the review panel and no response will be provided to proposers. For other program elements, the Step-1 proposal may be evaluated to determine if the anticipated research project exhibits sufficient programmatic relevance and responsiveness to the program element to permit or encourage submission of a full Step-2 proposal. The two-step process can be structured in two ways: 1) Nonbinding two-step process in which a Step-2 proposal may be submitted even if the preceding Step-1 was discouraged or 2) A binding two-step process in which a Step-2 proposal cannot be submitted if it is not "invited" after the evaluation of the preceding Step-1. In any case those who submitted Step-1 proposals will be informed no later than four weeks prior to the Step-2 due date whether they are, or are not, "encouraged" or "invited" to submit a full Step-2 proposal.

The required Step-1 proposal is typically just the contents of the 4000-character limited Proposal Summary field in the cover pages but rarely may require a PDF document upload. In such cases the permitted page length and required contents for the Step-1 proposal will be specified in the program element description. In some cases (e.g., Appendix C, Planetary Science), the team may be adjusted between the Step-1 and Step-2 proposal, but in other cases (e.g., Appendix B, Heliophysics), changes to the

team are limited. When a Step-2 proposal is created, the team members and their confirmation are carried forward from the Step-1 automatically. However, if a Step-1 team member has changed organizations since confirmation on the Step-1 proposals, this could prevent the submission of the Step-2 proposal. When a confirmed Step-1 team member has changed organizations, the proposer must instruct the team member to update his or her participation confirmation in NSPIRES for the Step-2 proposal and inform the NASA POC immediately.

Please read the program element carefully. Budget data will not be requested as part of the Step-1 proposal. Unlike a Notice of Intent, which may be submitted by an individual, the Step-1 proposal must be submitted by an Authorized Organizational Representative of the proposing organization. Step-2 proposals are to be submitted in full compliance with the *NASA Guidebook for Proposers* discussed in Section IV(a) above. Proposers are encouraged to read the instructions document on Submitting Step-1 proposals that appears under "Other Documents" on the NSPIRES web page of any program element that requires a Step-1 proposal.

The tables of due dates clearly indicate which program elements require a Step-1 proposal. At the time of release of this ROSES-2020 NRA, the program elements that solicit proposals using a two-step process include: most of the Heliophysics program elements (Appendix B), most program elements in Planetary Science (Appendix C), and the cross-division program elements E.3 Exoplanets Research and E.4 Habitable Worlds.

(viii) The Two-Phase Proposal Process

On occasion, NASA will solicit proposals using a two-phase proposal process for which Phase-1 is a request for an observation to be performed by a NASA space observatory as part of a NASA guest investigator/guest observer program element. Phase-2 is a proposal only for funding from NASA that is not peer reviewed. As such the Phase-2 proposals are not subject to the requirements in Section IV(b)iii to omit salary, fringe and overhead. An NOI may or may not be requested, and the Phase-1 observing request must be submitted to the observatory web page by the proposal due date in Tables 2 and 3 of this NRA. Note the time and mode of proposal submission.

This ROSES NRA contains a number of guest investigator/guest observer program elements in Astrophysics that use the two-phase proposal process: Neil Gehrels Swift Observatory Guest Investigator (D.5), Fermi Guest Investigator (D.6), NuSTAR Guest Observer (D.9), the TESS Guest Investigator Program (D.10), and NICER Guest Observer (D.11).

Phase-1 observing requests for these programs cannot be submitted via either NSPIRES or Grants.gov. They must be submitted via the URL given in the Summary Table of Key Information given at the end of program element description. The Phase-2 proposal for funding must be submitted via NSPIRES by a proposal due date that will be announced when NASA announces the disposition of the Phase-1 observing requests. The process and requirements for the submission of Phase-1 observing requests and Phase-2 proposals may differ for each program element; proposers should read carefully the relevant program element Appendix to this ROSES NRA. The tables of due dates clearly indicate which program elements require a Phase-1 proposal.

(c) Proposal Submission Due Dates and Deadlines

For each program element, the electronic proposal must be submitted in its entirety by an Authorized Organizational Representative (AOR) no later than the proposal deadline (time) on the appropriate proposal due date given in Tables 2 and 3 of this NRA. Unless stated otherwise in the program element (e.g., Phase-1 proposals in Astrophysics), the proposal deadline is 11:59 p.m. Eastern Time and must be submitted electronically using either NSPIRES or Grants.gov (see Sections IV(b)(i–iii) above).

Proposals (including Step-1 proposals) submitted after the proposal due date and deadline will be labeled "late" by the NSPIRES system and they (and mandatory NOIs) will be handled in accordance with the SMD Policy on Late Proposals. The vast majority of proposals received after the due date are rejected without review. If a late proposal is rejected, it is entirely at the discretion of the proposer whether or not to resubmit it in response to a subsequent appropriate solicitation.

(d) Proposal Funding Restrictions

In addition to the funding restrictions and requirements given in the *NASA Guidebook for Proposers* and the GCAM, the following restrictions are applicable to this ROSES NRA:

- The estimated funding and number of proposals anticipated to be funded, as shown in the Summary of Key Information at the end of each program element, are subject to the availability of appropriated funds, as well as the submission of a sufficient number of proposals of adequate merit.
- Unless specifically noted otherwise in the specific ROSES Appendix and/or program element, the proposing PI organization are expected to subaward funding for all proposed Co-Is at non-Government organizations, even though this may result in a higher proposal cost because of subawarding fees. Rare exceptions will be considered on a case by case basis when requested in the proposal and found to be in the interest of the Government and consistent with appropriate law, regulation, policy, and practice.
- Unless otherwise noted in a program element, SMD will send funds directly to Co-Is at NASA Centers and other U.S. Government organizations, including JPL. Thus, if a proposal submitted by a university has a Government Co-I, the funds will not pass through the university, so the university (or other institution that receives a grant) may not include overhead or any other pass through charges on those funds. Funds for Co-Is who do not work for the Government would pass through the university and those charges may be applied. Regardless of whether a Co-I will be funded through a subaward via the proposing institution or funded directly by NASA, the cover page budget for the proposal must include all funding requested from NASA for the proposed investigation, including salaries for NASA civil servants, see Section IV(b)iii. Time for Co-Is, costs of procurements (not labor or overhead), and other (non-salary) direct costs (e.g. technical support costs for on-site contractors) at NASA Centers and other U.S. Government organizations must be justified in the proposal's Budget Narrative. No indirect burden from non-governmental organizations should be applied to funds for Co-Is at NASA Centers and other U.S. Government organizations. (See the *NASA Guidebook for Proposers*).

- For most awards (e.g., non-contract awards), allowable costs are governed by 2 CFR Part 200. All proposed costs, including matching or cost sharing, must be allowable, allocable, and reasonable. Funds may only be used for the project. Unless otherwise directed in 2 CFR 200, for changes to the negotiated indirect cost rate that occur throughout the project period, you must apply the rate negotiated for that year, whether higher or lower than at the time of the initial award. All activities charged under indirect costs must be allowed under the cost principles in 2 CFR Part 200. In general, the construction of facilities is not an allowed activity for any of the program elements solicited in this NRA. As described in the GCAM Section 4 (Limitations), facilities are different and distinct from equipment, which may be an allowable expense.
- Computers are allowable under grants if they are essential for the project. It is no longer required that computers be used exclusively for the project. See ROSES FAQ #27 for more information on this topic.
- Travel, including foreign travel, is allowed as may be necessary for the meaningful completion of the proposed investigation, as well as for publicizing its results at appropriate professional meetings. Proposers from NASA Centers should consult the latest NASA policy document regarding restrictions on travel funding. Note that selection of a proposal and approval of a proposed budget that includes travel for civil servants does not guarantee that a NASA Center has sufficient travel authority to approve the proposed travel under NASA's reduced travel budget.
- In general, proposals for sponsorship of topical conferences, workshops, consortia, or symposia meeting certain criteria are solicited through the ROSES program element E.2 Topical Workshops, Symposia, and Conferences.
- Regardless of whether a conference is sponsored by NASA, individual conference travel by grantees is permitted and proposers from universities, or other eligible non-governmental institutions, may include a budget for travel to conferences and workshops. Proposers from NASA Centers should consult their Center implementing policy on the latest NASA guidance on conference spending and reporting requirements. Note that selection of a proposal and approval of a proposed budget that includes travel for civil servant does not guarantee that a NASA Center has sufficient travel authority under NASA's reduced travel budget to approve the proposed travel.
- Profit for commercial organizations is not allowable under grant or cooperative agreement awards, but is allowable under contract awards. Costs for managing the project may be allowed under a grant. These costs, whether direct charges or part of the indirect cost agreement, must be consistent with 2 CFR 200 Subpart E.
- NASA funding may not be used for subcontracted foreign research efforts. U.S. research award recipients may directly purchase supplies and/or services from non-U.S. sources that do not constitute research, but award funds may not be used to fund research carried out by non-U.S. organizations. However, a foreign national may receive remuneration through a NASA award for the conduct of research while employed either full- or part-time by a U.S. organization. Special restrictions apply to collaboration with China, see Section III(c).

- Travel by a participant in the research investigation, whether for the purpose of conducting the research, for collaboration, or for attending a conference, is considered to be a research expense. NASA conducts its collaborations with foreign institutions on a no exchange of funds basis. NASA funding may not be used for research efforts by foreign organizations at any level. Therefore, NASA funding may not be used for travel expenses by any team member who is not participating as a member of a U.S. organization.
- As noted in the *NASA Guidebook for Proposers*, costs of preparing, publishing, and disseminating the results of NASA funded research (e.g., page charges, open access fees, etc.) may be included in research proposals and are allowable charges against the grant, as long as the charges are levied impartially on all research papers published by the journal.
- Non-NASA U.S. Government organizations should propose based on full-cost accounting, unless no such standards are in effect; in that case such proposers should follow the Managerial Cost Accounting Standards for the Federal Government as recommended by the Federal Accounting Standards Advisory Board. NSPIRES cover pages and uploaded "Total" budgets must include all costs that will be paid out of the resulting award.
- Regardless of whether functioning as a team lead or as a team member, personnel from NASA Centers must propose budgets consistent with the current NASA accounting implementation for the requested year of performance. All NSPIRES cover page budgets must include all costs that will be paid out of the resulting award, including costs of NASA civil servants. Costs that will not be paid out of the resulting award, but are paid from a separate NASA budget (e.g., center management and overhead; CM&O) and are not based on the success of this specific proposal, should not be included in the proposal budget. For example, CM&O should not be included in the proposal budget while other direct charges (including procurements and labor) to the proposed research task should be included. NASA civil servant Co-Is must provide to the proposing organization all costs requested of the ROSES program, so that the proposing organization may correctly complete the cover page budgets in NSPIRES.

V. SUBORBITAL-CLASS INVESTIGATIONS

(a) Overview of Suborbital-Class Platforms

In each SMD Research Program (Earth Science, Heliophysics, Planetary Science, Astrophysics), flight investigations are solicited. Flight investigations solicited through ROSES generally have modest costs and reduced mission assurance requirements appropriate for the specific research program, and these investigations are referred to as suborbital-class investigations. Platforms for flight investigations include aircraft, balloons, sounding rockets, suborbital reusable launch vehicles, SmallSats/CubeSats,b and small International Space Station (ISS) payloads. General requirements for proposals to use any of these platforms (except aircraft, see below) are discussed in this section of ROSES.

Requirements for proposals using aircraft are discussed in the description of the Earth Science Research Program found in Appendix A. Moreover, the Aircraft Management Division (AMD https://ad.hq.nasa.gov/) provides capability leadership, oversight, and coordination of NASA's aviation assets, including Uncrewed Aircraft Systems (UAS). AMD coordinates functional reviews to ensure high standards of aviation safety and manages NASA's aircraft capability based on mission requirements. Proposals that include flight activities (not normal passenger travel) such as aircraft or helicopter flight services, including Uncrewed Aircraft Systems (UAS)/Drones operations or the acquisition or construction of such flight vehicles, must comply with NASA Policy Directive 7900.4. Questions concerning flight compliance requirements may be addressed to Norman Schweizer at norman.s.schweizer@nasa.gov.

Generally, proposals for investigations that are carried out through development, launch, and operation of a short duration orbital experiment, such as one on a CubeSat or ISS-based project, are permitted in any ROSES program element that solicits investigations for use on suborbital-class platforms. In this sense, a CubeSat or an ISS-based investigation is a "suborbital class" investigation, even though it will be placed into orbit. CubeSat or ISS-based "suborbital class" investigations are subject to the same cost constraints to which traditional suborbital investigations are subject.

Proposals for life and microgravity science investigations are not solicited through ROSES. Life and microgravity science investigations are solicited by the Human Exploration and Operations Mission Directorate. For further information, refer to the current "ROSBio" solicitation on NSPIRES.

(b) General Guidelines for Suborbital-Class Investigation Proposals

ROSES awards support science investigations and/or technology development utilizing payloads flown on suborbital-class platforms, or as flights of opportunity. Suborbital-class payloads may be recovered, refurbished, and reflown, in order to complete an investigation. A discussion of the plans for management and for reduction and analysis of the data must be given in the proposal. Although most awards are three or four years in duration, a five-year proposal may be accepted to develop a completely new, highly meritorious investigation through its first flight. Please read the individual ROSES program element for program specific requirements.

Budgets are expected to cover complete investigations, including payload development and construction, instrument calibration, launch, data analysis, and publication of results. The number of investigations that can be supported is limited and heavily dependent on the funds available to the relevant research program. Note that NASA does not carry reserves for Suborbital-Class Investigations and proposers should not expect NASA to accommodate any cost overrun incurred by a particular investigation, including the damage and/or loss of the payload owing to a suborbital- class platform system failure. Therefore, failure to achieve the proposed goals within the proposed time and budget could require descoping the initially proposed investigation, delaying it, canceling a particular launch date opportunity, or canceling the investigation altogether. Unlike most other ROSES investigations where the proposing PI organization must subcontract funding to non-Government investigators, funding for suborbital-class investigations will sometimes be split into multiple awards. Please read the individual

ROSES Appendix and consult with the POC.

(c) Points of Contact for Suborbital-Class Platforms

NASA provides some limited avenues for procurement of suborbital launch vehicle services, including: sounding rockets provided by the NASA Sounding Rockets Program Office (SRPO) at the NASA Goddard Space Flight Center/Wallops Flight Facility (NASA/GSFC/WFF), balloons provided by the NASA Balloon Program Office (BPO) at the NASA/GSFC/WFF, and suborbital reusable launch vehicle (sRLV) services provided by the NASA Space Technology Mission Directorate's (STMD) Flight Opportunities Program (FOP). SMD also solicits investigations as CubeSats and as small International Space Station payloads. Regardless of which launch vehicle service is anticipated, all prospective PIs are required to demonstrate the capacity, availability, and commitment of the suborbital-class platform to support their investigation. PIs are strongly urged to discuss prospective investigations with NASA program personnel (see below) prior to submitting their proposal to ensure that probable operational costs are properly anticipated.

(i) NASA-provided Sounding Rocket Services

Information on the capabilities of currently available sounding rocket vehicles is available at http://sites.wff.nasa.gov/code810/vehicles.html. Proposers are encouraged to consider these capabilities in designing their investigations, but the Sounding Rockets Program Office (SRPO) has the final authority in the choice of which vehicle is to be used.

The nominal U.S. launch sites for sounding rockets are White Sands Missile Range (WSMR) in New Mexico, Wallops Island in Virginia, Poker Flat Rocket Range (PFRR) in Alaska, and Reagan Test Site (RTS) in the Kwajalein Atoll. The SRPO also conducts launches from the established non-U.S. launch sites at Andoya, Norway; Kiruna, Sweden (Esrange); or Australia; subject to science community requirements and the availability of SRPO operations funding to conduct the campaign.

Investigators proposing payloads to be flown on sounding rockets should answer the program-specific questions on the NSPIRES proposal cover pages. This information is needed by the SRPO to generate a rough order of magnitude cost estimate for the operational requirements associated with a proposed investigation and is used for planning purposes. The required information includes the envisioned vehicle type, payload mass, trajectory requirements, launch site, telemetry requirements, attitude control, or pointing requirements, and any plans for payload recovery and reuse. Investigators proposing sounding rocket payloads should contact the SRPO to obtain technical information related to SRPO launch vehicle capabilities, services, and the latest planned campaign schedules. Questions concerning sounding rockets may be addressed to:

Giovanni Rosanova
Sounding Rockets Program Office
Code 810
GSFC/Wallops Flight Facility
National Aeronautics and Space Administration

Wallops Island, VA 23337
Telephone: (757) 824-2202
Email: giovanni.rosanova@nasa.gov

(ii) NASA-provided Balloon Services

Information on the capabilities of current available balloon vehicles is available at http://sites.wff.nasa.gov/code820/operations.html and at http://www.csbf.nasa.gov/balloons.html. Proposers are encouraged to consider these capabilities in designing their investigations, but the Balloon Program Office (BPO) has the final authority in the choice of which vehicles to be used.

The nominal U.S. launch sites for Balloons are Fort Sumner, New Mexico, and at the Columbia Scientific Balloon Facility in Palestine, Texas. The BPO also conducts launches from established non-U.S. launch sites at McMurdo, Antarctica; Alice Springs, Australia; Kiruna, Sweden (Esrange); or Wanaka, New Zealand, subject to science community requirements and the availability of BPO operations funding to conduct the campaign.

Proposers needing investigation unique engineering, flight support systems, and/or technical support services from NASA, such as the Wallops Arc-Second Pointing System (WASP), should contact the BPO directly for an estimate of the Government Furnished Equipment (GFE) cost of the desired support.

Investigators proposing balloon payloads should contact the BPO to obtain technical information related to BPO balloon capabilities, services, and the latest planned campaign schedules.
Questions concerning balloons may be addressed to:

Debora Fairbrother
Balloon Program Office
Code 820, GSFC/Wallops Flight Facility
National Aeronautics and Space Administration
Wallops Island, VA 23337
Telephone: (757) 824-1453
Email: debora.a.fairbrother@nasa.gov

(iii) Suborbital Reusable Launch Vehicles

Suborbital Reusable Launch Vehicles (sRLV) offer newly developed commercial capabilities for the conduct of NASA scientific research and technology advancement.

Proposals to ROSES program elements using sRLVs as platforms must be for complete investigations and must describe a complete suborbital science investigation, including payload construction, vehicle integration, launch and flight operations, data analysis, and publication of results. Proposers interested in using sRLVs as platforms to conduct an Earth or space science investigation must identify a vehicle that can provide the technical capabilities that are required to conduct the proposed investigation.

Proposals using sRLVs as platforms must specify the technical requirements that their investigation places on the vehicle. Proposals for investigations using sRLVs as platforms must provide a description of the instrument; its current status; a clear

assessment of what it will take to develop, modify, and integrate the instrument onto the sRLV; and include a plan to provide calibrated, research grade data.

SMD will conduct an sRLV continuing investigation review (CIR) for all sRLV-based projects. The CIR will take place following maturity of the sRLV-based project to the equivalent of a Phase A concept study report or a systems requirement review. A proposal for a sRLV-based project must describe the proposed schedule for CIR and the proposed funding required to reach CIR.

The CIR will include payload description, flight performance assessment, proposed payload configuration and interfaces, mission success criteria, requirements matrix, operational requirements, launch vehicle, and project schedule. Once the sRLV-based project reaches that level of design maturity, the CIR will be held at NASA Headquarters. The SMD Associate Administrator (or designee) is the decision authority for approval to proceed beyond the CIR. It is expected that sRLV-based projects will spend no more than approximately $100K prior to CIR approval.

Proposals for sRLV-based investigations must be submitted to the appropriate ROSES program element, depending on the science to be addressed by the proposed investigation. The proposed sRLV-based investigation must meet the constraints of the program element to which it is being proposed. This explicitly includes any constraints on the areas of science that are solicited, on the available funding, and on the requirement for a complete science investigation.

In addition to the normal evaluation factors specified in Section VI(a) and the *NASA Guidebook for Proposers*, evaluation of the intrinsic merit of sRLV-based proposals shall include the following additional factors:

- The extent that the proposed sRLV offers an advantage (e.g., scientific, technical, or cost) over other suborbital-class platforms (including sounding rockets, balloons, and aircraft);
- The likelihood that the proposed vehicle will be available at the proposed time for flight and that it will be capable of providing the required technical capabilities;
- The feasibility of the proposed technical investigation, including the concept for conduct of the experiment during the suborbital flight and the plans for calibrating and analyzing the data obtained to accomplish the proposed science objectives; and
- The quality of the plans for completing the preliminary design prior to the investigation confirmation review.

The cost to SMD for the flight and all other services provided by the sRLV vendor must be clearly stated in the proposal, included in the NSPIRES cover page budget (in Section F, line 10 labeled appropriately), and also in the separately uploaded "Total Budget" PDF. See Section IV(b)iii for information about the requirements for the separately uploaded "Total Budget" PDF.

In addition to the factors specified in the *Guidebook*, the evaluation of cost reasonableness of a proposal shall include:

- The affordability to SMD of the proposed vehicle vendor cost for the flight and other required services.

Proposers from Government Laboratories and NASA Centers (including JPL), but not others, may avail themselves of STMD's Flight Opportunities Program (FOP) contracts to sRLV flight service providers. Information on sRLV vehicles, including general vehicle capabilities and contact information for some vendors, is available at https://www.nasa.gov/directorates/spacetech/flightopportunities/flightproviders. The FOP will not sponsor participants to fly on suborbital reusable launch vehicles. The payloads to be flown on FOP-contracted sRLV flights must either be automated or remotely operated. The remote operation capability should be confirmed with the flight operator. For payloads to be flown on FOP contracted sRLV flights, the flight and all other services provided by the sRLV vendor will be procured directly by the FOP rather than through the award. FOP does not currently have a contract to provide parabolic flight.

Investigators proposing FOP-contracted sRLV flight service payloads are strongly urged to discuss prospective investigations with operations personnel in the Flight Opportunities Program and/or a potential vendor to ensure that probable integration, safety and mission assurance, and operational costs are properly anticipated.

All proposals from non-governmental organizations, and in addition any government proposers who choose not to use STMD's Flight Opportunities Program (FOP) contracts to sRLV flight service providers, must include a Letter of Endorsement from a commercial vendor that (i) describes how that vendor's vehicle will meet the investigation requirements and provides technical information on how the vehicle will meet the investigation requirements, (ii) states that the vehicle will be available for use at the time proposed for flight and provides information showing a plan for getting from the current vehicle status to flight status, and (iii) provides a quoted cost for the flight and all other services that are required from the vehicle vendor to enable and conduct the proposed investigation.

Questions concerning potential sRLV investigations may be addressed to:

Paul De León
Flight Opportunities Campaign Manager
Mail Stop 213-13
NASA Ames Research Center
Moffett Field, CA 94035
(650) 604-0275
paul.deleon@nasa.gov

(iv) Research Investigations utilizing the International Space Station

NASA has determined that there may be payload opportunities for small, suborbital-class space and Earth science research investigations, including both science and technology development, that utilize the International Space Station (ISS). Available external attach points include both zenith and nadir pointing locations and internal attach points include nadir pointing locations. NASA has available regular external launch opportunities and opportunities to launch pressurized (internal) cargo for use in the Window Observational Research Facility (WORF). Information on opportunities and

constraints for ISS attached payloads may be found at http://www.nasa.gov/mission_pages/station/research/research_information.html.

Proposals seeking use of the ISS must take advantage of the Station's unique capabilities. Proposals must include a clear and convincing scientific and/or technical argument that use of the ISS is required to produce the needed results in ways that could not be accomplished through the use of other platforms. Investigations that make use of the ISS may be proposed for periods of performance of up to five years.

Proposers interested in using the ISS to conduct an Earth or space science investigation must identify a specific accommodation location that can provide the technical capabilities required to conduct the proposed investigation. The proposal must include a letter of feasibility from the ISS Research Integration Office that must contain: (1) a preliminary assessment of the feasibility of the proposed concept and requirements for access to and accommodation on the Space Station, (2) identification of any significant challenges or conditional provisions for access and accommodation, and (3) a description of the level of technical interchange or negotiation required to mature the proposed concept for access and accommodation on ISS. Transportation and accommodation will be provided by NASA at no cost to the proposed research investigation, and costs for transportation to and accommodation on the ISS should not be included in the proposed budget. However, the PI's cost for all accommodation, safety, and other reviews that are conducted and supported by the PI must be included in the PI's proposed investigation budget. It can take the ISS Research Integration Office several weeks to prepare the letter of feasibility.

In addition to proposal requirements specified in the appropriate ROSES program element, proposals for investigations utilizing the ISS must provide a description of the instrument; its current status; a clear assessment of what it will take to develop, modify, and integrate the instrument onto the ISS; and include a plan to provide calibrated, research grade data in SI traceable units. Proposals must be for complete investigations that include payload development**,** construction, ISS integration, launch and flight operations, data analysis, and publication of results.

The ISS Research Integration Office will provide integration services, launch services, on-orbit operations and services, as well as safety and mission assurance reviews for all ISS investigations.

There is no one special due date for investigations for the ISS; rather, proposals must be submitted to the appropriate ROSES program element depending upon the science addressed by the proposed investigation. The proposed investigation must meet the constraints of the program element to which it is being proposed. This explicitly includes any constraints on the areas of science that are solicited, on the available funding, and on the requirement for a complete science investigation.

Investigations proposed for the ISS will be approved for the first year only. During the first year, in addition to beginning the proposed investigation, a detailed transportation and accommodation study will be undertaken with the ISS Research Integration Office. Approval for continued funding beyond the first year will be contingent on the ISS Program making a firm commitment for transportation and accommodation on the ISS that is compatible with the requirements of the proposed investigation.

All proposals will be evaluated with respect to the criteria specified in the *NASA Guidebook for Proposers*. In addition to the factors specified in the *Guidebook*, the intrinsic merit of a proposal shall include the following additional factors:

- The extent that the advantages (e.g., scientific, technical, or cost) of the International Space Station's capabilities and location will be utilized; and
- The feasibility of the proposed technical investigation, including the on-orbit operations concept and the plans for calibrating and analyzing the data obtained to accomplish the proposed science objectives.

External accommodations for payloads include Express Logistics Carriers (ELCs), the Japanese Experiment Module-Exposed Facility (JEM-EF), and the Columbus Orbiting Facility-Exposed Facility (COF-EF). Internal accommodations are also available in the pressurized environment via the Window Observational Research Facility (WORF). More detailed information can be found at www.nasa.gov/stationfacilities.

Attached payloads must be certified for transportation and use in a human tended vehicle. External payloads would be required to complete preliminary design review (PDR) approximately 36 months before launch, critical design review (CDR) approximately 24 months before launch, and be delivered for certification and integration approximately nine months before launch. Pressurized cargo for the WORF would be required to complete PDR approximately 12 months before launch, CDR approximately nine months before launch, and be delivered for certification and integration approximately four months before launch.

Investigators proposing ISS payloads are required to contact the ISS Research Integration Office to begin the technical discussion needed in order to start the ISS technical requirements interface and resource utilization feasibility and accommodation assessment. It is only after such feasibility assessment is performed by the ISS Research Integration Office that a signed feasibility letter will be issued to the investigator. The signed ISS feasibility letter must be submitted with any proposal requesting the use of ISS as a science platform to perform any experiment.

For ISS Program accommodation support please contact both of these points of contact from the ISS Program's Research Office **[Updated, July 6, 2020]**

Name	email	Telephone
Steve Huning	**steven.w.huning@nasa.gov**	**(281) 244-8043**
Pete Hasbrook	**Pete.Hasbrook@nasa.gov**	**(281) 483-0768**

(v) Use of Short Duration Orbital Platforms, including CubeSats

Short duration (<2 years, in orbit) orbital platforms, including any ISS mounted payload that is retrievable and returned to Earth, ISS CubeSat deployments, and CubeSats generally have historically been used as teaching tools and technology demonstrations, and offer newly developed capabilities for the conduct of NASA scientific research and technology advancement. CubeSats may be built as a single unit (1U), weighing less than 1.33 kg, or combined in units of two, three, six (2x1x3 form factor) and, where allowed (e.g., D.3 APRA), twelve (2x2x3 form factor). Proposers contemplating six or twelve U are strongly encouraged to communicate with the point of contact for the

ROSES program element to which they plan to propose to verify that those are solicited and that the costs can be accommodated.

Proposals for science investigations utilizing short duration orbital platforms, such as CubeSats, must be for complete investigations, and must describe a complete science investigation, including CubeSat construction, payload integration and test, launch vehicle integration, communications, mission operations, data analysis, and publication of results.

The CubeSat Launch Initiative (CSLI) program regularly provides launch opportunities for small satellites to fly as secondary (auxiliary) payloads on launch vehicles planned for upcoming U.S. Government missions. Under the CSLI process, an Agency-wide selection recommendation committee considers candidate CubeSats for selection from among those proposed from organizations both internal and external to NASA. At an appropriate time after selection, SMD will provide direction for being considered for manifest on a launch vehicle going to an appropriate orbit.

CubeSats are typically launched as secondary payloads to low-Earth orbit or from the International Space Station. Further, additional commercial opportunities to leave Earth orbit as a secondary payload may arise on future mission launches. Information on the EM-1 stand-alone CubeSat opportunity, can be found by contacting the CubeSat points of contact listed below.

For more information about the CSLI, including previously-selected respondents, see http://www.nasa.gov/directorates/heo/home/CubeSats_initiative.html. For more resources specifically for CubeSat and SmallSats proposers, please see https://www.nasa.gov/smallsat-institute.

As a result of their secondary status, CubeSats are placed into orbits that are dictated by the primary. Therefore, in any given year a finite number of specific orbits (e.g., inclinations and altitudes) will be available for CubeSats, and the types of orbits available will vary from year to year. Thus, CubeSat-based missions requiring very specific orbital parameters may be at a disadvantage for securing a timely launch. Proposals should include the CubeSat Mission Parameters Table (below) and clearly

CubeSat Mission Parameters								
Mission Name	Mass	Cube Size	Desired Orbit		Acceptable Orbit Range	400 km @ 51.6 degree incl. Acceptable – Yes or No	Ready Date	Desired Mission Life
			Altitude					
			Inclination					

indicate both the required and the acceptable range of orbital parameters needed to meet mission objectives. NASA's CubeSats are deployed from the ISS via NanoRacks or from an expendable launch vehicle via a dispenser on contract at the time of manifesting. CubeSats must be compliant with Launch Services Program, Program Level Dispenser and CubeSat Requirements Document (LSP-Req-317.01) and the Compliance and Reference Documents referenced therein. That document may be found at: http://www.nasa.gov/pdf/627972main_LSP-REQ-317_01A.pdf

Investigators proposing CubeSats in response to this solicitation are expected to comply with the requirements of NASA Procedural Requirement (NPR) 7120.8, NASA Research and Technology Program and Project Management Requirements, and should appropriately tailor these requirements, depending on the project size, complexity, and scope.

Proposals for CubeSat investigations should note the following:

- The cost of launch for a single, ≤ 3U, spacecraft to Low Earth Orbit (LEO) will be covered under the NASA/HEOMD CubeSat Launch Initiative (CSLI) at no cost to the investigation. For this standard case proposers should mention (e.g., in the budget justification) that only the standard CSLI-provided launch services are needed and proposers should not include such launch service charges in the budgets of a ROSES proposal.
- Proposals to go beyond LEO, utilize more than one spacecraft, or involve a CubeSat >3U must contact CSLI representatives (see below) to obtain a cost estimate. Proposals shall state explicitly in the budget justification that there are additional costs for launch within the proposed budget, and give those costs in the NSPIRES cover page budget and the separately uploaded Total Budget file. However, such CSLI quoted launch services costs are not in the hands of the proposing organization and overhead must not be charged on those costs.
- The proposed CubeSat investigation must meet the constraints of the program element to which it is being proposed. This explicitly includes any constraints on the areas of science that are solicited, on the available funding, and on the requirement for a complete science investigation.
- Proposals will be evaluated with respect to the criteria specified in the *NASA Guidebook for Proposers*. In addition to the factors specified in the *Guidebook*, the proposal will be evaluated against any additional factors called out in the program element to which it is being proposed.
- Proposals for investigations using CubeSats must satisfy the constraints for a standard CubeSat and the NASA CubeSat deployer.
- Please note that there isn't a 12U deployer on ISS.
- Proposals must specify any constraints placed on the required orbit and orbital lifetime. The likely availability of NASA launches satisfying any constraints in the time period contemplated will be a consideration for the ROSES evaluation. The less stringent the orbital constraints, the more probable it will be that NASA can manifest the CubeSat investigation for launch.
- Proposals must demonstrate knowledge of the requirements for limiting orbital debris and must address how the mission will meet the requirements of NPR 8715.6 for Limiting Orbital Debris.
- Proposals must address the approach to downlink and uplink communications licensing, frequency band selection, and frequency coordination for operations between space and ground within the RF spectrum.
- All costs for preparing, testing, and delivering the CubeSat for launch must be included in the proposal. Launch service charges should be included in the

proposal cost request only if they exceed the normal CSLI-provided launch services, as described above.

- Proposals for short duration orbital experiments other than CubeSats must include provisions for access to space as part of the proposal.

Investigators proposing CubeSats are strongly urged to discuss prospective investigations with personnel listed below regarding constraints, launch opportunities, and other technical matters.

For further information on SMD CubeSats, please contact:

Florence Tan
Phone: (202) 358-0058
Email: florence.w.tan@nasa.gov

For further information on CSLI, please contact:

Samantha Fonder,
Launch Services Program Executive,
Phone: 202-358-1521
Email: samantha.fonder@nasa.gov

VI. Proposal Review Information

(a) Evaluation Criteria

As stated in the *NASA Guidebook for Proposers*, proposals are ordinarily evaluated on three criteria: intrinsic merit, relevance, and cost. A ROSES proposal that is not relevant is not selectable, no matter what the scores for Merit or Cost, or mean or median of all three criteria scores. Indeed, SMD may return without peer review a proposal deemed to be not relevant. The manner in which SMD evaluates ROSES proposals for relevance and cost varies from program to program. ROSES proposals may be scored by peer reviewers for all three criteria on a full scale, or the proposal may be scored on a full scale only for merit, with relevance and/or cost evaluated on an abridged scale, or with only comments provided for relevance and/or cost, or the peer review panel may not be asked to comment on relevance and cost at all.

Note the following specific points:

- Some of the program elements discussed in Appendices A through E will give specific factors, based on the solicited research objectives, which will be considered when evaluating a proposal's science and/or technical merits and/or its relevance to program objectives.
- Unless otherwise stated, relevance will be judged by whether the proposal addresses goals and objectives for the ROSES Appendix and/or specific program element to which it was submitted, rather than NASA's broader goals. Unless otherwise stated in the program element, relevance of the proposed work is judged based on whether the work proposed is deemed to be relevant, independent of whether or not it includes an overt, clear and direct statement of relevance. That is, unless otherwise stated in the program element, no proposal will be returned as noncompliant for lack of a relevance section or statement, and inclusion of a

relevance section or statement is no guarantee that the proposal will be judged relevant. Please read the program elements carefully. See also Section I(h).

- Cost data for U.S. proposals may be evaluated by peer review (for reasonableness) and by NASA program personnel (for consistency with the available budget). Proposers must follow the budget requirements in Section IV(b)iii and Table 1 of this document. When evaluating the cost reasonableness of the proposals, reviewers will assess whether the proposed level of effort (i.e., labor FTEs) and the proposed other direct costs (i.e., supplies, equipment, travel) are commensurate with those required to accomplish the goals of the investigation. Salary levels, fringe benefit rates, and overhead rates are not part of that evaluation, and will be hidden from peer reviewers.
- Except in rare instances where it is explicitly acknowledged in the program element (e.g., A.39 Ecological Forecasting), neither the existence of proposed voluntary cost sharing nor the lack thereof or the magnitude of such cost sharing will be used as evaluation criteria or as a precondition for award. If voluntary cost sharing is proposed, the proposer should describe, in detail, any proposed cost sharing arrangements (see Section III(d) above). Please note that the Table of Personnel and Work Effort is no longer in the budget section and the *Guidebook* explicitly notes that any planned work commitment not funded by NASA is not considered cost sharing as defined in 2 CFR § 200.29.
- The *NASA Guidebook for Proposers* gives definitions for five adjectival ratings from Excellent down to Poor. NASA may provide decision letters and or evaluations with intermediate scores such as "Excellent/Very Good".
- A NASA awards officer will conduct a pre-award review of risk associated with the proposer as required by 2 CFR 200.205. For all proposals selected for award, the Grant Officer will review the submitting organization's information available through the Federal Awardee Performance and Integrity Information System (FAPIIS) and the System for Award Management (SAM) to include checks on entity core data, registration expiration date, active exclusions, and delinquent federal debt.
- Prior to making a Federal award with a total amount of Federal share greater than the simplified acquisition threshold, NASA is required to review and consider any information about the applicant that is in the designated integrity and performance system (currently FAPIIS) accessible through the System for Award Management (SAM, https://www.sam.gov/SAM/) (see 41 U.S.C. 2313). An applicant, at its option, may review information in FAPIIS and comment on any information about itself that NASA previously entered and is currently in FAPIIS. NASA will consider any comments by the applicant, in addition to the other information in FAPIIS, in making a judgment about the applicant's integrity, business ethics, and record of performance under Federal awards when completing the review of risk posed by applicants as described in 2 CFR 200.205 Federal awarding agency review of risk posed by applicants.
- For proposal evaluation and other administrative processing, NASA may find it necessary to release information submitted by the proposer to individuals not employed by NASA. Business information that would ordinarily be entitled to confidential treatment may be included in the information released to these individuals. Accordingly, by submission of this proposal, the proposer hereby

consents to a limited release of its confidential business information (CBI). Except where otherwise provided by law, NASA will permit the limited release of CBI only pursuant to non-disclosure agreements signed by the assisting contractor or subcontractor, and their individual employees and peer reviewers who may require access to the CBI to perform the assisting contract.

(b) Review and Selection Processes

Review and selection of proposals submitted to this NRA will be consistent with the policies and provisions given in the *NASA Guidebook for Proposers*, the SMD Peer Review Policy and the SMD policy on avoidance of Peer Review Conflicts of Interest.

Although not part of the peer review process, the selection official may take into account programmatic considerations such as impact on current or future missions, balance across subdisciplines, technologies, methodologies, career stage, risk, innovation, types of institutions, and project size (such as funding several small investigations instead of one large one).

Unless otherwise specified, the SMD Division Director responsible for a research program (or a delegate, such as the R&A Lead in the Earth Science and Planetary Science Divisions) is its Selection Official.

SMD is strongly committed to ensuring that the review of proposals is performed in an equitable and fair manner that reduces the impacts of any unconscious biases. To this end, selected program elements under ROSES will employ a dual-anonymous peer review (DAPR) process in which, not only are proposers not told the identity their reviewers, the reviewers are not told the identity of the proposers, until after they have evaluated all of the anonymized proposals.

DAPR will be applied to proposals submitted to: A.30 The Earth Science U.S. Participating Investigator program, B.4, Heliophysics Guest Investigators-Open, D.2 Astrophysics Data Analysis, all Astrophysics GO/GI programs (D.5, D.6, D.9-D.11) and E.4 Habitable Worlds. Proposers to these program elements must adhere to the instructions in those program elements on how to prepare anonymized proposals. Also, detailed instructions for the preparation of proposals will be posted on the NSPIRES page for these ROSES elements and at https://science.nasa.gov/researchers/dual-anonymous-peer-review.

In brief, proposers to these program elements will provide an anonymized version of the proposal for peer review, and a separate not anonymized "Expertise and Resources - Not Anonymized " document that contains the identifying expertise and resources. DAPR panels will be instructed to evaluate the anonymized proposals based on their scientific merit, without taking into account the proposing team qualifications. As a final check, and only after the scientific evaluation is finalized for all proposals, the panel will be provided with the separate non-anonymized Expertise and Resources document to assess the team capabilities required to execute the proposed science investigation.

Starting in ROSES-2020 another novel variant of the peer review process will be focused on high-(intellectual)-risk high-impact proposals. SMD will collect information from proposers and reviewers to assess (intellectual) risk and impact of ROSES proposals and the Associate Administrator will assemble a second panel of senior

researchers to examine a few high-risk high-impact proposals that were not selected for funding through the normal review process, but were nominated by selection officials for an independent evaluation of intellectual risk and impact.

(c) Selection Announcement and Award Dates

SMD's goal is to announce selections within 150 days of the proposal due date and within 60 days after the conclusion of the peer review. Selections are typically announced between 150 days and 220 days after the proposal due date. Although there are many reasons why selections are not announced earlier, the most common are the uncertainty in the NASA budget at the time selection decisions could be made and the time required to conduct an appropriate peer review and selection process. NASA does not usually announce new selections until the funds needed for those awards are approved through the Federal budget process. Therefore, a delay in the budget process for NASA usually results in a delay of the selection announcement date. After 150 days have passed since the proposal due date, proposers may contact the responsible Program Officer listed at the conclusion of that program element and on the SARA web page (see Section VIII). If the program officer does not respond proposers may send an inquiry to SARA@nasa.gov.

In order to announce selection decisions as soon as is practical, even in the presence of budget uncertainties, the Selection Official may make and announce selection decisions about some proposals and defer decisions on others. If a Selection Official uses this option, then proposers may be told that a proposal has been "selected," "declined," or that a decision has not yet been made. If a decision has not yet been made, then those proposals are termed "selectable" and will be considered for a supplemental selection if circumstances allow. Eventually proposers will be notified whether their proposal is selected or is no longer being considered for selection. All proposers will be notified via NSPIRES and provided with a written review (usually the panel evaluation) of the proposal. Proposers may contact the Program Officer for a "debriefing" to gain a better understanding of the evaluation process and the reasoning supporting the decision not to select the proposal, see the SMD Reconsideration Policy for more information.

(d) Processes for Appeals

(i) Reconsideration by SMD

SMD has a process for requesting a debrief and/or reconsideration of the declination of a proposal submitted in response to an SMD NASA Research Announcement and Cooperative Agreement Notices. Reconsideration may be requested if the PI believes that the proposal evaluation contained factual errors or was otherwise handled improperly. This process is described in the SMD Reconsideration Policy document available in the Library section of the SARA website at http://sara.nasa.gov).

(ii) Ombudsman Program

The NASA Procurement Ombudsman Program is available under this NRA as a procedure for addressing concerns and disagreements. The clause at NASA FAR Supplement (NFS) 1852.215-84 ("Ombudsman") is incorporated into this NRA.

The cognizant ombudsman is

Monica Manning
Deputy Assistant Administrator for Procurement
Telephone: 202-358-1050
Email: agency-procurementombudsman@nasa.gov

(iii) Protests

Only contract awards are subject to bid protest, either at the Government Accountability Office (GAO) or with the Agency, as defined in FAR 33.101. The provisions at FAR 52.233-2 (Service of Protest) and NFS 1852.233-70 (Protests to NASA) are incorporated into this NRA. Under both of these provisions, the designated official for receipt of protests to the Agency and copies of protests filed with the GAO is

Jeffrey Cullen
Director of Program Operations
NASA Headquarters
Washington, DC 20546-0001
Telephone: 202-358-1463
Email: jeffrey.m.cullen@nasa.gov

(e) Service as a Peer Reviewer

The success of NASA's research program rests on the quality of peer review. NASA will contact expert investigators and ask them to serve as peer reviewers. Since those whose proposals were selected in prior competitions are highly qualified and may not be submitting a proposal to the current competition, they are highly encouraged to serve on SMD peer review panels. Potential reviewers are encouraged to volunteer to be reviewers by filling out one of the review forms at https://science.nasa.gov/researchers/volunteer-review-panels or by sending an email to one of the program officers or to sara@nasa.gov. It is good experience for early-career scientists, and the influx of new reviewers is healthy for the process.

VII. AWARD ADMINISTRATION INFORMATION

(a) Notice of Award

All proposers will be notified via NSPIRES from which they will be able to retrieve their proposal evaluation and official decision letter (i.e., a decline or accept letter, what is sometimes called a "notice of intent to make a federal award"). If a proposal is selected, the business office of the offeror will be contacted by a NASA Grants Officer from the NASA Shared Services Center (NSSC), who is the only official authorized to obligate the Government. Any costs incurred by the proposer in anticipation of an award will be subject to 2 CFR Section 1800.209 Preaward costs. NASA waives the approval requirement for preaward costs of 90 days or fewer.

(b) Administrative and National Policy Requirements

This solicitation does not invoke any special administrative or national policy requirements: 2 CFR 200, 2 CFR 1800, 14 CFR 1274, and the Grants and Cooperative Agreement Manual will apply to any awards that derive from this NRA, as applicable.

Note that the research terms and conditions have been updated - see Section 5.10.1 of the GCAM for more information. Moreover, when a grant or cooperative agreement is issued for research, additional research terms and conditions apply – see section 5.10.2 of the GCAM for reference. All award requirements are posted at https://prod.nais.nasa.gov/pub/pub_library/srba/index.html.

Awards from this funding announcement that are issued under 2 CFR 1800 are subject to the Federal Research Terms and Conditions (RTC) located at http://www.nsf.gov/awards/managing/rtc.jsp. In addition to the RTC and NASA-specific guidance, three companion resources can also be found on the website: Appendix A - Prior Approval Matrix, Appendix B - Subaward Requirements Matrix, and Appendix C - National Policy Requirements Matrix.

(c) Award Reporting Requirements

The reporting requirements for awards made through this NRA will be consistent with 2 CFR 200.327-.329. Award recipients must also comply with reporting requirements found in 2 CFR 180.335 and 2 CFR 180.350.

Award recipients may also be subject to reporting requirements under the NASA Plan for Increasing Access to Results of Federally Funded Research. Such requirements include reporting of final peer-reviewed manuscripts in annual and final progress reports. In other words, award recipients should report on progress in archiving of data and manuscripts in their progress reports and especially in the final report. All requirements will be identified in the Notice of Award.

If the total value of your currently active grants, cooperative agreements, and procurement contracts from all Federal awarding agencies exceeds $10,000,000 for any period of time during the period of performance of this Federal award, additional reporting requirements will apply. See 2 CFR 200 Appendix XII—Award Term and Condition for Recipient Integrity and Performance Matters.

If the total Federal share of an award includes more than $500,000 over the award's period of performance, NASA must include the term and condition available in Appendix XII—Award Term and Condition for Recipient Integrity and Performance Matters. See also §200.113 Mandatory disclosures. The non-Federal entity or applicant for a Federal award must disclose, in a timely manner, in writing to the Federal awarding agency or pass-through entity all violations of Federal criminal law involving fraud, bribery, or gratuity violations potentially affecting the Federal award. Non-Federal entities that have received a Federal award including the term and condition outlined in Appendix XII - Award Term and Condition for Recipient Integrity and Performance Matters - are required to report certain civil, criminal, or administrative proceedings to SAM. Failure to make required disclosures can result in any of the remedies described in §200.338 Remedies for noncompliance, including suspension or debarment (See also 2 CFR part 180, 31 U.S.C. 3321, and 41 U.S.C. 2313).

(d) Compliance with the National Environmental Policy Act

All awards made in response to proposals to this solicitation must comply with the National Environmental Policy Act (NEPA). Thus, proposers are encouraged to plan and budget for any anticipated environmental impacts. While most research awards will not

trigger action specific NEPA review, there are some activities, including international actions, that will. The majority of grant-related activities are categorically excluded (from specific NEPA review) as research and development (R&D) projects that do not pose any adverse environmental impact. A blanket NASA Grants Record of Environmental Consideration (REC) provides NEPA coverage for these anticipated activities. The NSPIRES cover pages include questions to determine whether a specific proposal falls within the Grants REC and must be completed as part of the proposal submission process. Activities outside of the bounding conditions of the Grants REC will require additional NEPA analysis. Examples of actions that will likely require NEPA analysis include, but are not limited to: suborbital-class flights not conducted by a NASA Program Office (see Section V); activities involving groundbreaking construction/fieldwork; and certain payload activities such as the use of expendable weather reconnaissance devices (dropsondes). Questions concerning environmental compliance may be addressed to Tina Norwood, NASA NEPA Manager, at tina.norwood-1@nasa.gov or (202) 358-7324.

(e) Acknowledgement of Support for Antarctic Access

For science projects that receive assistance from the U.S. Antarctic Program, this support must be acknowledged in publications. The acknowledgement should include: "Logistical support for this project in Antarctica was provided by the U.S. National Science Foundation through the U.S. Antarctic Program." Any additional requirements will be specified in the program element description.

VIII. Points of Contact for Further Information

General questions and comments about the policies of this NRA may be directed to:

Max Bernstein
SMD Lead for Research
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546-0001
Email: sara@nasa.gov (preferred)
Telephone: (202) 358-0879

Note: Proposals must not be submitted to this address. Proposals must be submitted electronically, as described in Section IV above.

Specific questions about a given program element in this NRA should be directed to the Program Officer(s) listed in the Summary Table of Key Information at the end of each program element appendix. Up-to-date contact information for program officers can also be found online at the SARA web page's Program Officers List at https://science.nasa.gov/researchers/sara/program-officers-list.

Inquiries about accessing or using the NASA proposal submission web interface located at http://nspires.nasaprs.com should be directed by an email that includes a telephone number to nspires-help@nasaprs.com or by calling (202) 479-9376. This help center is staffed Monday through Friday, 8:00 a.m. – 6:00 p.m. Eastern Time.

Inquiries about accessing or using Grants.gov located at http://www.grants.gov should be directed by an email to support@grants.gov or by calling (800) 518-4726 twenty-four hours a day, seven days a week, except Federal holidays when the center is closed.

Students, faculty or staff in programs receiving NASA financial assistance, such as grant awards from this solicitation, may raise allegations of discrimination, including harassment, by contacting the NASA Office of Diversity and Equal Opportunity. Information on filing a complaint through ODEO at https://missionstem.nasa.gov/filing-a-complaint.html.

IX. Ancillary Information

(a) Announcement of Updates/Amendments

Because this NRA is released far in advance of many of the deadlines given in Tables 2 and 3, additional information for programs may develop before their proposal due dates. If so, such information will be added as a formal amendment to this NRA no later than 30 days before the proposal due date, or, if that is not possible, the proposal due date will be extended to allow 30 days for proposal submission from the date of the amendment. All amendments are posted on the main ROSES webpage at http://solicitation.nasaprs.com/ROSES2020 (or by going to http://solicitation.nasaprs.com/open and selecting "NNH20ZDA001N"). Also, a blog for amendments, clarifications, and corrections to ROSES can be found in one place at http://science.nasa.gov/researchers/sara/grant-solicitations/roses-2020/. NASA SMD will also send an electronic notification of any such amendments to all subscribers of its electronic notification system (see Section IX(c) below). The prospective proposer is responsible to check this NRA's NSPIRES homepage for updates concerning the program(s) of interest. Any clarifications or questions and answers that are published will be posted on the relevant program element's NSPIRES web page.

(b) Electronic Submission of Proposal Information

On-time electronic submission over the Internet is required for every proposal and mandatory NOI. While every effort is made to ensure the reliability and accessibility of the electronic proposal submission systems (NSPIRES and Grants.gov) and to maintain help centers via email and telephone, difficulty may arise at any point, including with the user's own equipment. Therefore, prospective proposers are urged to familiarize themselves with the submission system(s) and to submit the required proposal materials well in advance of the deadline of the program of interest. Difficulty in registering with or using a proposal submission system is not, in and of itself, a sufficient reason for NASA to consider a proposal that is submitted after the proposal due date (see Section IV(c) above). After submission via NSPIRES, proposers can verify proposal delivery by logging into NSPIRES and selecting "proposals" and "Submitted Proposals/NOIs." Additionally, the proposal PI and the submitting organization's AOR(s) will receive an email from NSPIRES confirming that the submission has been completed.

(c) Electronic Notification of SMD Research Solicitations

SMD maintains an electronic notification system to alert interested researchers of its research program announcements. Subscription to this service is free to all registered users of the NASA proposal database system at http://nspires.nasaprs.com. To add or change a subscription to the electronic notification system, users should login to the database system and select "Account Management" then "email Subscriptions." Owing to the increasingly multidisciplinary nature of SMD programs, this email service will notify all subscribers of (i) all NASA SMD research program solicitations regardless of their type or science objectives; (ii) amendments to all SMD solicitations that have been released for which the proposal due dates have not passed; and (iii) special information that SMD wishes to communicate to those interested in proposing to its sponsored research programs. Altogether, a subscriber may receive 50 - 75 notifications per year. SMD maintains this subscription list in confidence and does not attempt to discern the identity of its subscribers. Regardless of whether or not this service is used, all SMD research announcements may be accessed at http://solicitation.nasaprs.com/open by selecting "NNH20ZDA001N" as soon as they are posted (typically by ~9:00 a.m. Eastern Time on their release date).

Note: Automated spam filtering software may identify SMD's electronic notifications as spam or junk mail. Subscribers are advised to ensure that email received from "NSPIRES-help@nasaprs.com" or "nspires@nasaprs.com" are not identified by any automated email filtering system as unwanted email. Note that the latter address is an outgoing (from NSPIRES) address only; all enquiries should be directed to the former address.

NRAs issued by SMD are synopsized on Grants.gov (http://www.grants.gov) at the time they are released. This ROSES NRA was synopsized upon its release.

(d) Further Information on SMD Research and Analysis Programs

SMD maintains a website for improving communication with the research community. This site is maintained by the SMD Research Lead, is referred to as the SARA website, and is located at http://sara.nasa.gov. The SARA website contains information related to NASA's Science Research Programs, including the solicitations, selections, a blog for changes to ROSES, and contact information for program officers.

(e) Archives of Past Selections

For more information about the types of research supported by the program elements solicited in previous editions of this NRA and other predecessor NRAs, the titles and abstracts of all investigations selected through previous solicitations (issued after January 1, 2005) are available by program element at http://nspires.nasaprs.com: click "Solicitations" and then "Closed/Past Selected", search on the particular ROSES program element of interest and information on the selected proposals will be in a downloadable PDF file. For example, for the selections from the last set of proposals submitted (in 2017) to The Science of TERRA, AQUA, and SUOMI NPP one would go to the NSPIRES page for that program element, and download the PDF of "The Science of TERRA, AQUA, and SUOMI NPP 2017 selections" under the heading "Selections". One can also search the grants (only) that resulted from all NASA programs at

http://www.research.gov/ by selecting "Search awards" and then using the "Advanced Search" to search for NASA awards only. One can also search the grants (only) that resulted from all NASA programs, but not abstracts at https://www.nssc.nasa.gov/grantstatus.

(f) Meeting Geospatial Standards

NASA pioneered the development of metadata and the accessibility and interoperability of space and Earth science data. When grants result in the development of data that NASA both identifies as geospatial and intends to distribute, then NASA awards will require that documentation (metadata) meet Federal Geographic Data Committee standards. NASA will assure that this documentation is electronically accessible to the Clearinghouse network (http://www.fgdc.gov/dataandservices/) and discoverable through https://www.data.gov/geospatial/.

X. Concluding Statement

Through this ROSES NRA, NASA encourages the participation of the space and Earth science communities in its Science Mission Directorate research and technology programs. These programs, while quite diverse in objectives and types, in fact form the foundation of both the basic and applied research that allows NASA's space and Earth science programs to be properly planned and carried through to the successful interpretation of data and its application to the needs of end users. Comments about this NRA are welcome and may be directed to the point of contact for general questions and comments identified in Section VIII above.

Table 1: Checklist for ROSES-2020 Proposals

This list does not apply to Step-1 proposals. Many items on this checklist may be superseded by the program element and, if there is a difference, the text in the program element takes precedence. The instructions here supersede the *NASA Guidebook for Proposers* if there is a difference, see Section I(g).		
NSPIRES cover pages: This table lists the few aspects that most commonly cause difficulties to proposers. There are many required parts to the cover pages, see the NSPIRES tutorials for guidance.		
	Team	All investigators must indicate participation via NSPIRES, except proposals submitted via grants.gov. If any team member doesn't confirm their participation the AOR will get an error that prevents submission.
	Team	Paid team members may not be collaborators, they should be given a role permitted to receive funds, such as Co-I.
	Team	A critical partner with a sustained, continuing role is a Co-I, not a collaborator, even if unpaid. See also FAQ #21.
	Project Summary	Project Summary (abstract) must be in the 4000-character text box in the NSPIRES cover pages, not the Science/Technical/ Management section of the proposal (except DAPR proposals).
	Budget	List all costs. Include all salary and indirect costs in the NSPIRES cover page budgets but not in the proposal PDF, see Section IV.(b)iii.
	Submission	The author must "release" the proposal and the AOR must "submit" prior to the due date.
	Other	There are questions that must be answered and there may be other required content, e.g., some program elements in Appendix C collect a relevance statement via the cover page, see VI(a).
Proposal document		
Table of contents		First component of proposal. One page only and optional.
Scientific/ Technical/ Management (S/T/M) Section		Second component and the main part of the proposal. The sequence for science content here is recommended proposers may order the elements as they prefer.
	Length restriction	Typically, 15 pages (except for a Step-1 proposal) and more may be permitted for some (e.g., suborbital) programs and less for others (e.g., C.17 PMEF, E.2 TWSC). Please read the program element and refer to the summary table of key information.
	Format	8.5" x 11.0" paper size
	Format	Single spaced, single column text (unless otherwise specified).
	Format	One-inch margins on all four sides. No reviewable content in margins.
	Format	No more than 5.5 lines per vertical inch

Table 1 Continued: Checklist for ROSES-2020 Proposals

	Text Format	No more than 15 characters per horizontal inch, including spaces. This is typically consistent with a font size of 12.
	Captions Format	As above (font size 12 etc.). Text necessary for the proposal may not be solely in figures, tables, or their captions.
	Figure Format	Text and content on/in figures must be easily legible without magnification.
	Table Format	Text and content on/in Tables must be easily legible without magnification.
	Content	Discuss objectives and their significance.
	Content	Discuss perceived impact of the work.
	Content	Discuss relevance of the work to the program element. See VI.(a)
	Content	Explain the technical approach and methodology.
	Content	Discuss potential sources of uncertainty
	Content	Present mitigation strategy or alternate approach given obstacles
	Content	Discuss roles of all team members so it's clear what they are doing
	Content	Present a work plan, with milestones, management structure
	Content	Present a data sharing and/or archiving plan in the S/T/M section only if it is required by program element, see Section II.(c).
	Special Content	Provide other special requirements of program element, e.g., special statements for participating scientists, team leads, etc.
References: Third component of proposal		
	Length	No page limit
	Excluded	No references to documents unavailable to reviewers. See https://science.nasa.gov/researchers/sara/faqs#19.
Data Management Plan (DMP) fourth component of proposal		
	Length	2 pages
	Required	Unless otherwise stated, a DMP or explanation of why it is not needed must be provided in this section.
	Content	See Section II(c) and the DMP FAQ for content and templates.
Biographical Sketches/Curriculum Vitae (CVs): fifth component of proposal		
	Required	For a PI and each Co-I.
	Length restriction	CV for a PI (or Science PI) - up to two pages, unless otherwise specified.
	Length restriction	CVs for anyone other than a PI are limited to one page
	Not required	CVs for collaborators are typically not needed, but may be included
Table of Personnel and Work Effort: This is the sixth component of the proposal. Note, location may differ from that given in *Guidebook*. See Section IV(b)iii		
	Required	Names and/or titles of all personnel to perform the proposed effort
	Required	Planned work commitment (e.g., in weeks, months etc.) to be funded by NASA see example in Section IV(b)iii.

Table 1 Continued: Checklist for ROSES-2020 Proposals

	Required	Planned work commitment (e.g., in weeks, months etc.) that will not be funded by NASA, if any. See example in Section IV(b)iii.
	Note	This table is outside of the budget Section. Time commitment included here that is not funded by NASA is not considered cost sharing, as defined in 2 CFR § 200.29.
	General	Where names are not known, include the position, such as postdoctoral fellow or technician.
Current and Pending Support: seventh component of the proposal, not page limited.		
	Required	Required for the PI and funded team members who are proposed to devote ≥10% of their time to the proposed work.
	Required	For each current project or pending proposal list the level of effort for that team member (only) per year. Award values are not required.
	Excluded	Do not include Current and Pending for collaborators.
	Discouraged	Current and Pending for students is discouraged.
	Discouraged	Current and Pending for Foreign Co-Is is discouraged.
	Excluded	Do not self-reference this proposal in the current and pending
Statements of Commitment and Letters of Support, feasibility and Endorsement, the eighth component of the proposal.		
	General	Statements of Commitment by team members have been replaced by an indication of participation via the NSPIRES web interface.
	Statements of Commitment	Statements of Commitment must be included for Grants.gov proposals, since web confirmation of team member participation is not possible via Grants.gov.
	Letter of Endorsement – only permitted in special cases.	In general, not permitted. Special cases include 1) Foreign Co-Is must include letters of endorsement from their government agency or funding/sponsoring institution in their country and 2) Letters from commercial vendor are required for proposals for investigations using sRLVs not contracted by the Flight Opportunities Program. See Section V(b)iii.
	Letter of Support	A letter of support is required from the owner of any facility or resource that is not under the direct control of the PI or a Co-I, acknowledging that the facility or resource is available for the proposed use during the proposed period.
	Letter of feasibility	A letter of feasibility from the NASA Space Station Payload Office must be included with proposals to use ISS.
	Letter of affirmation	In general, letters of affirmation are not permitted for normal research proposals, but letters from the community may be included only where explicitly allowed, e.g., for C.17 PMEF, and E.2 TWSC.

Table 1 Continued: Checklist for ROSES-2020 Proposals

Budget Justification: The ninth component of the proposal, no page limit overall.		
	General	Please explain in words what is being purchased and why it is reasonable. See the *Guidebook for Proposers*
	Required	Budget Narrative: justify each proposed component of cost, including subcontracts/subawards, consultants, other direct costs (including travel), and facilities and equipment. Give the "basis of estimate;" quotes need not be provided, but the proposal should indicate that the cost was based upon a quote, prior experience, etc.
	Excluded	Do not include any values for salary, fringe, or overhead.
	Optional	Proposers need not specify anticipated award type (i.e., grant vs. contract), see Section II(a)
Facilities and Equipment: The tenth component of the proposal, no page limit.		
	Length restriction	None, as needed
	Excluded content	Does not add scientific or technical information beyond a description of the facilities and equipment, i.e., don't add here what should be in the page-limited scientific/technical Section.
Detailed Budget: The eleventh and final component of the main proposal document.		
	Strongly Recommended	Detailed budget, itemizing expenses.
	Strongly Recommended	Separate detailed budget from each subaward organization.
	Excluded	Do not include any $ or % values for salary, fringe, or overhead in this section which is peer reviewed. See the FAQ at https://science.nasa.gov/researchers/sara/faqs#8
PDF Appendices Separate from the main proposal document		
	"Total" Budget Document (separate PDF file attached as type "Total Budget").	
	Required	Separately uploaded "Total" Budget PDF file see Section IV(b)(iii).
	HEC Appendix Document (separate PDF file attached as "Appendix")	
	If necessary	If the Program Specific Data Question on the use of NASA-provided HEC was answered in the affirmative, an appendix document must be provided. See Section I(d) for information.
	Expertise and Resources - Not Anonymized (separate PDF file attached as document type "Appendix")	
	Selectively required	This document is required only for those program elements employing the Dual-Anonymous Peer Review process. See Section IV(b)i and relevant program elements for more information.

ROSES 2020
TABLE 2: SOLICITED RESEARCH PROGRAMS
(In Order of Full/Step-2 Proposal Due Dates) [1]

Appendix	Program Element	NOI/(Step-1) Due Date [2]	Proposal Due Date
C.5	Exobiology	04/22/2020	05/22/2020
E.6	**Science Activation Program Integration**	**03/25/2020**	**05/27/2020**
E.3	Exoplanets Research	03/27/2020 **(mandatory NOIs)** ~~(Step-1)~~	05/29/2020 ~~(Step-2)~~
A.2	Land Cover/ Land Use Change	03/16/2020	06/01/2020
C.2	**Emerging Worlds**	**04/17/2020** **(Step-1)**	06/01/2020 (Step-2)
A.26	Earth Surface and Interior	05/01/2020	06/02/2020
A.8	Global Ecosystem Dynamics Investigation (GEDI) Science Team	05/01/2020	06/16/2020
C.6	Solar System Observations	**04/22/2020** (Step-1)	06/**17**/2020 (Step-2)
C.24	Yearly Opportunities for Research in Planetary Defense	**04/22/2020** (Step-1)	06/**17**/2020 (Step-2)
D.14	Theoretical and Computational Astrophysics Networks	N/A	**06/23/2020**
A.7	**Biodiversity**	**05/27/2020**	**06/25/2020**
A.9	Physical Oceanography	05/28/2020	06/25/2020
A.38	Earth Science Applications: Health and Air Quality Applied Sciences Team	04/17/2020	**06/30**/2020
B.12	**Heliophysics Data Environment Enhancements**	**05/08**/2020 (Step-1)	**07/01**/2020 (Step-2)
B.13	Heliophysics U.S. Participating Investigator	**05/08**/2020 (Step-1)	**07/01**/2020 (Step-2)
C.10	Cassini Data Analysis	05/07/2020 (Step-1)	07/09/2020 (Step-2)
C.20	Development and Advancement of Lunar Instrumentation Program	04/17/2020 (Step-1)	**07/10/2020** (Step-2)
A.16	Modeling Analysis and Prediction	05/22/2020	**07/14**/2020
C.16	Laboratory Analysis of Returned Samples	**05/15/2020** **(Step-1)**	**07/14/2020** **(Step-2)**
A.30	Earth Science U.S. Participating Investigator	06/18/2020	07/16/2020
D.2	**Astrophysics Data Analysis**	**05/05/2020**	**07/16/2020**

C.13	Maturation of Instruments for Solar System Exploration	04/17/2020 (Step-1)	**07/17**/2020 (Step-2)
A.44	**Advanced Component Technology**	**05/22/2020**	**07/21/2020**
A.3	**Ocean Biology and Biogeochemistry**	**04/30/2020**	**07/23/2020**
C.4	Planetary Data Archiving, Restoration, and Tools	05/15/2020 (Step-1)	**07/24**/2020 (Step-2)
B.4	Heliophysics Guest Investigators Open	04/**29**/2020 (Step-1)	07/**29**/2020 (Step-2)
A.17	Cryospheric Science	06/02/2020	**07/30**/2020
A.19	Atmospheric Composition: Laboratory Research	N/A	08/13/2020
A.39	Earth Science Applications: Ecological Forecasting	07/17/2020	08/14/2020
B.14	**Early Career Investigator Program**	05/**27**/2020 (Step-1)	08/**26**/2020 (Step-2)
A.42	**Commercial SmallSat Data Analysis**	**07/01/2020 (mandatory NOIs)**	**09/01/2020**
B.8	Heliophysics Technology and Instrument Development for Science	N/A	**09/09/**2020
A.41	**Citizen Science for Earth Systems Program**	**08/04/2020 (mandatory NOIs)**	**09/11/2020**
A.49	**Solar Irradiance Science Team**	**08/07/2020**	**09/11/2020**
D.13	Astrophysics Explorers U.S. Participating Investigators	**08/03/2020 (mandatory NOIs)**	**09/15/2020**
A.18	Atmospheric Composition: Upper Atmospheric Composition Observations	N/A	09/17/2020
A.23	Atmospheric Composition Campaign Data Analysis and Modeling	N/A	09/18/2020
A.13	**Ocean Salinity Field Campaign**	**08/27/2020**	**09/24/2020**
D.5	Neil Gehrels Swift Observatory Guest Investigator Cycle 17	N/A	09/25/2020 (Phase-1 via ARK RPS)
C.21	**Double Asteroid Redirection Test (DART) Participating Scientist Program**	**08/10/2020 (mandatory NOIs)**	**10/01/2020**
A.32	**New (Early Career) Investigator Program in Earth Science**	**08/18/2020**	**10/06/2020**
B.9	Heliophysics Low Cost Access to Space	N/A	**10/07/**2020
A.14	Ocean Surface Topography Science Team	09/10/2020	10/08/2020
D.16	**Astrophysics Pioneers**	**08/13/2020 (mandatory NOIs)**	**10/08/2020**
A.6	Carbon Monitoring System	08/31/2020	10/16/2020

A.34	**Studies with ICESat-2**	**09/30/2020**	**10/30/2020**
C.11	Discovery Data Analysis	08/28/2020 (Step-1)	10/30/2020 (Step-2)
C.7	New Frontiers Data Analysis	**09/03/2020** (Step-1)	**11/05/2020** (Step-2)
A.27	**CYGNSS Competed Science Team**	**10/02/2020**	**11/06/2020**
A.50	**SAGE III/ISS Science Team**	**09/18/2020**	**11/06/2020**
B.5	**Living With a Star Science**	**09/03/2020 (Step-1)**	**11/12/2020 (Step-2)**
D.11	**NICER Guest Observer Cycle 3**	N/A	11/17/2020 (Phase-1 via ARK RPS)
C.9	Mars Data Analysis	09/25/2020 (Step-1)	11/20/2020 (Step-2)
C.12	Planetary Instrument Concepts for the Advancement of Solar System Observations	09/18/2020 (Step-1)	11/20/2020 (Step-2)
A.5	**Carbon Cycle Science**	**09/28/2020**	**12/03/2020**
B.10	**Heliophysics Flight Opportunities Studies**	**N/A**	**12/03/2020**
C.19	**Planetary Science Early Career Award Program**	**N/A**	**12/08/2020**
E.9	**Citizen Science Seed Funding Program**	**10/13/2020**	**12/11/2020**
D.15	**LISA Preparatory Science**	**09/15/2020 (mandatory NOIs)**	**12/15/2020**
D.3	**Astrophysics Research and Analysis**	10/23/2020 (mandatory NOIs)	12/17/2020
D.8	Nancy Grace Roman Technology Fellowships for Early Career Researchers	See D.3 and D.7	
A.51	**Science Team for the OCO Missions**	**11/13/2020**	**01/13/2021**
A.24	Terrestrial Hydrology	**12/02/2020**	**01/14/2021**
E.4	**Habitable Worlds**	11/17/2020 (Step-1)	01/15/2021 (Step-2)
E.7	**Support for Open Source Tools, Frameworks, and Libraries**	**11/19/2020**	**01/19/2021**
D.10	**TESS Guest Investigator Cycle 4**	**N/A**	**01/22/2021 (Phase-1 via ARK RPS)**
D.17	**Extreme Precision Radial Velocity Foundation Science**	**12/17/2020 (Step-1)**	**01/28/2021 (Step-2)**
C.3	**Solar System Workings**	11/13/2020	01/29/2021

D.9	**NuSTAR General Observer Cycle 7**	**N/A**	**01/29/2021 (Phase-1 via ARK RPS)**
C.17	**Planetary Major Equipment and Facilities: Stand-alone proposals**	**12/04/2020 (Step-1)**	**02/05/2021 (Step-2)**
B.2	Heliophysics Supporting Research	11/18/2020 (Step-1)	02/17/2021 (Step-2)
B.7	**Space Weather Science Applications Operations 2 Research**	**12/16/2020 (Step-1)**	**02/17/2021 (Step-2)**
C.26	**COLDTech: Autonomy, Communications, and Radiation-Hard Devices**	**12/01/2020 (Step-1)**	**02/19/2021 (Step-1)**
D.6	**Fermi Guest Investigator Cycle 14**	N/A	02/19/2021 (Phase-1 via ARK RPS)
C.8	Lunar Data Analysis	12/01/2020 (Step-1)	02/26/2021 (Step-2)
B.16	Parker Solar Probe Guest Investigators	01/20/2021 (Step-1)	03/17/2021 (Step-2)
C.18	**Early Career Fellowship Start-Up Program for Named Fellows**	**Mandatory email to POC by 09/01/20**	**03/29/2021**
A.28	Rapid Response and Novel Research in Earth Science	N/A	Rolling submissions through 03/29/2021
B.15	GOLD-ICON Guest Investigators	02/**24**/2021 (Step-1)	04/14/2021 (Step-2)
E.2	**Topical Workshops, Symposia, and Conferences**	**N/A**	**Rolling submissions through 04/14/2021**
E.8	**Supplemental Open Source Software Awards**	**N/A**	**Rolling submissions through 04/14/2021**
C.17	Planetary Major Equipment and Facilities: Appended proposals	See Program of Interest	
A.33	The Science of Terra, Aqua, and Suomi-NPP	**TBD**	**TBD**
A.45	In-Space Validation of Earth Science Technologies	TBD	TBD
B.6	Living With a Star Strategic Capabilities	TBD	TBD
B.11	Heliophysics Flight Opportunities for Research and Technology	N/A	TBD
E.5	Future Investigators in NASA Earth and Space Science and Technology	N/A	TBD

A.4	Terrestrial Ecology	Not Solicited This Year
A.10	Ocean Salinity Science Team	Not Solicited This Year
A.11	Sea Level Change Science Team	Not Solicited This Year
A.12	Surface Water and Ocean Topography Science Team	Not Solicited This Year
A.15	Ocean Vector Winds Science Team	Not solicited This Year
A.20	Atmospheric Composition: Radiation Sciences Program	Not solicited This Year
A.21	Atmospheric Composition: Modeling and Analysis Program	Not solicited This Year
A.22	Atmospheric Composition: Tropospheric Composition Program	Not solicited This Year
A.25	Weather and Atmospheric Dynamics	Not Solicited This Year
A.29	Airborne Instrument Technology Transition	Not Solicited This Year
A.31	Interdisciplinary Research in Earth Science	Not Solicited This Year
A.35	Earth Science Applications: Water Resources	Not Solicited This Year
A.36	SERVIR Applied Science Team	Not Solicited This Year
A.37	Earth Science Applications: Disaster Risk Reduction and Resilience	Not Solicited This Year
A.40	Advancing Collaborative Connections for Earth System Science	Not Solicited This Year
A.43	Instrument Incubator Program	Not Solicited This Year
A.46	Sustainable Land Imaging - Technology	Not Solicited This Year
A.47	Decadal Survey Incubation	Not Solicited This Year
A.48	Advanced Information Systems Technology	Not Solicited This Year
B.3	Heliophysics Theory, Modeling, and Simulations	Not Solicited This Year
B.17	**Interdisciplinary Science for Eclipse**	**Not Solicited This Year**
C.14	**Planetary Science and Technology Through Analog Research**	**Not solicited This Year**
C.15	Planetary Protection Research	Not solicited This Year
C.22	**Radioisotope Power Systems Enabling Missions Beginning with Research and Technology**	**Not Solicited This Year**
C.23	Interdisciplinary Consortia for Astrobiology Research	Not Solicited This Year
C.25	**Mars Organic Molecule Analyser (MOMA) Participating Scientist Program**	**Not Solicited This Year**
D.4	Astrophysics Theory Program	Not solicited This Year
D.7	**Strategic Astrophysics Technology**	**Not Solicited This Year**
D.12	**X-Ray Imaging and Spectroscopy Mission Guest Scientist**	**Not Solicited This Year Moved to ROSES-21**

A.1	Earth Science Research Overview	N/A	N/A
B.1	Heliophysics Research Program Overview	N/A	N/A
C.1	Planetary Science Research Program Overview	N/A	N/A
D.1	Astrophysics Research Program Overview	N/A	N/A
E.1	Cross Division Research Overview	N/A	N/A

Notes:

[1] Amended due dates and new program elements will be indicated with bold red text as ROSES-2020 is amended through the year.

[2] See Sections IV(b)(vi) and IV(b)(vii) of the *Summary of Solicitation* for a discussion of Notice of Intent (NOI) vs. a Step-1 proposal. If NOIs are requested, a due date is provided in the table. If NOIs are required by a program in order to be able to submit a proposal, it will be indicated on this table with "(mandatory)". If NOIs are replaced by a Step-1 proposal, the table entry will include that information.

ROSES 2020
TABLE 3: SOLICITED RESEARCH PROGRAMS
(In Order of Appendices A-E) [1]

Appendix	Program Element	NOI/(Step-1) Due Date [2]	Proposal Due Date
A.1	Earth Science Research Overview	N/A	N/A
A.2	Land Cover/ Land Use Change	03/16/2020	06/01/2020
A.3	**Ocean Biology and Biogeochemistry**	**04/30/2020**	**07/23/2020**
A.4	Terrestrial Ecology	Not Solicited This Year	
A.5	**Carbon Cycle Science**	**09/28/2020**	**12/03/2020**
A.6	Carbon Monitoring System	08/31/2020	10/16/2020
A.7	**Biodiversity**	**05/27/2020**	**06/25/2020**
A.8	Global Ecosystem Dynamics Investigation (GEDI) Science Team	05/01/2020	06/16/2020
A.9	Physical Oceanography	05/28/2020	06/25/2020
A.10	Ocean Salinity Science Team	Not Solicited This Year	
A.11	Sea Level Change Science Team	Not Solicited This Year	
A.12	Surface Water and Ocean Topography Science Team	Not Solicited This Year	
A.13	**Ocean Salinity Field Campaign**	**08/27/2020**	**09/24/2020**
A.14	Ocean Surface Topography Science Team	09/10/2020	10/08/2020
A.15	Ocean Vector Winds Science Team	Not solicited This Year	
A.16	Modeling Analysis and Prediction	05/22/2020	**07/14**/2020
A.17	Cryospheric Science	06/02/2020	**07/30**/2020
A.18	Atmospheric Composition: Upper Atmospheric Composition Observations	N/A	09/17/2020
A.19	Atmospheric Composition: Laboratory Research	N/A	08/13/2020
A.20	Atmospheric Composition: Radiation Sciences Program	Not solicited This Year	
A.21	Atmospheric Composition: Modeling and Analysis Program	Not solicited This Year	
A.22	Atmospheric Composition: Tropospheric Composition Program	Not solicited This Year	
A.23	Atmospheric Composition Campaign Data Analysis and Modeling	N/A	09/18/2020
A.24	Terrestrial Hydrology	**12/02/2020**	**01/14/2021**
A.25	Weather and Atmospheric Dynamics	Not Solicited This Year	
A.26	Earth Surface and Interior	05/01/2020	06/02/2020
A.27	**CYGNSS Competed Science Team**	**10/02/2020**	**11/06/2020**

A.28	Rapid Response and Novel Research in Earth Science	N/A	Rolling submissions through 03/29/2021
A.29	Airborne Instrument Technology Transition	Not Solicited This Year	
A.30	Earth Science U.S. Participating Investigator	06/18/2020	07/16/2020
A.31	Interdisciplinary Research in Earth Science	Not Solicited This Year	
A.32	**New (Early Career) Investigator Program in Earth Science**	**08/18/2020**	**10/06/2020**
A.33	The Science of Terra, Aqua, and Suomi-NPP	**TBD**	**TBD**
A.34	**Studies with ICESat-2**	**09/30/2020**	**10/30/2020**
A.35	Earth Science Applications: Water Resources	Not Solicited This Year	
A.36	SERVIR Applied Science Team	Not Solicited This Year	
A.37	Earth Science Applications: Disaster Risk Reduction and Resilience	Not Solicited This Year	
A.38	Earth Science Applications: Health and Air Quality Applied Sciences Team	04/17/2020	**06/30**/2020
A.39	Earth Science Applications: Ecological Forecasting	07/17/2020	08/14/2020
A.40	Advancing Collaborative Connections for Earth System Science	Not Solicited This Year	
A.41	**Citizen Science for Earth Systems Program**	**08/04/2020 (mandatory NOIs)**	**09/11/2020**
A.42	**Commercial SmallSat Data Analysis**	**07/01/2020 (mandatory NOIs)**	**09/01/2020**
A.43	Instrument Incubator Program	Not Solicited This Year	
A.44	**Advanced Component Technology**	**05/22/2020**	**07/21/2020**
A.45	In-Space Validation of Earth Science Technologies	TBD	TBD
A.46	Sustainable Land Imaging - Technology	Not Solicited This Year	
A.47	Decadal Survey Incubation	Not Solicited This Year	
A.48	Advanced Information Systems Technology	Not Solicited This Year	
A.49	**Solar Irradiance Science Team**	**08/07/2020**	**09/11/2020**
A.50	**SAGE III/ISS Science Team**	**09/18/2020**	**11/06/2020**
A.51	**Science Team for the OCO Missions**	**11/13/2020**	**01/13/2021**
B.1	Heliophysics Research Program Overview	N/A	N/A
B.2	Heliophysics Supporting Research	11/18/2020 (Step-1)	02/17/2021 (Step-2)
B.3	Heliophysics Theory, Modeling, and Simulations	Not Solicited This Year	

B.4	Heliophysics Guest Investigators Open	04/29/2020 (Step-1)	07/29/2020 (Step-2)
B.5	**Living With a Star Science**	**09/03/2020 (Step-1)**	**11/12/2020 (Step-2)**
B.6	Living With a Star Strategic Capabilities	TBD	TBD
B.7	**Space Weather Science Applications Operations 2 Research**	**12/16/2020 (Step-1)**	**02/17/2021 (Step-2)**
B.8	Heliophysics Technology and Instrument Development for Science	N/A	**09/09/**2020
B.9	Heliophysics Low Cost Access to Space	N/A	**10/07/**2020
B.10	**Heliophysics Flight Opportunities Studies**	**N/A**	**12/03/2020**
B.11	Heliophysics Flight Opportunities for Research and Technology	N/A	TBD
B.12	**Heliophysics Data Environment Enhancements**	**05/08**/2020 (Step-1)	**07/01**/2020 (Step-2)
B.13	Heliophysics U.S. Participating Investigator	**05/08**/2020 (Step-1)	**07/01**/2020 (Step-2)
B.14	**Early Career Investigator Program**	05/**27**/2020 (Step-1)	08/**26**/2020 (Step-2)
B.15	GOLD-ICON Guest Investigators	02/**24**/2021 (Step-1)	04/14/2021 (Step-2)
B.16	Parker Solar Probe Guest Investigators	01/20/2021 (Step-1)	03/17/2021 (Step-2)
B.17	**Interdisciplinary Science for Eclipse**	**Not Solicited This Year**	
C.1	Planetary Science Research Program Overview	N/A	N/A
C.2	**Emerging Worlds**	**04/17/2020** (Step-1)	06/01/2020 (Step-2)
C.3	**Solar System Workings**	11/13/2020	01/29/2021
C.4	Planetary Data Archiving, Restoration, and Tools	05/15/2020 (Step-1)	**07/24**/2020 (Step-2)
C.5	Exobiology	04/22/2020	05/22/2020
C.6	Solar System Observations	**04/22/2020** (Step-1)	06/**17**/2020 (Step-2)
C.7	New Frontiers Data Analysis	**09/03/2020** (Step-1)	**11/05/2020** (Step-2)
C.8	Lunar Data Analysis	12/01/2020 (Step-1)	02/26/2021 (Step-2)
C.9	Mars Data Analysis	09/25/2020 (Step-1)	11/20/2020 (Step-2)
C.10	Cassini Data Analysis	05/07/2020 (Step-1)	07/09/2020 (Step-2)

C.11	Discovery Data Analysis	08/28/2020 (Step-1)	10/30/2020 (Step-2)
C.12	Planetary Instrument Concepts for the Advancement of Solar System Observations	09/18/2020 (Step-1)	11/20/2020 (Step-2)
C.13	Maturation of Instruments for Solar System Exploration	04/17/2020 (Step-1)	**07/17**/2020 (Step-2)
C.14	**Planetary Science and Technology Through Analog Research**	**Not solicited This Year**	
C.15	Planetary Protection Research	Not solicited This Year	
C.16	Laboratory Analysis of Returned Samples	**05/15/2020 (Step-1)**	**07/14/2020 (Step-2)**
C.17	Planetary Major Equipment and Facilities: Appended proposals	See Program of Interest	
C.17	**Planetary Major Equipment and Facilities: Stand-alone proposals**	**12/04/2020 (Step-1)**	**02/05/2021 (Step-2)**
C.18	**Early Career Fellowship Start-Up Program for Named Fellows**	**Mandatory email to POC by 09/01/20**	**03/29/2021**
C.19	**Planetary Science Early Career Award Program**	**N/A**	**12/08/2020**
C.20	Development and Advancement of Lunar Instrumentation Program	04/17/2020 (Step-1)	**07/10/2020** (Step-2)
C.21	**Double Asteroid Redirection Test (DART) Participating Scientist Program**	**08/10/2020 (mandatory NOIs)**	**10/01/2020**
C.22	**Radioisotope Power Systems Enabling Missions Beginning with Research and Technology**	**Not Solicited This Year**	
C.23	Interdisciplinary Consortia for Astrobiology Research	Not Solicited This Year	
C.24	Yearly Opportunities for Research in Planetary Defense	**04/22/2020** (Step-1)	06/**17**/2020 (Step-2)
C.25	**Mars Organic Molecule Analyser (MOMA) Participating Scientist Program**	**Not Solicited This Year**	
C.26	**COLDTech: Autonomy, Communications, and Radiation-Hard Devices**	**12/01/2020 (Step-1)**	**02/19/2021 (Step-1)**
D.1	Astrophysics Research Program Overview	N/A	N/A
D.2	**Astrophysics Data Analysis**	**05/05/2020**	**07/16/2020**
D.3	**Astrophysics Research and Analysis**	10/23/2020 (mandatory NOIs)	12/17/2020

D.4	Astrophysics Theory Program	Not solicited This Year	
D.5	Neil Gehrels Swift Observatory Guest Investigator Cycle 17	N/A	09/25/2020 (Phase-1 via ARK RPS)
D.6	**Fermi Guest Investigator Cycle 14**	N/A	02/19/2021 (Phase-1 via ARK RPS)
D.7	**Strategic Astrophysics Technology**	**Not Solicited This Year**	
D.8	Nancy Grace Roman Technology Fellowships for Early Career Researchers	See D.3 and D.7	
D.9	**NuSTAR General Observer Cycle 7**	**N/A**	**01/29/2021 (Phase-1 via ARK RPS)**
D.10	**TESS Guest Investigator Cycle 4**	**N/A**	**01/22/2021 (Phase-1 via ARK RPS)**
D.11	**NICER Guest Observer Cycle 3**	N/A	11/17/2020 (Phase-1 via ARK RPS)
D.12	**X-Ray Imaging and Spectroscopy Mission Guest Scientist**	**Not Solicited This Year Moved to ROSES-21**	
D.13	Astrophysics Explorers U.S. Participating Investigators	**08/03/2020 (mandatory NOIs)**	**09/15/2020**
D.14	Theoretical and Computational Astrophysics Networks	N/A	**06/23/2020**
D.15	**LISA Preparatory Science**	**09/15/2020 (mandatory NOIs)**	**12/15/2020**
D.16	**Astrophysics Pioneers**	**08/13/2020 (mandatory NOIs)**	**10/08/2020**
D.17	**Extreme Precision Radial Velocity Foundation Science**	**12/17/2020 (Step-1)**	**01/28/2021 (Step-2)**
E.1	Cross Division Research Overview	N/A	N/A
E.2	**Topical Workshops, Symposia, and Conferences**	**N/A**	**Rolling submissions through 04/14/2021**
E.3	Exoplanets Research	03/27/2020 **(mandatory NOIs)** ~~(Step-1)~~	05/29/2020 ~~(Step-2)~~
E.4	**Habitable Worlds**	11/17/2020 (Step-1)	01/15/2021 (Step-2)
E.5	Future Investigators in NASA Earth and Space Science and Technology	N/A	TBD

E.6	**Science Activation Program Integration**	**03/25/2020**	**05/27/2020**
E.7	**Support for Open Source Tools, Frameworks, and Libraries**	**11/19/2020**	**01/19/2021**
E.8	**Supplemental Open Source Software Awards**	**N/A**	**Rolling submissions through 04/14/2021**
E.9	**Citizen Science Seed Funding Program**	**10/13/2020**	**12/11/2020**

Notes:

[1] Amended due dates and new program elements will be indicated with bold red text as ROSES-2020 is amended through the year.

[2] See Sections IV(b)(vi) and IV(b)(vii) of the *Summary of Solicitation* for a discussion of Notice of Intent (NOI) vs. a Step-1 proposal. If NOIs are requested, a due date is provided in the table. If NOIs are required by a program in order to be able to submit a proposal, it will be indicated on this table with "(mandatory)". If NOIs are replaced by a Step-1 proposal, the table entry will include that information.

APPENDIX A. EARTH SCIENCE RESEARCH PROGRAM

A.1 EARTH SCIENCE RESEARCH OVERVIEW

NOTICE: Corrected June 29, 2020. This overview has been updated to reflect the addition of three new program elements (A.49-A.51) and the change in status of A.33 TASNPP, which was originally listed as not solicited, to one that will be solicited. References to these program elements have been added/changed in the appropriate places in sections 2.1-2.6, and brief descriptions of them have been added to Section 2.7. No other changes to this overview have been made. New text is in bold, deleted text is struck through.

1. Introduction

NASA's Earth Science Research Program supports research activities that address the Earth system and seek to characterize its properties on a broad range of spatial and temporal scales, to understand the naturally occurring and human-induced processes that drive them, and to improve our capability for predicting its future evolution. The focus of the Earth Science Research Program is the use of space-based measurements to provide information not available by other means. NASA's program is an end-to-end one that starts with the development of observational techniques and the instrument technology needed to implement them; tests them in the laboratory and from an appropriate set of *in situ,* surface-, ship-, balloon-, aircraft-, and/or space-based platforms; uses the results to increase basic process knowledge; incorporates results into complex computational models that can be used to more fully characterize the present state and future evolution of the Earth system; and develops partnerships with other national and international organizations that can use the generated information in environmental forecasting and in policy, business, and management decisions.

The scientific documentation underlying the Earth Science Research Program provides a comprehensive background for the science solicited here. The Research Program addresses NASA's Strategic Goal 1.1 to "Understand The Sun, Earth, Solar System, and Universe". (See the most recent *NASA Strategic Plan: https://www.nasa.gov/sites/default/files/atoms/files/nasa_2018_strategic_plan.pdf*). In particular, it addresses the more specific Science Goals (see the *Science Plan for NASA's Science Mission Directorate* (hereafter the *NASA Science Plan*), also available at https://smd-prod.s3.amazonaws.com/science-red/s3fs-public/atoms/files/2014_Science_Plan_PDF_Update_508_TAGGED_1.pdf), which are to:

- Advance the understanding of changes in the Earth's radiation balance, air quality, and the ozone layer that result from changes in atmospheric composition;
- Improve the capability to predict weather and extreme weather events;
- Detect and predict changes in Earth's ecosystems and biogeochemical cycles, including land cover, biodiversity, and the global carbon cycle;
- Enable better assessment and management of water quality and quantity to accurately predict how the global water cycle evolves in response to climate change;

- Improve the ability to predict climate changes by better understanding the roles and interactions of the oceans, atmosphere, land, and ice in the climate system;
- Characterize the dynamics of the Earth's surface and interior, improving the capability to assess and respond to natural hazards and extreme events; and
- Further the use of Earth system science research to inform decisions and provide benefits to society.

The most up-to-date description of the Earth Science Research Program may be found in Section 4.2 of the *NASA Science Plan* at http://science.nasa.gov/about-us/science-strategy. The most recent Decadal Survey covering NASA's Earth science activities, *Thriving on our Changing Planet: A Decadal Strategy for Earth Observation from Space*, was released on 1/5/2018 by the National Academies of Science, Engineering, and Medicine (see https://www.nap.edu/catalog/24938/thriving-on-our-changing-planet-a-decadal-strategy-for-earth). This 2017 Decadal Survey now serves as a foundational document for NASA's Earth Science Division (ESD), and includes recommendations for the scopes, foci, and relative budgetary magnitudes of the Research and Analysis (R&A), Applications, and Technology portions of the ESD program. In addition, the Decadal Survey includes a specific endorsement of the NASA missions making up the 2017 Program of Record (comprehensively defined in the Survey's Appendix A).

NASA's Earth Science Research Program is a major contributor to several interagency efforts within the U.S. Government, most notably the U.S. Global Change Research Program (USGCRP, see http://www.globalchange.gov), to which NASA is the major contributor. This program released its strategic plan in 2012, the National Global Change Research Plan 2012-2021: A Strategic Plan for the U. S. Global Change Research Program (http://www.globalchange.gov/browse/reports/national-global-change-research-plan-2012–2021-strategic-plan-us-global-change). This plan is updated triennially; the most recent such update may be found at https://downloads.globalchange.gov/strategic-plan/2016/usgcrp-strategic-plan-2016.pdf. Similarly, there are interagency programs related to Weather, Oceans and the Arctic. In addition, there are several other subgroups of the Committee on the Environment that serve to provide interagency coordination in areas covered by NASA's Earth Science Research Program. NASA's Earth Science Research Program has focused bilateral efforts with other Federal agencies on transitioning knowledge and approaches from research to operations, most notably with the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Geological Survey (USGS).

Research is solicited in four major areas for the Earth Science Research Program: research and analysis (R&A), satellite missions, applied sciences, and enabling capabilities, with R&A containing the bulk of the solicited research. R&A emphasizes the development of new scientific knowledge, including the analysis of data from NASA satellite missions and the development and application of complex models that assimilate these science data products and/or use them for improving predictive capabilities. Within the Earth Science Research Program, the research and analysis activities include those historically coming under R&A, mission science team, interdisciplinary science, and calibration/validation activities.

The applied sciences area supports efforts to discover and demonstrate innovative and practical uses of NASA Earth science observations and research through applications

projects carried out in partnership with end user organizations (http://AppliedSciences.nasa.gov/). Applied sciences, thus, serves as a bridge between the data, modeling, and knowledge generated by NASA Earth science and the information required by Government agencies, companies, and organizations to improve their products, services, and decision making.

Enabling capabilities include those programmatic elements with sufficient breadth to contribute to a broad range of activities within the Earth Science Research Program and typically involve the development of some kind of capability whose sustained availability is considered to be important for the Program's future. These include focused activities in support of education; data, information, and management; and airborne science, as well as some broadly-based technology-related elements (others which are very focused towards a single scientific area of the Earth Science Research Program will be solicited through the R&A area).

The overarching goal of NASA's Earth Science program is to develop a scientific understanding of Earth as a system. Scientific knowledge is most robust and actionable when resulting from transparent, traceable, and reproducible methods, requiring open access to not only the data used in scientific analysis, but the software used to arrive at results as well. Additionally, software developed to be openly accessible, without restrictions on modification and distribution, enables reuse across Federal agencies, reduces overall costs to the Government, removes barriers to innovation, ensures consistency through the application of uniform standards, and facilitates collaboration between agencies and non-Federal institutions. NASA addresses these goals by encouraging the open development, access, and distribution of the source code used to generate, manipulate, and analyze science data and results.

Program elements will give preference to proposals that include a plan for committing software as Open Source Software (OSS), beginning at the inception of the proposed work. This plan will include the identification of software components developed as part of the proposed work, and designate a permissive, widely accepted OSS license and a public repository hosting service for these components. Please read the individual appendices and associated amendments carefully and contact the program officers if you have any questions regarding OSS development for a given call.

Contracts will not be issued in response to proposals submitted to the research program elements in Appendix A, unless otherwise noted (e.g., exceptions include calls for flight hardware). Instead, awards to non-governmental organizations will be made in the forms of grants or cooperative agreements, which are most appropriate given the nature of the work solicited. Awards internal to the government will be made through the usual Agency processes.

Earth Science Division Templates for the Table of Work Effort and Current and Pending Support are now required for an increasing number of program elements in Appendix A, including A.3, A.7, A.8, A.14, A.17 A.26, A.27, A.38, and A.39.

1.1 Data Management Plans and Archiving

New in ROSES-2020: The data management plan (DMP) will be evaluated as part of the Intrinsic Merit of the proposal and must be included in a special section (see below).

To broaden access to the results of NASA-funded research, most proposals to ROSES require a data management plan (DMP) or an explanation of why one is not necessary given the nature of the work proposed. The philosophy behind this requirement is that all relevant taxpayer-supported data should be made publicly available (i.e., without fee or restriction of use) at the time of publication, or at the earliest practical time thereafter, through a stable and long-term supported public data repository. Where proposals do not generate or otherwise produce data suitable for deposition in a public, then that should be explicitly justified in the DMP. Individual program elements may provide instructions that amplify the following requirements, but those stated below are the minimum.

The kinds of proposals that require a data management plan are described in the NASA Plan for increasing access to results of Federally funded research and in the SARA DMP Frequently Asked Questions (FAQs) for ROSES. Proposals to instrument development programs (e.g., Advanced Information Systems Technology, the Instrument Incubator Program, Advanced Component Technology, and In-Space Validation of Earth Science Technologies) do not require a DMP. Moreover, select calls, include data requirements in the text that make redundant Any proposal intending to submit data products for archival and public distribution by a NASA Distributed Active Archive Center (DAAC) should review guidelines on the Earthdata web site.

For some program elements, the nature of the work is inexorably linked to the handling of data so DMP is part of the page limited for Scientific/Technical/Management (S/T/M) section of the proposal, e.g., A.8 GEDI Science Team (ST). With the exception of elements like A.8 GEDI ST where it explicitly says otherwise, all proposals to any of the ROSES elements that require DMPs must place it in a special section of the proposal, not to exceed two pages in length entitled "Data Management Plan" immediately following the references and citations for the S/T/M portion of the proposal. The two-page DMP section does not count against the 15-page limit of the S/T/M section. Formatting requirements for DMPs are the same as for the S/T/M section.

The DMP must cover any data needed to validate the scientific conclusions of peer-reviewed publications, particularly data underlying figures, maps, and tables. It also needs to cover any other data and software that would enable future research or the replication/reproduction of published results.

"Data" does not include preliminary and other unpublished data, data in prepublication documents, private communications, or certain other types of information that have been specifically exempted from the DMP requirement.

In the case of a project that would produce no data, as defined above, or only data specifically exempted, the DMP must state that no data preservation or data sharing is needed, but must also explain why. In a case where no appropriate archive exists for a particular data set, the DMP should discuss alternative methods for making the data publicly available.

The DMP must contain the following elements, as appropriate to the project, in adequate detail for review:

- A description of data types, volume, formats, and (where relevant) standards;
- A description of the schedule for data archiving and sharing;

- A description of the intended repositories for archived data, including mechanisms for public access and distribution;
- A discussion of how the plan enables long-term preservation of data;
- A discussion of roles and responsibilities of team members in accomplishing the DMP. If funds are required for data management activities, these should be covered in the normal budget and budget justification sections of the proposal.

Software, whether a stand-alone program, an enhancement to existing code, or a module that interfaces with existing codes, created as part of a ROSES award, should be made publicly available when it is practical and feasible to do so, and when there is scientific utility in doing so. Stand-alone code that is not straightforward to implement, or whose utility is significantly outweighed by the costs to share it, is not expected to be made available. This expectation extends to three types of software, defined as follows:

Short Name	Name	Description	Examples
Libraries	Libraries and toolkits	Generic tools implementing well-known algorithms, providing statistical analysis or visualization, and so on, that are incorporated in other software categories.	Numerical Recipes, NumPy, general FFTs, LAPACK, scikit-learn, AstroPy, GDAL
Analysis software	Analysis, post-processing, or visualization software	Generalized software (not low-level libraries) used to manipulate measurements or model results to visualize or gain understanding.	Stand-alone image processing, topology analysis, vector-field analysis, satellite analysis tools, and so on
Frameworks	Modeling frameworks	Multicomponent software systems that incorporate a variety of models and couple them together in a complex way.	Community Earth System Model (CESM) is a collection of coupled models including atmospheric, oceanographic, sea ice, land surface, and other models

NASA expects that the source code, with associated documentation sufficient to enable use of the code, will be made publicly available as Open Source Software (OSS). This includes all software developed with ESD funding used in the production of data products, as well as software developed to discover, access, visualize, and transform NASA data. OSS is defined as software that can be accessed, used, modified, and shared by anyone. The definition of OSS, along with examples of OSS licensing and public code repositories, can be found on the Earthdata web site. Some elements, like A.9 Physical Oceanography and A.14 Ocean Surface Topography Science Team require a separate Software Development Plan. Please read the program elements carefully.

General statement about model results or any derived data products: Whether derived products and model output should be archived is determined by the scientific utility and need on a case-by-case basis. When these types of data/output are considered for

long-term archive and availability at a DAAC the utility is evaluated by the DAAC UWG and the DAAC program scientist. If it is determined there is sufficient scientific justification and budget a DAAC will then archive the data. See this web page for details: https://earthdata.nasa.gov/collaborate/new-missions/adding-competitive-other.

For proposals that use non-mission data (e.g., laboratory results, Earth-based observations) not publicly available (e.g., in a publicly accessible archive, in the literature, etc.), the project is expected to make the data available following the Data Management Plan guidelines.

The sufficiency of the data management plan (DMP) will be evaluated as part of Merit and thus may have a bearing on whether or not the proposal is selected. Proposals that do not address each of these items in their DMP, even if determined to be selected or selectable for funding, may not be funded until an adequate DMP is submitted. Funded researchers, research institutions, and NASA centers are responsible for ensuring and demonstrating compliance with the DMPs approved as part of their awards. Awardees who do not fulfill the intent of their DMPs may have continuing funds withheld and this may be considered in the evaluation of future proposals.

2. Earth Science Research and Analysis Focus Areas

The Earth Science R&A activity is built around the creation of new scientific knowledge about the Earth system. The analysis and interpretation of data from NASA's satellites form the heart of the R&A program in the Earth Science Research Program, although a full range of underlying scientific activity needed to establish a rigorous base for the satellite data and their use in computational models, including those for assimilation and forecasting, is also included. The complexity of the Earth system, in which spatial and temporal variability exists on a range of scales, requires that an organized scientific approach be developed for addressing the complex, interdisciplinary problems that exist, taking good care that, in doing so, there is a recognition of the objective to integrate science across the programmatic elements towards a comprehensive understanding of the Earth system.

In the Earth system, these elements may be built around aspects of the Earth that emphasize the particular attributes that make it stand out among known planetary bodies. These include the presence of carbon-based life and their associated ecology; water in multiple, interacting phases; a fluid atmosphere and ocean that redistribute heat over the planetary surface; an oxidizing and protective atmosphere, *albeit* one subject to a wide range of fluctuations in its physical properties (especially temperature, moisture, and winds); a solid but dynamically active surface and interior that drive changes in the Earth's shape, orientation, rotation, gravity, and surface and atmospheric composition; and an external environment driven by a large and varying star whose magnetic field also serves to shield the Earth from the broader astronomical environment. The resulting structure is comprised of six interdisciplinary science Focus Areas:

- Carbon Cycle and Ecosystems,
- Water and Energy Cycle,
- Climate Variability and Change,
- Atmospheric Composition,

- Weather and Atmospheric Dynamics, and
- Earth Surface and Interior.

These Focus Areas form the basis around which R&A activity is solicited for the Earth Science Research Program. Given the interconnectedness of these science Focus Areas, research that crosses individual Focus Areas is also sought, and a number of specific cases of such connectivity will be identified in some of the specific research opportunities identified below. In particular, several instrument science teams for NASA satellite missions are solicited through this NRA. These can contribute to scientific advances in several areas, and potential investigators may want to look carefully at all such teams for opportunities that may be relevant to them. In addition, there are several cross-cutting elements included within this appendix, most notably one that solicits proposals that address rapid response to significant Earth system events, as well as truly novel work that doesn't easily fit the active ROSES-2020 elements this year or in the recent past (Rapid Response and Novel Research in Earth Science – program element A.28).

Several elements solicited in prior years are not being solicited this year, but have program-specific ROSES-2020 elements for completeness, as well as to provide potential proposers with plans about the anticipated dates of the next solicitation.

- Terrestrial Ecology (program element A.4);
- Ocean Salinity Science Team (program element A.10);
- Sea Level Change Team (program element A.11);
- SWOT Science Team (program element A.12);
- Ocean Vector Winds Science Team (program element A.15);
- Atmospheric Composition: Radiation Sciences Program (program element A.20);
- Atmospheric Composition: Modeling and Analysis (program element A.21);
- Atmospheric Composition: Tropospheric Composition Program (program element A.22);
- Weather and Atmospheric Dynamics (program element A.25);
- Airborne Instrument Technology Transition (program element A.29);
- Interdisciplinary Research (program element A.31);
- ~~The Science of Terra, Aqua, and Suomi-NPP (program element A.33);~~
- Earth Science Applications: Water Resources (program element A.35):
- SERVIR Applied Science Team (program element A.36);
- Earth Science Applications: Disaster Risk Reduction and Resilience (program element A.37);
- Advancing Collaborative Connections for Earth System Science (program element A.40);
- Instrument Incubator Program (program element A.43);
- Sustainable Land Imaging – Technology (program element A.46);
- Decadal Survey Incubation (program element A.47); and
- Advanced Information Systems Technology (program element A.48).

Elements for which it has not yet been decided whether or not to solicit during the period of applicability of ROSES-2020 are not included in this list, but are included by focus area and/or program component later in Appendix A. Note that not all elements

which have been solicited in previous ROSES are included this year; some will reappear in future solicitations at an appropriate time that should allow for smooth transition between the currently funded tasks and those that would come out of the next solicitation.

2.1 Carbon Cycle and Ecosystems

The carbon cycle, which encompasses the flow and transformation of carbon between reservoirs, is the backbone that sustains life on planet Earth. The cycling of carbon dioxide and methane into the atmosphere contributes to the planetary greenhouse effect and global climate. Organic and inorganic carbon flow through ecosystems as part of food webs, and interact with the climate system. Earth's carbon cycle and ecosystems are subject to human intervention and environmental changes on an unprecedented scale, in both rate and geographical extent. This has the potential to impact ecosystem services, which provide a wide variety of essential goods to human societies. Our ability to ameliorate, adapt to, or benefit from these rapid changes requires fundamental knowledge of the responses of the carbon cycle and terrestrial and marine ecosystems to global change. Also required is an understanding of the implications of these changes for food production, biodiversity, sustainable resource management, and the maintenance of a healthy, productive environment.

The Carbon Cycle and Ecosystems Focus Area addresses: (1) the distribution and cycling of carbon among the active terrestrial, marine, and atmospheric reservoirs and (2) ecosystems as they are affected by human activity, as they change due to their own intrinsic biogeochemical dynamics, and as they respond to climatic variations and, in turn, affect climate. Research activities focus on providing data and information derived from remote sensing systems to answer the following science questions:

- How are global ecosystems changing?
- What changes are occurring in global land cover and land use, and what are their causes?
- How do ecosystems, land cover and biogeochemical cycles respond to and affect global environmental change?
- What are the consequences of land cover and land use change for human societies and the sustainability of ecosystems?
- What are the consequences of climate change and increased human activities for coastal regions?
- How will carbon cycle dynamics and terrestrial and marine ecosystems change in the future?

Frequent, repeat observations from space, at both moderate and high spatial resolutions, are required to address the heterogeneity of living systems. Complementary airborne and *in situ* observations, intensive field campaigns and related process studies, fundamental research, data and information systems, and modeling are employed to interpret the satellite observations and answer the science questions.

The goal of the Carbon Cycle and Ecosystems Focus Area is to:

- Quantify, understand, and predict changes in Earth's ecosystems and biogeochemical cycles, including the global carbon cycle, land cover, and biodiversity.

Anticipated products and payoffs include:

- Assessments of ecosystem response to climatic and other environmental changes and the effects on food, fiber, biodiversity, primary productivity, and other ecological goods and services;
- Quantitative carbon budgets for key ecosystems along with the identification of sources and sinks of carbon dioxide and other greenhouse gases;
- Documentation and prediction of land-cover and land-use change, as well as assessments of consequences to society and for resource sustainability;
- Identification of factors that determine the distribution and abundance of elements of biodiversity as well as how biodiversity acts as a driver on the wider Earth System;
- Understanding of ecosystem interactions with the atmosphere and hydrosphere leading to comprehensive modeling of the exchange of gases, aerosols, water, and energy among the components of the Earth system; and
- Improved representations of ecosystem and carbon cycling processes within global climate models leading to more credible predictions of climate and other Earth system functions.

Interdisciplinary collaborations with other Earth Science Research Program Focus Areas include:

- Work with the Water and Energy Cycle Focus Area on land-atmosphere exchanges of water and energy and the effects of land-cover and land-use change on water resources;
- Work with the Atmospheric Composition Focus Area on surface emissions and atmospheric transport of trace gases and aerosols and on measurement of carbon-containing greenhouse gases;
- Work with the Climate Variability and Change and Weather and Atmospheric Dynamics Focus Areas on air-sea CO_2 exchange and to share the observations of climate, weather, ecosystems, and land cover that are needed to drive Earth system models; and
- Coordinate with the Earth Surface and Interior Focus Area to advance and/or exploit radar, lidar, and hyperspectral remote sensing technologies for surface properties.

The ROSES elements most closely directed towards the Carbon Cycle and Ecosystems Focus Area that are or may be soliciting proposals in ROSES-2020 are:

- Land-Cover and Land-Use Change (program element A.2);
- Ocean Biology and Biogeochemistry (program element A.3);
- Carbon Cycle Science (program element A.5);
- Carbon Monitoring System (program element A.6);
- Biodiversity (program element A.7); and

- GEDI Science Team (program element A.8).

Topics relevant to the Carbon Cycle and Ecosystems Focus Area that are actively or potentially soliciting in ROSES-2020 include the following program elements:

- Atmospheric Composition Campaign Data Analysis and Modeling (program element A.23);
- Rapid Response and Novel Research in Earth Science (program element A.28);
- U.S. Participating Investigator (program element A.30);
- New (Early Career) Investigator Program in Earth Science (program element A.32);
- **The Science of Terra, Aqua, and Suomi-NPP (program element A.33);**
- Studies With ICESat-2 (program element A.34);
- Health and Air Quality Applied Sciences Team (program element A.38);
- Citizen Science for Earth Systems Program (program element A.41);
- Commercial SmallSat Data Evaluation Team (program element A.42);
- Advanced Component Technology (program element A.44);
- In-space Validation of Earth Science Technologies (program element A.45);
- **Science Team for the OCO Missions (program element A.51); and**
- Topical Workshops, Symposia, and Conferences (program element E.2).

2.2 Climate Variability and Change

Climate change is one of the major themes guiding Earth System Science today, and NASA is at the forefront of quantifying forcings and feedbacks of recent and future climate change. To address the challenging questions associated with Climate Variability and Change, NASA implements a comprehensive end-to-end program which ranges from global high-resolution observations to data assimilation and model predictions. Recently, the Climate Variability and Change Focus Area has directed its research toward addressing five specific questions:

- How and why is global ocean circulation varying on interannual, decadal, and longer time scales?
- What changes are occurring in the mass and extent of the Earth's ice cover, and what drives them?
- How is global sea level affected by natural variability and human-induced change in the Earth system?
- What are the climate-relevant land, atmosphere, ocean, cryosphere and biospheric processes, and how do they interact?
- How can predictions of climate variability and change be improved?

NASA provides near-global coverage of key observations for studying the climate system. This includes selected ocean properties every two to ten days as well as observations of the vast expanses of polar land and sea ice. Importantly, these observations are provided at the temporal and spatial scales necessary to detect change. Current capabilities include global measurements of sea-surface topography, ocean-vector winds, ice topography and motion, and mass movements of the Earth's fluid envelope and cryosphere. By combining these observation with other NASA space-based measurements, the ocean and cryosphere can be linked to other components of

the Earth System which are the topic of other Focus Areas such as cloud distribution, snow cover, surface temperatures, humidity characteristics and others. In addition to investments in space-based observations, NASA maintains an active research program to utilize data from satellites to both improve our understanding of these components of the Earth system and the interactions between them and to assess how satellite observations can be used to improve predictive capability.

Climate-variability and change research is now not just a global issue, but also a research problem that directly impacts regional to local environments. In fact, local-to-regional anthropogenic-induced changes are having global impacts whose magnitudes are expected to increase in the future. Climate models have moved toward higher and higher spatial resolution as computer resources have improved. During the next decade, climate models are expected to approach the spatial resolution of weather and regional models as more details of Earth System processes are incorporated.

The climate system is dynamic and complex, and modeling is the only way we can effectively integrate the observations and current knowledge of individual components fully to characterize current conditions and underlying mechanisms, as well as to project the future states of the climate system. This modeling requires a concerted effort both to improve the representation of physical, chemical, and biological processes and to incorporate observations into climate models through data assimilation and other techniques. The ultimate objective is to enable a predictive capability of climate change on time scales ranging from seasonal to multidecadal.

The ROSES elements most closely directed towards the Climate Variability and Change Focus Area that are or may be soliciting proposals in ROSES-2020 are:

- Physical Oceanography (program element A.9);
- Ocean Salinity Field Campaign (program element A.13);
- Ocean Surface Topography Science Team (program element A.14);
- Modeling, Analysis, and Prediction (program element A.16); and
- Cryospheric Science (program element A.17).

Topics relevant to the Climate Variability and Change Focus Area that are actively or potentially soliciting in ROSES-2020 include the following program elements:

- Carbon Monitoring System (program element A.6);
- GEDI Science Team (program element A.8);
- Atmospheric Composition Campaign Data Analysis and Modeling (program element A.23);
- CYGNSS Competed Science Team (program element A.27);
- U.S. Participating Investigator (program element A.30);
- New (Early Career) Investigator Program in Earth Science (program element A.32);
- **The Science of Terra, Aqua, and Suomi-NPP (program element A.33);**
- Studies With ICESat-2 (program element A.34);
- Health and Air Quality Applied Sciences Team (program element A.38);
- Citizen Science for Earth Systems Program (program element A.41);
- Commercial SmallSat Data Evaluation Team (program element A.42);

- Advanced Component Technology (program element A.44);
- In-space Validation of Earth Science Technologies (program element A.45);
- **Solar Irradiance Science Team (program element A.49);**
- **SAGE III/ISS Science Team (program element A.50);**
- **Science Team for the OCO Missions (program element A.51); and**
- Topical Workshops, Symposia, and Conferences (program element E.2).

2.3 Atmospheric Composition

Changes in atmospheric composition affect air quality, weather, climate, and critical constituents, such as ozone and aerosol particles. Atmospheric exchange links terrestrial and oceanic pools within the carbon cycle and other biogeochemical cycles. Solar radiation affects atmospheric chemistry and is, thus, a critical factor in atmospheric composition. Atmospheric composition, in turn, affects incoming solar and outgoing long wave radiation. Atmospheric composition is central to Earth system dynamics, since the atmosphere integrates surface emissions globally on time scales from weeks to years and couples several environmental issues. NASA's research for furthering our understanding of atmospheric composition is geared to providing an improved prognostic capability for such issues (e.g., the recovery of stratospheric ozone and its impacts on surface ultraviolet radiation, the evolution of greenhouse gases and their impacts on climate, the impact of clouds and aerosol particles on the Earth's energy budget and the evolution of aerosols and tropospheric ozone and their impacts on climate and air quality). Toward this end, research within the Atmospheric Composition Focus Area addresses the following science questions:

- How is atmospheric composition changing?
- What trends in atmospheric composition and solar radiation are driving global climate?
- How does atmospheric composition respond to and affect global environmental change?
- What are the effects of global atmospheric composition and climate changes on regional air quality?
- How will future changes in atmospheric composition affect ozone, climate, and global air quality?

NASA expects to provide the necessary monitoring and evaluation tools to assess the effects of climate change on ozone recovery and future atmospheric composition, improved climate forecasts based on our understanding of the forcings of global environmental change, and air quality forecasts that take into account the feedbacks between regional air quality and global climate change. Achievements in these areas via advances in observations, data assimilation, and modeling enable improved predictive capabilities for describing how future changes in atmospheric composition affect ozone, climate, and air quality. Drawing on global observations from space, augmented by airborne, balloon, and ground-based measurements, NASA is uniquely poised to address these issues. This integrated observational strategy is furthered via studies of atmospheric processes using unique suborbital platform-sensor combinations to investigate, for example: (1) the processes responsible for the emission, uptake, transport, and chemical transformation of ozone and precursor molecules associated

with its production in the troposphere and its destruction in the stratosphere; and (2) the formation, properties, and transport of aerosol particles in the Earth's troposphere and stratosphere, as well as aerosol particle interaction with clouds. NASA's research strategy for atmospheric composition encompasses an end-to-end approach for instrument design, data collection, analysis, interpretation, and prognostic studies.

The ROSES elements most closely directed towards the Atmospheric Composition Focus Area that are or may be soliciting proposals in ROSES-2020 are:

- Atmospheric Composition: Upper Atmospheric Composition Observations (program element A.18);
- Atmospheric Composition: Laboratory Research (program element A.19); and
- Atmospheric Composition Campaign Data Analysis and Modeling (program element A.23).

Topics relevant to the Atmospheric Composition Focus Area are actively or potentially soliciting in ROSES-2020 include the following program elements:

- Ocean Biology and Biogeochemistry (program element A.3);
- Carbon Cycle Science (program element A.5);
- Carbon Monitoring System (program element A.6);
- Modeling, Analysis, and Prediction (program element A.16);
- Rapid Response and Novel Research in Earth Science (program element A.28);
- U.S. Participating Investigator (program element A.30);
- New (Early Career) Investigator Program in Earth Science (program element A.32);
- **The Science of Terra, Aqua, and Suomi-NPP (program element A.33);**
- Studies With ICESat-2 (program element A.34);
- Health and Air Quality Applied Sciences Team (program element A.38);
- Citizen Science for Earth Systems Program (program element A.41);
- Commercial SmallSat Data Evaluation Team (program element A.42);
- Advanced Component Technology (program element A.44);
- In-space Validation of Earth Science Technologies (program element A.45);
- **Solar Irradiance Science Team (program element A.49);**
- **SAGE III/ISS Science Team (program element A.50);**
- **Science Team for the OCO Missions (program element A.51); and**
- Topical Workshops, Symposia, and Conferences (program element E.2).

2.4 Water and Energy Cycle

Earth is a unique, living planet in our Solar System due to the abundance of water and the vigorous cycling of that water throughout its global environment. The global water cycle represents the transport and transformation of water within the Earth system, and, as such, distributes fresh water over the Earth's surface. The water cycle operates on a continuum of time and space scales and exchanges large amounts of energy as water undergoes phase changes and is moved from one part of the Earth system to another. Through latent heat release from condensation and sublimation, the water cycle is a major driving agent of global atmospheric circulation. Clouds play a critical role in modulating the flow of energy into and out of the Earth system, while at the same time

modulating the continuous supply of solar energy that keeps the water cycle in motion. So, while the water cycle delivers the hydrologic consequences of climate changes, the global water cycle is both a consequence of, and influence on, the global energy cycle.

The global water and energy cycles maintain a considerable influence upon the global pathways of biogeochemical cycles. The cycling of water and energy and nutrient exchanges among the atmosphere, ocean, and land help determine the Earth's climate and cause much of the climate's natural variability. Natural and human-induced changes to the water and energy cycle have major impacts on industry, agriculture, and other human activities. For example, increased exposure and density of human settlements in vulnerable areas amplify the potential loss of life, property, and commodities that are at risk from intense precipitation events. Improved monitoring and prediction of the global water and energy cycle enable improved knowledge of the Earth system that must be nurtured to proactively mitigate future adversities. Current and forthcoming projections of such impacts will remain speculative unless fundamental understanding is assimilated into global prediction systems and effective decision-support tools applicable to local conditions.

The Terrestrial Hydrology Program resides exclusively within the Water and Energy Cycle Focus Area. Other programs (Radiation Sciences, Weather and Atmospheric Dynamics, and Land-Cover Land-Use Change) which contribute to this focus area are shared with other focus areas (Atmospheric Composition, Weather and Atmospheric Dynamics, and Carbon Cycle and Ecosystems, respectively). In brief, the Water and Energy Cycle Focus Area seeks to address the topics discussed above by enhancing our understanding of the transfer and storage of water and energy in the Earth system. For the water cycle, the Focus Area's emphasis is on atmospheric and terrestrial stores, including seasonal snow cover. Permanent snow and ice, as well as ocean dynamics, are studied within the Climate Variability and Change Focus Area. The Water and Energy Cycle Focus Area aims to resolve all fluxes of water and the corresponding energy fluxes involved with water changing phase.
In addition to the study of the individual components of the water and energy cycle, this Focus Area places a high priority on integrating these components in a coherent fashion as is pursued by the NASA Energy and Water Cycle Study (NEWS), for which more information can be found at https://wec.gsfc.nasa.gov. NEWS has been established to create a mechanism to export and import information, results, and technology to and from other U.S. agencies and international partners concerned with the study and observation of water and energy cycles, such as the Global Energy and Water Cycle Exchanges project (GEWEX; http://www.gewex.org/).

All of the Focus Area's activities should enhance the community's ability to answer these research questions:

- How are global precipitation, evaporation, and the cycling of water changing?
- What are the effects of clouds and surface hydrologic processes on Earth's climate?
- How are variations in local weather, precipitation, and water resources related to global climate variation?
- What are the consequences of land cover and land use change for human societies and the sustainability of ecosystems?

- How can weather forecast duration and reliability be improved?
- How can prediction of climate variability and change be improved?
- How will water cycle dynamics change in the future?

Pursuit of answers to these questions should lead to research products, such as satellite data and model outputs, that are useful to activities sponsored by the Applied Sciences Program, in particular, the Applications areas of water resources, disasters, and ecological forecasting (see Section 3 for more details on the Applied Sciences Program). Ultimately, Water and Energy Cycle Focus Area-sponsored activities will lead to the fulfillment of its goal: "Models capable of predicting the water cycle, including floods and droughts, down to tens of kilometers resolution."

The ROSES elements most closely directed towards the Water and Energy Cycle Focus Area that are or may be soliciting for proposals in ROSES-2020 are:

- Terrestrial Hydrology (program element A.24).

Topics relevant to the Water and Energy Cycle Focus Area that are actively or potentially soliciting in ROSES-2020 include the following program elements:

- Carbon Cycle Science (program element A.5);
- CYGNSS Competed Science Team (program element A.27);
- Rapid Response and Novel Research in Earth Science (program element A.28);
- U.S. Participating Investigator (program element A.30);
- New (Early Career) Investigator Program in Earth Science (program element A.32);
- **The Science of Terra, Aqua, and Suomi-NPP (program element A.33);**
- Citizen Science for Earth Systems Program (program element A.41);
- Commercial SmallSat Data Evaluation Team (program element A.42);
- Advanced Component Technology (program element A.44);
- In-space Validation of Earth Science Technologies (program element A.45); and
- Topical Workshops, Symposia, and Conferences (program element E.2).

2.5 Weather and Atmospheric Dynamics

The Weather and Atmospheric Dynamics Focus Area represents the cooperation among NASA programs for Atmospheric Dynamics, Weather Forecast Improvement, and Ocean and Land Remote Sensing. It has strong ties to other Focus Areas, especially Climate Variability and Change and Water and Energy Cycle, and it has a supporting role in Carbon Cycle and Ecosystems and the Atmospheric Composition Focus Areas.

The Weather and Atmospheric Dynamics Focus Area is primarily designed to apply NASA scientific remote sensing expertise to the problem of obtaining accurate and globally distributed measurements of the atmosphere and the use of these measurements in retrievals, research, and operational weather forecast models in order to both enhance our understanding of weather systems and their role(s) in the Earth system, as well as to improve and extend U.S. and global weather prediction. This Focus Area is implemented in coordination with other U.S. agencies' programs and it is guided by the question from the 2003 Earth Science Enterprise Strategy:

- How can weather forecast duration and reliability be improved?

NASA sponsored research continues to gain new insight into weather and extreme-weather events by the utilization of data obtained from a variety of NASA- and partner satellite platforms and hurricane field experiments. Major numerical weather prediction (NWP) centers both outside (European Centre for Medium Range Weather Forecasts (ECMWF) and in the U.S. – NOAA/National Centers for Environmental Prediction (NCEP), NASA Global Modeling and Assimilation Office (GMAO), and the U.S. Navy – have shown notable improvements from the assimilation of Atmospheric Infrared Sounder (AIRS) data into their operational forecast systems.

An extra benefit of AIRS data assimilation at NWP centers is its use in establishing readiness to assimilate data from other current and future operational instruments, as has been demonstrated for the Crosstrack Infrared Sounder (CrIS) on the Suomi National Polar-orbiting Partnership (NPP) and Joint Polar Satellite System-1 satellite slaunched in October 2011 and November, 2017, respectively. Recent advancement in the Nation's operational geostationary capability, especially the Advanced Baseline Imager (ABI) and Geostationary Lightning Mapper (GLM) on the Geostationary Operational Environmental Satellite (GOES) – R series are of interest to the Weather and Atmospheric Dynamics Focus Area. Currently NASA is prioritizing on assimilating all-sky radiance into GEOS-5 to take advantage of the GPM data.

The study and analysis of the dynamics of the atmosphere and its interaction with the oceans and land is also an important component of the Weather and Atmospheric Dynamics Focus Area. Improvement of our knowledge of weather processes and related phenomena is crucial in gaining a better understanding of the Earth system. Applying NASA Scientific remote sensing data such as from the Global Precipitation Measurement (GPM) mission, GOES, ATMS, SMAP, and CYGNSS could lead to improved retrieval algorithms, increased knowledge of atmospheric dynamical processes, and assimilation of these measurements into NASA's research investigations, cloud and climate models, and quasi-operational weather models should improve global weather prediction, climate change studies, and information on the interactions within the Earth System.

Two major investments in the Weather and Atmospheric Dynamics Focus Area form the integrator and transition centers of research results in this area. Through collaborations in the Joint Center for Satellite Data Assimilation (JCSDA) (https://www.star.nesdis.noaa.gov/jcsda/), observations from Suomi-NPP were assimilated into the operational weather forecast systems in a record seven months after the satellite launch. Observation impact analyses conducted with NASA Goddard Earth Observing System model, version 5 (GEOS-5) in the NASA Global Modeling and Assimilation Office, showed that, in concert with other observations, the Advanced Technology Microwave Sounder (ATMS) and CrIS have made positive impacts on a global integrated forecast metric.

On the short time scale, the NASA Short-term Prediction Research and Transition (SPoRT) (http://weather.msfc.nasa.gov/sport/) program is an end-to-end research-to-operations (R2O) activity focused on improving weather forecasts through the use of unique high-resolution, multispectral observations from NASA and NOAA satellites,

nowcasting tools, and advanced modeling and data assimilation techniques. The SPoRT program has established a successful R2O paradigm in which the end-users (mainly forecasters at NOAA/NWS forecast offices and National Centers) are involved in the entire process. SPoRT also partners with universities and other Government agencies to develop new products that are transitioned to applicable end user decision support systems. SPoRT has recently succeeded in broadening its activities to other National Weather Service (NWS) Regions and its active participation in NOAA Proving Ground activities and Testbeds.

The ROSES element most closely directed towards the Weather and Atmospheric Dynamics Focus Area soliciting for proposals in ROSES-2020 is:

- CYGNSS Competed Science Team (program element A.27)

Topics relevant to the Weather and Atmospheric Dynamics Focus Area that are actively or potentially soliciting in ROSES-2020 include the following program elements:

- Carbon Monitoring System (program element A.6);
- Rapid Response and Novel Research in Earth Science (program element A.28);
- U.S. Participating Investigator (program element A.30);
- New (Early Career) Investigator Program in Earth Science (program element A.32);
- **The Science of Terra, Aqua, and Suomi-NPP (program element A.33);**
- Citizen Science for Earth Systems Program (program element A.41);
- Commercial SmallSat Data Evaluation Team (program element A.42);
- Advanced Component Technology (program element A.44);
- In-space Validation of Earth Science Technologies (program element A.45); and
- Topical Workshops, Symposia, and Conferences (program element E.2).

2.6 Earth Surface and Interior

The Earth Surface and Interior Focus Area promotes the development and application of remote sensing to better understand core, mantle, and lithospheric structure and dynamics, and interactions between these processes and Earth's fluid envelopes. ESI studies provide the basic understanding and data products needed to inform the assessment, mitigation, and forecasting of natural hazards, including phenomena such as earthquakes, tsunamis, landslides, and volcanic eruptions. These investigations also exploit the time-variable signals associated with other natural and anthropogenic perturbations to the Earth system, including those associated with the production and management of natural resources. Space-based remote sensing is vital to forecasting in the solid Earth sciences, providing a truly comprehensive perspective for monitoring the entire solid Earth system. ESI seeks to address the questions:

1. What is the nature of deformation associated with plate boundaries and what are the implications for earthquakes, tsunamis, and other related natural hazards?
2. How do tectonic processes and climate variability interact to shape Earth's surface and create natural hazards?
3. How does the solid Earth respond to climate-driven exchange of water among Earth systems and what are the implications for sea-level change?

4. How do magmatic systems evolve, under what conditions do volcanoes erupt, and how do eruptions and volcano hazards develop?
5. What are the dynamics of Earth's deep interior and how does Earth's surface respond?
6. What are the dynamics of Earth's magnetic field and its interactions with the rest of Earth's systems?
7. How do human activities impact and interact with Earth's surface and interior?

ESI's Space Geodesy Program (SGP) produces observations that refine our knowledge of Earth's shape, rotation, orientation, and gravity, advancing our understanding of the motion and rotation of tectonic plates, elastic properties of the crust and mantle, mantle-core interactions, solid Earth tides, and the effects of surface loading resulting from surface water, ground water, glaciers, and ice sheets. SGP infrastructure enables the establishment and maintenance of a precise terrestrial reference frame that is foundational to many Earth missions and location-based observations.

Modeling, calibration, and validation are essential components in advancing the above solid-Earth science objectives. ESI views natural laboratories as a critical component for the validation and verification of remote sensing algorithms. For example, NASA joins with the National Science Foundation (NSF) in support of the Geodetic Facility for the Advancement of Geoscience (GAGE) initiative to maintain and operate a set of foundational geodetic capabilities that are essential for current research efforts to measure Earth changes with unprecedented spatial and temporal resolution, enabling advances in our understanding of tectonic processes; earthquakes and tsunami; magmatic processes; landslide hazards; continental water storage; atmospheric, ice sheet and glacier dynamics; and interactions among these components of the Earth system.

Among the many activities carried out by ESI are the following:

- Geodetic and thermal imaging of the precise metrology of Earth's surface and its changes through GNSS, lidar, radar constellations, and optical arrays, coupled with geopotential field measurements to understand the dynamics of the Earth's surface and interior;
- Development of a stable terrestrial reference frame, highly precise realization of topography and topographic change, and understanding of changes in the Earth's angular momentum and gravity fields, which can be applied to issues such as sea-level change, polar mass balance, and land subsidence;
- Use of gravitational and magnetic observables for studying the inner dynamics of the Earth, as well as for studies of how the ionosphere responds to changes in the Earth's surface; and
- Improved forecasts and early warnings for earthquakes, tsunamis, landslides, and volcanic eruptions through the use of a broad range of Earth surface remote sensing and space geodesy approaches.

The ROSES element most closely directed towards the Earth Surface and Interior Focus Area that are or may be soliciting for proposals in ROSES-2020 is:

- Earth Surface and Interior (program element A.26).

Topics relevant to the Earth Surface and Interior Focus Area that are actively or potentially soliciting in ROSES-2020 include the following program elements:

- Rapid Response and Novel Research in Earth Science (program element A.28);
- U.S. Participating Investigator (program element A.30);
- New (Early Career) Investigator Program in Earth Science (program element A.32);
- **The Science of Terra, Aqua, and Suomi-NPP (program element A.33);**
- Citizen Science for Earth Systems Program (program element A.41);
- Commercial SmallSat Data Evaluation Team (program element A.42);
- Advanced Component Technology (program element A.44);
- In-space Validation of Earth Science Technologies (program element A.45); and
- Topical Workshops, Symposia, and Conferences (program element E.2).

2.7 Cross-Cutting and Interdisciplinary

There are several cross-cutting and interdisciplinary elements in ROSES-2020, all of which have been identified as related elements to specific research focus areas in Sections 2.1 through 2.6 (and also briefly summarized in the overview to Section 2). These elements, all of which are being actively solicited in ROSES-2020 or are being evaluated for possible solicitation, are:

- CYGNSS Competed Science Team (program element A.27) - Proposals are solicited for participation in the Science Team for the Cyclone Navigation Global Satellite System (CYGNSS). NASA launched the CYGNSS mission of 8 satellites in December 2016, each carrying a four-channel bistatic radar receiver that measures GPS signals scattered by the Earth's surface. It has been operating on orbit producing four primary science products from Level 1 to Level 3. Proposals are solicited to support the continued use of both CYGNSS's ocean and land data products through scientific investigations and end-user applications. Successful proposers will become members of the Competed CYGNSS Science Team.
- Rapid Response and Novel Research in Earth Science (program element A.28) - This program element allows for two types of proposals not normally solicited through ROSES - (a) immediate research activity to take advantage of a target of opportunity due to an unforeseen event in the Earth system, and (b) exceptionally novel and innovative ideas to advance Earth remote sensing that do not fit within ESD's current slate of solicitations and or programs;
- U.S. Participating Investigator (program element A.30*)* – This program element solicits for participation of U.S. investigators in satellite missions carried out on a foreign space mission that address the Earth Science Research Program objectives listed in the NASA Science Plan. Proposed efforts must also facilitate access to data from assets of foreign space agencies.
- New (Early Career) Investigator Program in Earth Science (program element A.32) – This program element is designed to support scientific research and career development of scientists and engineers at the early stage of their professional careers. The program welcomes innovative research initiatives and seeks to cultivate diverse scientific leadership in Earth system science.

Participation in this program is limited to those who received their PhD degree within six years of the issuance data of ROSES-2020.

- **The Science of Terra, Aqua, and Suomi-NPP (program element A.33) – This will provide an opportunity for scientists to conduct integrative research using the data and products resulting from these satellites (Terra, Aqua, Suomi-NPP). Additionally, this program element welcomes the opportunity to fuse multiple sensors and data streams, including Terra, Aqua, and Suomi NPP, to conduct interdisciplinary and multi-disciplinary Earth System Science. It also provides an opportunity to develop new products by combining multi-sensorand multi-platform data, or by developing innovative approaches to data retrievals.**
- Studies with ICESat-2 (program element A.34) – This program element solicits proposals for Earth science research using observations from the Ice, Cloud, and land Elevation Satellite-2 (ICESat-2), which was launched in September, 2018. While the primary focus of the satellite is to characterize elevation changes in Earth's polar ice, the mission acquires data globally, which allows independent determination of vegetation height, and supports research in hydrology, oceanography, atmospheric sciences, and other Earth and applied sciences.
- Citizen Science for Earth Systems Programs (program element A.41) – This program element solicits proposals to develop and implement capabilities to harness voluntary contributions from members of the general public to advance understanding of the Earth as a system. The program aims to advance the use of citizen science in scientific research about the Earth by directly supporting citizen science activities, as well as by deploying technology to further citizen science research.
- Commercial SmallSat Data Evaluation Team (program element A.42) – This program element identifies, evaluates and acquires data from commercial sources that support NASA's Earth science research and applications activities. The Commercial SmallSat Data Evaluation Team plays a critical role in NASA Commercial SmallSat Data Acquisition Program by conducting science and applications evaluations of commercial data.
- **Solar Irradiance Science Team (program element A.49) – This program element solicits proposals for the development of consistent multi-instrument/multi-platform space-based data sets of solar irradiance (both total and spectrally resolved) using data from currently and/or previously operating satellites.**
- **SAGE III/ISS Science Team (program element A.50) – This program elements solicits proposals for the analysis, utilization, and improvement of data from NASA's Stratosphere Aerosol and Gas Experiment III (SAGE III) instrument flying aboard the Interntional Space Station. Data analysis using SAGE III/ISS data can be carried out in the context of related data sources, including those from previous SAGE instruments and other measurements of the atmospheric constituents that they measure.**
- **Science Team for the OCO Missions (program element A.51) – This program element solicits proposals for the analysis, utilization, and improvement of data from NASA's two Orbiting Carbon Observatory (OCO)**

missions, including their measurements of both carbon dioxide and solar induced fluorescence. Proposals solicited include both those that use the measurements to learn more about the Earth's carbon cycle, the transfer of carbon between the Earth's biosphere and atmosphere, and the properties of the OCO measurements themselves.

3. Applied Sciences

The Applied Sciences Program supports efforts to discover and demonstrate innovative and practical uses of NASA Earth science data, knowledge, and technology. The program (http://AppliedSciences.NASA.gov/) develops applications knowledge and understanding of how Earth science can be applied to serve society, increasing the benefits of the nation's investments in NASA Earth science. The Program funds applied science research and applications projects to enable near-term uses of Earth science, transition applied knowledge to public and private organizations, and integrate Earth science and satellite observations as inputs to organizations' decision-making and services. The projects are carried out in partnership with end user organizations. The Program, thus, serves as a bridge between the data and knowledge generated by NASA Earth science and the information needs and decision making of Government agencies, companies, regional associations, international organizations, not-for-profit organizations, and others.

The Program's applications themes align with the U.S. Group on Earth Observations (USGEO) Societal Benefit Areas, with current emphasis on Water Resources, Health and Air Quality, Disasters, and Ecological Forecasting. Applied Sciences projects leverage products, knowledge, and outcomes of Research and Analysis activities described in Section 2.

The ROSES element most closely directed towards Applied Sciences that are or may be soliciting for proposals in ROSES-2020 are:

- Health and Air Quality Applied Sciences Team (program element A.38); and
- Ecological Forecasting (program element A.39).

Topics relevant to the Applied Sciences Program that are actively or potentially soliciting in ROSES-2020 include the following program elements:

- Carbon Monitoring System (program element A.6);
- GEDI Science Team (program element A.8);
- CYGNSS Competed Science Team (program element A.27);
- Rapid Response and Novel Research in Earth Science (program element A.28);
- U.S. Participating Investigator (program element A.30);
- New (Early Career) Investigator Program in Earth Science (program element A.32);
- Citizen Science for Earth Systems Program (program element A.41);
- Commercial SmallSat Data Evaluation Team (program element A.42);
- Advanced Component Technology (program element A.44);
- In-space Validation of Earth Science Technologies (program element A.45); and
- Topical Workshops, Symposia, and Conferences (program element E.2).

4. Technology

Advanced technology plays a major role in enabling Earth research and applications. The Earth Science Technology Program (ESTP) enables previously infeasible science investigations, improves existing measurement capabilities, and reduces the cost, risk, and/or development times for Earth science instruments.

As the implementer of the ESTP, the Earth Science Technology Office (ESTO) performs strategic technology planning and manages the development of a range of advanced technologies to enable new science observations or reduce the cost of current observations. ESTO employs an open, flexible, science-driven strategy that relies on competitive solicitations and peer-review to produce a portfolio of cutting-edge technologies for NASA Earth science endeavors. This is done through:

- Planning investments by careful analyses of science requirements
- Selecting and funding technologies through competitive solicitations and partnership opportunities
- Actively managing the progress of funded projects
- Facilitating the infusion of mature technologies into science measurements

Needs for advanced technology development are based on Earth science measurement and system requirements articulated in chapter 4 of the *Science Plan for NASA's Science Mission Directorate* (https://smd-prod.s3.amazonaws.com/science-red/s3fs-public/atoms/files/2014_Science_Plan_PDF_Update_508_TAGGED_1.pdf) and the most recent Decadal Survey covering NASA's Earth science activities, *Thriving on our Changing Planet: A Decadal Strategy for Earth Observation from Space*, which was released on 1/5/2018 by the National Academies of Science, Engineering, and Medicine (see https://www.nap.edu/catalog/24938/thriving-on-our-changing-planet-a-decadal-strategy-for-earth). This 2017 Decadal Survey now serves as a foundational document for NASA's Earth Science Division (ESD), and includes recommendations for the scopes, foci, and relative budgetary magnitudes of the R&A, Applications, and Technology portions of the ESD program.

The Earth Science Technology Office (http://esto.nasa.gov) maintains several program lines through which technology investments are regularly competed through ROSES, and that cover a range of technology readiness levels (TRLs). Currently, both the Advanced Component Technology Program and the In-Space Validation of Earth Science Technologies Program will be solicited in ROSES-2020:

- ACT (program element A.44): The Advanced Component Technology program develops a broad array of components and subsystems for instruments and observing systems;
- InVEST (program element A.45): The In-Space Validation of Earth Science Technologies program provides a path for some new technologies to be validated in space prior to use in science mission.

Other ESTO programs that are periodically solicited are NOT being solicited in ROSES-2020:

- AIST (program element A.48): The Advanced Information Systems Technology program advances technologies that enable: unique measurement collection

capabilities through distributed sensing; optimizing Science missions return on investment through flexible information integration; and agile Science investigations through data analytics and artificial intelligence tools and algorithms;

- Instrument Incubator Program (program element A.43): The Instrument Incubator Program (IIP) funds technology development that leads directly to new Earth observing instruments, sensors, and systems. From concept through field demonstrations and infusion, IIP developments yield smaller, less resource intensive, and easier-to-build flight instruments.
- SLI-T (program element A.46): The Sustainable Land Imaging Technology Program - The Sustainable Land Imaging Technology program develops technologies leading to new SLI instruments, sensors, systems, components, data systems, measurement concepts, and architectures in support of the nation's future SLI activities; and
- Decadal Survey Incubation (program element A.47): The Decadal Survey Incubation program develops and matures observing systems, instrument technology, and measurement concepts for Planetary Boundary Layer and Surface Topography and Vegetation observables through technology development, modeling/system design, analysis activities, and small-scale pilot demonstrations.

5. Enabling Capability

Enabling capabilities include those programmatic elements that are of sufficient breadth that they contribute to a broad range of activities within the Earth Science Research Program. They typically involve the development of some kind of capability whose sustained availability is considered to be important for the Earth Science Research Program's future. These include focused activities in support of education; data, information, and management; and airborne science, as well as some broadly-based technology-related elements (others which are very focused towards a single scientific area of the Earth Science Research Program will be solicited through the research and analysis area).

5.1 Education

The Earth Science Research Program recognizes its essential role in NASA's mission to inspire the scientists and engineers of tomorrow. The Earth system science concept pioneered by NASA is changing not only how science research is conducted, but also the way Earth and space science education is taught at elementary through postgraduate levels, as well as the way space exploration is presented to the public by the media and informal learning communities.

In 2015, SMD announced selections from the Science Education Cooperative Agreement Notice. These organizations (https://science.nasa.gov/science-activation-team) are collaborating with SMD in the execution of its science education efforts. The desired outcome is to increase the overall coherence of the SMD science education program leading to more effective, sustainable, and efficient utilization of SMD science discoveries and learning experiences to meet overall SMD science education objectives. Fundamental to achieving this outcome is to enable NASA scientists and

engineers to engage more effectively with learners of all ages. In addition, SMD is moving away from mission-by-mission products and services and towards aggregating efforts into science-based disciplines aligned with SMD Divisions.

The Earth Science Research Program will continue its management of the Global Learning and Observations to Benefit the Environment (GLOBE) Program (https://www.globe.gov/) and oversight of the GLOBE Implementation Office that is responsible for the coordination of the worldwide community in relation to GLOBE science, education, evaluation, communication, and other common functions. It will also continue to oversee the GLOBE Data and Information System. ESD welcomes proposals that incorporate the use of GLOBE observations, where appropriate. Observations can be accessed via the GLOBE Visualization System (https://vis.globe.gov/GLOBE/) and the GLOBE Advanced Data Access Tool (ADAT; https://datasearch.globe.gov/). Data can also now be accessed via the GLOBE Application Programming Interface (API; https://www.globe.gov/globe-data/globe-api).

5.2 Graduate and Early-Career Research

The NASA Earth Science Division recognizes the importance of workforce enrichment. To this end, the Earth Science Division sponsors the Earth component of the Future Investigators in NASA Earth and Space Science and Technology (FINESST) program, that replaced the NASA Earth and Space Science Fellowship (NESSF) program. FINESST supports graduate student-designed research projects that contribute to SMD's science, technology, and exploration goals.

Previous awardees of NESSF will be able to submit renewal proposals to a NESSF renewal solicitation for the 2020/2021 school years for a maximum of three years of total support. See NESSF20R for the 2020/2021 school year; note this solicitation is outside of ROSES and proposals are due March 16, 2020. This is the last time NESSFR will be solicited.

FINESST is now incorporated into ROSES. The opportunity to propose for the 2020/2021 school year was announced in ROSES-2019 and proposals were due February 4, 2020. The opportunity to propose for the 2021/2022 school year will be in program element E.5 of ROSES-2020. It is anticipated that FINESST final text will be released in November 2020, with proposals due in February 2021. Those currently holding FINESST awards do not submit renewal proposals for their next year of funding; rather they submit annual progress reports due in March.

The New (Early Career) Investigator Program in Earth Science (program element A.32), which is directed towards scientists and/or engineers within six years of their receipt of a Ph.D. degree, is solicited every three years. It is being solicited in ROSES-2020.

5.3 Data and Information Management

NASA's space observation capabilities are a central part of the Agency's contribution to Earth system science, along with the science information systems that compile and organize observations and related data for research purposes. The Earth Science Research Program has established a number of strategic principles for the development and deployment of its observing and information systems, recognizing the importance of providing active and informed stewardship for the large volumes of data that are

returned to Earth every day. The broad range of uses to which the data are put and the large and diverse user community require multiple temporal and spatial scales, emphasize the need for having a range of data products, and place stringent requirements on NASA for its data processing, archival, and data dissemination activities. These products and services will be variously useful to multiple classes of users, from sophisticated scientific users to other Government and private sector entities that use NASA's information for policy and resource management decisions and including scientifically attentive members of the public who utilize data and information for general information and recreation.

Three program elements related to Data and Information Management have been solicited periodically by the Earth Science Division in recent years – The Advancing Collaborative Connections for Earth System Science (ACCESS, program element A.40), the Making Earth System Data Records for Use in Research Environments (MEaSUREs, most recently solicited in ROSES-2017 as program element A.43), and Citizen Science for Earth Systems Program (program element A.41), which is the only one of these solicited in ROSES-2020.

Unless otherwise specified, any data proposed to be analyzed in response to Appendix A program elements from any source, including NASA and other satellite data, ancillary data, and data from commercial sources, must use publicly available data, in the sense that they are openly accessible. Commercial data need not be free, but it must be purchasable by all potential investigators. Proposals that utilize any data that is not, or not yet, publicly available will *not* be considered unless permitted by the call for proposals or associated Frequently Asked Questions. Please read the individual appendices and associated amendments to ROSES carefully and contact the program officers if you have any questions regarding whether a restricted dataset is permissible for a given call.

Data, model results and other information created is subject to NASA's Earth Science Data policy (see http://science.nasa.gov/earth-science/earth-science-data/data-information-policy/ for the policy). All data will be released along with the source code for algorithm software, coefficients, and ancillary data used to generate products. Proposers are encouraged to utilize data acquired by the Commercial SmallSat Data Acquisition Program (CSDAP). The CSDAP program evaluates and procures data from commercial vendors that advance NASA's Earth science research and applications activities. The scientific community may use data that have been previously acquired by NASA for scientific purposes in adherence to vendor-specific terms and conditions. Currently, data acquired during the evaluations of Planet, Maxar (Digital Globe) and Spire Global are available, as are data from the Teledyne Brown Engineering DLR Earth Sensing Imaging Spectrometer (DESIS). These products are available at no cost to PIs and are subject to scientific use licenses. Please check the link that follows regularly, for new data being added to the list as evaluations and procurements are completed. For an up-to-date list of available data and associated licenses please visit https://earthdata.nasa.gov/csdap.

5.4 High-End Computing, Networking, and Storage

High-end computing, networking, and storage are critical enabling capabilities for Earth system science. Satellite observations must be converted into scientific data products through retrieval and/or data assimilation processes. Long-term data sets must be synthesized together and become a physically consistent climate-research quality data set through reanalysis. These data products, in turn, provide initial and boundary conditions, validation and verification references, and internal and external constraints to the models that describe the behavior of the Earth system. None of the above will be possible without advanced techniques in high-end computing, networking, and storage.

SMD recognizes the need of such an enabling capability and maintains the high-end computing, networking, and storage within its programs. Computing resources are provided through various program elements. Over the past several years, computational resources have become significantly constrained. Since 2016 SMD has implemented a more rigorous resource allocation process. Proposals that would make use of NASA's High-End Computing (HEC) Resources must follow the instructions given in Section 1(d) of the *ROSES Summary of Solicitation* generating and submitting a request via https://request.hec.nasa.gov. Save a PDF copy of your request after submitting it using the button provided in RMS and then attach that (as a separate file as type "Appendix") to your ROSES proposal (this is not counted against the technical proposal page limit). The form includes a written justification of how the computational resources would support the investigation and this will be used during the proposal evaluation and selection processes. This justification should include how the computational resources may support the investigation and a multiyear resource-phasing plan, in annual increments, identifying the computing system and facility location where the computational project will be accomplished for the duration of the proposed award period. Proposers to this NRA must follow the instructions in Section I(d) of the *Summary of Solicitation* of this NRA to request computing resources, including explicit descriptions of computing resource needs.

NASA also supports computational science research and development, including parallelization of codes to an advanced computing architecture for the advancement of Earth system modeling and data assimilation.

In ROSES-2020, no program elements specifically targeted towards High End Computing, Networking, and Storage will be solicited.

5.5 NASA Earth Exchange

For large-scale global high-resolution Earth science data analysis and modeling projects, especially in areas of land surface hydrology, land cover, land use, carbon management, and terrestrial ecosystems, NASA encourages using the new NASA Earth Exchange (NEX) collaboration facility. The NEX facility includes a state-of-the-art Earth system modeling and data analytics system for the use of remote sensing data from NASA and other agencies. It is supported by a world-class supercomputing and data storage system. Much of the global Landsat, MODIS, AVHRR and related data have been staged online for easy access. Recently, NEX also includes a partial collection of data from operational geostationary satellite systems. This sub-system is called GeoNEX (https://www.nasa.gov/geonex). NEX (http://nex.nasa.gov) represents a scientific collaboration platform to deliver a complete work environment, in which users

can explore and analyze large Earth science data sets, run modeling codes, collaborate on new or existing projects, and share results.

Since it is a unique platform for large-scale data analyses that cannot be easily accommodated by a single Principal Investigator (PI) or small research group-based data analysis system, proposals that require the utilization of NEX should include a section to justify the need for using NEX, specifies the data storage and processing needs, and includes a data management plan as described above in Section 1. The resource availability will be considered during the proposal review and selection process.

Proposals that involve the use of NEX must be submitted to the appropriate ROSES program element depending on the science addressed by the proposed investigation. Additional constraints and requirements for proposals to use NEX are available at https://nex.nasa.gov/nex/resource_updates.

In ROSES-2020, no program elements directed towards the enhancement of NEX are being solicited.

5.6 Airborne Science

The Earth Science Research Program airborne science program provides access to airborne platforms that can be used to obtain measurements of the Earth. Airborne platforms may be used to test new measurement approaches, collect detailed *in situ* and remote sensing observations that are needed to better document and test models of Earth system processes, and/or provide calibration/validation information for satellites. Airborne platforms can also be an important part of training the next generation of scientists, because students can be engaged in all aspects of scientific investigations, from sensor development, through utilization, to completing analysis of data obtained.

Aircraft have proven to be of significant value in Earth system science research, particularly for investigation into atmospheric processes. NASA makes use of several existing aircraft, including the NASA-owned DC-8, G-III, GV, ER-2, and P-3B, as well as several independently owned aircraft, including, but not limited to, those operated by other Federal agencies and commercial aircraft providers. Proposers that utilize commercial aircraft service providers must ensure real time position tracking of the aircraft and provide flight reports after the completion of flights. Information regarding the utilization and reporting requirements of airborne assets to support proposals can be found at https://airbornescience.nasa.gov/.

Proposals that require the acquisition of new airborne data may be submitted in response to other active ROSES elements, unless otherwise specified in the element. In any such cases, proposers are encouraged to contact the program manager indicated prior to submitting such proposals.

The NASA Headquarters science concurrence is provided by the manager of the NASA Research Program under which the grant or contract is issued. User fees are paid by the investigator's funding source’s research program or directly from the investigator's grant funds.

Any airborne science experiment using NASA assets, personnel, instruments, or funds, must be in compliance with NASA Policy Directive 7900 and NASA Procedural Requirement Series 7900. It is NASA policy that when utilizing other than NASA aircraft, including foreign owned or leased aircraft, those aircraft are subject to the same compliance requirements.

All participants in ESD Airborne activities will comply with all appropriate NASA Procedural Requirements including medical qualifications for Qualified Non-Crewmembers (QNC). Participants will be screened (in a timely fashion) by the appropriate Center medical personnel to determine their readiness for QNC duties.

A.2 LAND-COVER/LAND-USE CHANGE

NOTICE: The emphasis of this ROSES-2020 Land-Cover/Land-Use Change call is Multi-Source Land Imaging of High Impact Land-Cover and Land-Use Change. This year this program element will not use a two-step proposal process.

1. The LCLUC Program

The NASA Land-Cover/Land-Use Change (LCLUC) program is aimed at using satellite observations to improve our understanding of LCLUC as an important component of Earth System Science. The LCLUC program includes studies that detect and quantify changes in land cover and land use; examine their impact on the environment, climate, and society; or model future scenarios of LCLUC and its various impacts and feedbacks. The LCLUC program is developing interdisciplinary research combining aspects of physical, social, and economic sciences, with a high level of societal relevance, using remote sensing data methods, and tools. The LCLUC program is aimed at developing the capability for periodic satellite-based inventories of land cover to characterize and monitor changes in land cover and land use. Additional information on the NASA LCLUC program can be found at http://lcluc.hq.nasa.gov or contact Dr. Garik Gutman, the NASA Land-Cover/Land-Use Change Program Manager, see Section 3 below.

2. Scope: Multi-Source Land Imaging of High Impact LCLUC ("Hot Spots")

This call is requesting proposals on the use of Multi-Source Land Imaging to identify high impact LCLUC "hotspot" areas around the globe where human-induced LCLUC is occurring at a landscape scale (of the order of 10,000 km^2). The types of LCLUC considered should include at least two of the following sectors: agriculture, forestry, urban, coastal zone.

The increased availability of moderate resolution (≤30m) optical and microwave data, Very High Resolution (VHR) commercial data (≤5m) and high-performance computing is enabling multi-source monitoring of the land surface at regional to global scales. The combined use of data from multiple sensors/satellites provides a means for enhanced monitoring of LCLUC. This solicitation calls for the use of multi-source data to identify and quantify areas of high impact LCLUC. The emphasis for this solicitation is threefold: i) development of methods for multi-data fusion for detecting and quantifying LCLUC over large areas of change, ii) focus on LCLUC that has a significant impact, for example in terms of ecosystem services or societal relevance and quantifying that impact, iii) demonstration that the methods developed are scalable to similar changes taking place in different parts of the globe.

Moderate resolution data are well-suited to spatially explicit land-change monitoring over large areas. The NASA LCLUC Program is interested in the development of multi-sensor, multi-resolution fusion methods based on increased spectral, temporal and spatial coverage to advance the virtual constellation paradigm for land imaging systems with continental to global scale coverage. To get the most out of current remote sensing capabilities to study land surface, estuarine, and coastal processes as related to land-use change, NASA solicits for efficient use of satellite sensor data from US and non-US moderate resolution sources (Landsat-class observations), combining optical data with

radar and thermal IR observations, newly available sensors on board of the International Space Station (GEDI, ECOSTRESS, DESIS), and commercial VHR data.

A proposal to the current solicitation must use data or data products from at least two of the mid-resolution systems in combination with at least one source of VHR (≤5m) data. Automated VHR resolution change detection is an area for research and development. Proposers are encouraged to utilize the available time-series record of VHR data that may extend for several years (e.g. 10 years for RapidEye) and to quantify the benefit of using the dataset comprising Planet Lab and Digital Globe data that are available free of charge at NASA Goddard Space Flight Center (https://earthdata.nasa.gov/esds/small-satellite-data-buy-program) as well as from non-U.S. sources that are freely available. For example, the French-Israeli Venμs mission 5 and 10m data are available for registered applicants on the following site: https://theia.cnes.fr/atdistrib/rocket/#/search?collection=VENUS. The map with the locations of sites with Venμs data is on https://umap.openstreetmap.fr/fr/map/theias-vens-sites_235143#2/27.0/23.6). Proposals highlighting novel methods of multi-resolution data fusion and approaches are encouraged. Proposals need to include a description of the algorithm approach and describe preliminary validation (accuracy assessment) of the product.

Land-use change is receiving increased attention from the scientific and policy communities, as recently evidenced by the IPCC Special Report on Climate Change and Land (https://www.ipcc.ch/report/srccl/), the IPBES Global Assessment Report on Biodiversity and Ecosystem Services (https://www.ipbes.net/global-assessment-report-biodiversity-ecosystem-services) and the central role of land in the UN Sustainable Development Goals (SDG's) (https://sustainabledevelopment.un.org/sdgs). LCLUC, ubiquitous around the globe, is having a significant impact on the environment, the provision of ecosystem services and human livelihoods at the national, regional or global scale, often with economic and policy implications. Such policy implications can be in terms of current policies that have prompted, or exacerbated land-use change.

Note that the LCLUC process proposed for a study should have national to regional importance, with significant impact and policy relevance. The proposal should analyze and quantify the impact of the identified changes. Quantifying LCLUC and the impacts of change are key aspects of land system science and a hallmark of this program.

This solicitation does not require the incorporation of a socio-economic research component normally requested by the LCLUC program, although the analysis to quantify the impacts of LCLUC may include the use of socio-economic methods. That is, the socio-economic part is not mandatory in this solicitation but may be included. Selections of this solicitation will enhance the Multi-Source Land Imaging (MuSLI) Science component of LCLUC with the development of potential new products and will also enhance the incorporation of VHR observations in the MuSLI methodology. Proposers are encouraged to visit the LCLUC Web site to explore the previously completed or currently funded projects in the research of interest. Where similarities in the previous and proposed work exist, proposers should elaborate on what is novel about the newly proposed work as compared to what has been accomplished in the program to date. Funded investigators will be expected to attend at least one NASA MuSLI annual meeting held in conjunction with NASA LCLUC Program Science Team Meetings. P.I.'s

of successful proposals will be expected to provide and update project (and collaborators') information for the LCLUC webpage associated with the funded research. Commercial data requirements should be identified with associated costs. If data are available at NASA (https://earthdata.nasa.gov/esds/small-satellite-data-buy-program) or will be obtained by NASA through a special purchase, then data will be provided without the associated funding and the proposal cost will be adjusted.

2.1 International collaboration

For those examining LCLUC outside the U.S., proposals should identify an explicit collaboration with non-U.S. partners, e.g., those working on the non-U.S. sensor data or land-use experts for the regions being studied. Proposers are encouraged to explore the existing regional collaborations in the GOFC-GOLD (Global Observations of Forest Cover and Land Dynamics) Regional Information Networks (http://gofcgold.org). The non-U.S. partners should provide letters signed by the authorities of the collaborating institution, which would indicate agreement to participate in the project as proposed, with the necessary institutional support to participate in the collaborative research and attend team meetings. All else being equal, preference will be given to proposals that include partnerships with international investigators. The rationale for the latter is that U.S. PIs would benefit from the partners' experience in using non-NASA data or work on the ground in the region of interest.

NASA's policy welcomes the opportunity to conduct research with non-U.S. organizations on a cooperative, no-exchange-of-funds basis. Although Co-Principal Investigators (Co-Is) or collaborators employed by non-U.S. organizations may be identified as part of a proposal submitted by a U.S. organization, NASA funding may not normally be used to support research efforts by non-U.S. organizations at any level. The *NASA Guidebook for Proposers* states "NASA funding may not be used for foreign research efforts at any level, whether as a collaborator or a subcontract. The direct purchase of supplies and/or services, which do not constitute research, from non-U.S. sources by U.S. award recipients is permitted…". NASA funding may not be used for travel expenses by any participant who is not employed either full-time or part-time by a U.S. organization. See also Section III (c) of the *ROSES Summary of Solicitation* for restrictions involving China.

2.2 Expected deliverables

It is expected that proposals funded through this solicitation will result in peer-reviewed publications quantifying high impact LCLUC around the World. The findings of each funded research project and 'hot spots' will be incorporated in an interactive web page on global LCLUC Hot Spots and it is expected that PI's will contribute material for the LCLUC web-site, as requested. In addition to quantifying LCLUC and its impact, it is expected that the proposals will develop, test, and publish methods for multi-source data fusion and the use of VHR data to studying LCLUC. It is expected that PI's will make available any data products generated under this research following the data management plan outlined in the proposal.

2.3 Programmatic Information

2.3.1 *Period of Performance for Selected Proposals*

Research awards will be for three-year period of performance (or less) with annual funding contingent upon satisfactory progress reporting and available funding.

2.3.2 *Funding Available for Support of Selected Proposals*

About $2.5M per year is expected to be available for new awards with annual budgets of $200-250K per project. NASA will make selections for this announcement in September-October of 2020. Anticipated starting date for selected projects is January 1, 2021.

A budget for travel to at least one MuSLI Science Team session per year, which will be a part of the LCLUC Science Team meeting, is required in the proposal. In addition, sufficient international travel should be included in the proposal budget for productive collaboration between U.S. PI's and the non-U.S. partners. See Section 2.1 on what is and what is not allowed in the budget concerning non-U.S. participation.

2.3.3 *Evaluation of Proposals*

All proposals will be submitted to the NASA peer review process in accordance with the guidelines provided in Section VI of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*. This peer review will be followed by a programmatic review in which NASA will assess program balance across the competitive range of proposals and evaluate any logistical, implementation, cost, and/or management concerns. The funding recommendations will then be forwarded to a Selecting Official for confirmation. NASA then will announce the official selection of proposals for award.

3. Summary of Key Information

Expected annual program budget for new awards	~ $2.5M
Number of new awards pending adequate proposals of merit	10-12
Maximum duration of awards	3 years
Due date for NOI	See Tables 2 and 3 of this ROSES NRA.
Due date for Proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	January 1, 2021
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Table 1 of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the Earth Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA

General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section IV and Table 1 of the *ROSES Summary of Solicitation* and Section 3 of the *NASA Guidebook for Proposers*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of the *ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-LCLUC
Point of contact concerning this program	Garik Gutman Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: 202-358-0276 Email: ggutman@nasa.gov

A.3 OCEAN BIOLOGY AND BIOGEOCHEMISTRY

NOTICE: Amended March 23, 2020. This Amendment presents final text for this program element. Notices of intent are requested by April 30, 2020, and proposals are due July 23, 2020.

Proposers to this program element must use Earth Science Division templates for the required summary table of work effort and current and pending support sections of the proposal, see Section 4.3.

1. Scope of Program

NASA's Ocean Biology and Biogeochemistry (OBB) Program focuses on better understanding the ocean's role in the Earth System, and predicting future causes and impacts of change driven by Earth's climate, the environment, and event-scale phenomena on ocean biology, biogeochemistry, and ecology. NASA utilizes remotely sensed measurements of aquatic properties, including data obtained from space, aircraft, and other suborbital platforms; data from field studies and campaigns; and interdisciplinary data assimilation and modeling efforts to describe, understand, quantify, and predict changes to the biological and biogeochemical regimes of the upper ocean. Ocean Biology and Biogeochemistry research primarily supports NASA's Carbon Cycle and Ecosystem Focus Area, which addresses changes in Earth's carbon cycle and ecosystems to improve understanding of the structure and function of global aquatic ecosystems, their interactions with the atmosphere, terrestrial and cryospheric systems, and the ocean's role in the cycling of the major biogeochemical elements.

A.1, The Earth Science Research Overview, provides an overview of how the OBB Program fits into the Earth Science Division within NASA's Science Mission Directorate. Program goals and objectives for the coming decades can be found in the Ocean Biology and Biogeochemistry Program's advance plan.

The OBB Program supports a number of Presidential mandates and associated Federal research objectives, such as the 2018 Executive Order Regarding the Ocean Policy to Advance the Economic, Security, and Environmental Interests of the United States, which calls for the need to provide economic, security, and environmental benefits for present and future generations of Americans. In addition, the NASA OBB Program supports the U.S. Global Change Research Program (USGCRP) and its strategic plan (last updated in 2017) which, as part of its treatment of the full Earth system, addresses aspects of Carbon Cycle and Ecosystem research from space, with a focus on understanding Earth's aquatic environment and its role within the Earth System. The OBB Program is also responsive to and supports priorities identified in the Subcommittee on Ocean Science and Technology (SOST) 2018 report Science and Technology for America's Oceans: A Decadal Vision. This vision identifies five goals to advance U.S. ocean science and technology and the Nation in the coming decade; OBB Program research will utilize space-based observations and provide new suborbital observations that support the identified goals, furthering our understanding of the ocean's role in the Earth System in support of a blue economy, ecosystem management, and policy for societal benefits. Research developed under the OBB Program is anticipated to support the Global Ocean Observing System (GOOS) Essential Ocean Variables (EOV) defined by the GOOS Biogeochemistry and Biology

and Ecosystems panels, all of which specify remote sensing as a critical tool in Earth system research. The OBB Program also supports the International Ocean Color Coordinating Group (IOCCG) scientific objectives as appropriate, in support of the Committee on Earth Observing Satellites (CEOS), as well as the Surface Ocean - Lower Atmosphere Study (SOLAS) research project.

2. Types of Solicited Research

This solicitation calls for research on specific topics of current, strong scientific interest and programmatic relevance. In addition, key research to prepare scientifically for new measurements derived from the observables and scientific priorities recommended by the 2017 Decadal Survey for Earth Science and Applications from Space (ESAS) of the National Academies of Sciences, Engineering and Medicine (NASEM), Thriving on Our Changing Planet: A Decadal Strategy for Earth Observations from Space, is also sought.

The NASA OBB Program requests the following subelements of research investigations in no priority order:

a. New quantitative analyses of vulnerability and shifts of aquatic biology and/or ecosystems in response to climate change.
b. Science investigations to advance ocean biology/ecology research through the development and utilization of new and/or multisensor remote sensing approaches or data fusion, utilizing data from historical, existing, and new NASA and non-NASA sensors.
c. Studies that focus on remote detection, quantification, and analysis of marine debris.
d. Research in ocean ecology, specifically to prepare scientifically for new ocean measurements from the Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission in the program of record or the Surface Biology and Geology (SBG) and the Aerosol and Cloud, Convection and Precipitation (ACCP)-designated observables recommended by the NASEM report, Thriving on Our Changing Planet: A Decadal Strategy for Earth Observations from Space.
e. Research to advance foundational optical oceanography with an eye on the next decade of ocean biology remote sensing.
f. Successor studies that clearly demonstrate past performance and offer to significantly advance the results of prior NASA Ocean Biology and Biogeochemistry research toward meaningful answers to important NASA Earth Science Research questions.

These six research subelements are detailed in the following subsections (2.1-2.6); in some cases, there may be more than one "area" within a research subelement.

NASA makes no commitment to funding proposals in each of these areas, and for those areas for which proposals are funded, NASA will base the number of proposals selected for the different areas on a combination of programmatic priorities and quality of the submitted proposals.

2.1 Analyses of Vulnerability and Shifts of Aquatic Ecosystems

The global ocean is being rapidly transformed in response to anthropogenic climate forcings, which alter its physical, biological, and chemical properties. These changes are happening at semi-annual, annual, and decadal time scales, and have a direct impact on aquatic ecosystems, including loss of species habitat and degradation, with economic and other consequences for humans who depend on these resources. Indeed, the Intergovernmental Panel on Climate Change (IPCC) Special Report on the Ocean and Cryosphere in a Changing Climate notes the risk of severe impacts to ecosystem structure and function under current emissions scenarios, thus making it a priority to understand how aquatic ecosystems have already been altered under climate change, to understand the intensity and frequency of such climate-driven disturbances on these ecosystems, and to improve predictions of aquatic ecosystem response to global ocean change. Deciphering, understanding, and quantifying the impact(s) of climate change on aquatic ecology are paramount to adequately devise strategies for mitigation and/or adaptation. However, identifying the response of aquatic ecosystems to climate change represents a challenge since it requires complementary types of observations to capture the complexity of the ecosystem. Oftentimes, such observations must be collected over long periods of time to avoid aliasing and to capture time of emergence (ToE) of ecosystem response to climate change. While large-scale climate change is important, marine ecological systems respond to local climate and environmental conditions, rather than to basin-scale or global averages. In addition, ecosystem sensitivity and resilience will vary depending on the organisms and the regionally distinctive stressors or forcings that may impact them. Whether marine ecosystems endure or disappear under changing ocean conditions will depend on their suitability to adapt, how the climate is changing, and our ability to manage the Earth and its resources.

This subelement seeks investigations in two main areas:

Area 1. New quantitative remote sensing analyses of impacts to and vulnerability of aquatic ecosystems to global environmental or climate variability and change. Of particular interest are coastal areas and interactions between the open ocean and coastal areas.

Area 2. Research focused on understanding changes in aquatic ecological patterns, habitat shifts, and effects of environmental change on biological or ecological community structure that utilize multi-platform remote sensing and other observational data. Of particular interest are ecosystems in high-latitude and tropical regions.

2.1.1 *Area 1: New analyses of impact and vulnerability*

Biological and ecosystem variability and change in response to a changing climate are anticipated to be greater in the coastal ocean (including islands) than in the open ocean. Responses of local biology to climate shifts will have important implications for coastal species and ecosystem services on which humans depend. In addition, the complex coastal conditions (e.g., freshwater interfaces, large sediment and nutrient inputs, high temporal variability, etc.) can mask and complicate the detection of trends and changes. But coastal regions are not isolated; they are impacted by, and exert an influence on, the open ocean. To understand future impacts on and vulnerability of coastal

ecosystems to changing conditions, it is necessary to measure aquatic ecosystem properties across biological, physical, and chemical boundaries and better integrate coastal observations within regional and global frameworks and models.

Research proposed under this area must be integrative, and utilize remote sensing observations to identify significant ocean biology and ecology impacts and vulnerabilities in response to global climate and environmental variability and change, to understand the processes controlling them, and to assess and quantify the likely magnitude of change(s). Proposals must offer compelling rationales as to (1) why the impacts and/or vulnerabilities to be studied are expected to be highly significant, representing major perturbations to the Earth system, and (2) how the remote sensing data and data products to be utilized in the study provide unique and powerful information for addressing the research issues/questions posed. The proposal must also provide a clear definition of the "geographic" boundaries of the ecosystem under study. Ecosystem in this context could be defined on any number of scales but must be clearly defined for the study, and MUST be compellingly defined and justified in the global context.

2.1.2 *Area 2: Understanding environmental change utilizing multi-platform data*

High-latitude ecosystems, in particular in the Northern Hemisphere, have experienced some of the most dramatic warming during the past century, which has resulted in critical ecosystem shifts and changes. Tropical aquatic ecosystems are highly productive and contain a disproportionate amount of global biodiversity; however, tropical ecosystems are subject to a range of stressors and societal pressures, are critically under-sampled, and are challenging to observe by satellite because of persistent cloudiness and limited on-ground calibration/validation information. NASA seeks proposals in this area that utilize existing in situ/field data - in particular bio-optical data (See Sec. 3.4) - in conjunction with satellite and/or NASA airborne measurements to investigate (1) how marine ecosystems have been altered under climate change, (2) what have been the main causes of change, and (3) how the system is anticipated to continue changing in the future in response to further climate change. As marine ecological systems respond to local climate and environmental conditions, local/regional studies are of interest, but proposals must provide a rationale for investigating a particular ecosystem and region, and explain the importance of such choices within the global context. In addition, research ideas with a tie to applications, such as ecosystem management, economic valuation, sustainability, etc., are sought. Utilization of Earth system model experiments, in conjunction with in situ/field data to better understand the ramifications of climate change on aquatic ecosystems are also encouraged. Collaborations with field research organizations and scientists already working in established time-series or ecological programs are welcome.

2.2 <u>Development of New and/or Multisensor Remote Sensing Approaches</u>

Continuing research is needed to develop, evaluate, and utilize new data analysis methodologies for extracting biological, ecological, and biogeochemical information from space-based observations of the ocean. This research applies to new uses of historical, existing, and new airborne and/or spaceborne satellites or sensors such as, but not limited to, Hyperspectral Imager for the Coastal Ocean (HICO), Global Ecosystem

Dynamics Investigation (GEDI), Orbiting Carbon Observatory (OCO)-2, OCO-3, DLR Earth-Sensing Imaging Spectrometer (DESIS), ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS), Airborne Visible/Infrared Imaging Spectrometer (AVIRIS), Airborne Visible/Infrared Imaging Spectrometer-Next Generation (AVIRIS-NG), Portable Remote Imaging SpectroMeter (PRISM), High Spectral Resolution Lidar (HSRL), and Second-generation GLobal Imager (SGLI). This research includes utilization of data from Earth Venture-Suborbital (EVS) efforts such as the North Atlantic Aerosols and Marine Ecosystems Study (NAAMES) and the COral Reef Airborne Laboratory (CORAL). Multisensor research approaches are especially important and relevant given that abundant, complementary types of satellite and airborne observations are now available, as are adequate computational resources and analytical tools.

This sub-element specifically solicits research to apply new combinations of data and/or data products from different sensors, and to demonstrate their suitability for answering key ocean biological, ecological, and biogeochemical science questions. These investigations MUST use NASA airborne or satellite data as one primary research tool. Exploratory studies and projects that demonstrate new scientific applications are relevant. Studies to actively utilize such data and data products in ocean biological and biogeochemical modeling, synthesis activities, and diagnostic analyses are of interest. This opportunity is not appropriate for the production of major, new Earth System Data Records (ESDR).

2.3 Detection, Quantification and Analysis of Marine Debris

Marine debris is a major threat to ocean ecosystems and human health and poses new risks to ocean safety. Plastic debris is ubiquitous in all marine environments, from shorelines to coasts, the open ocean's surface, its water column, and the deep sea. Marine debris is a global problem; it is durable, and is able to survive long travels from the continents where it originates, across the vastness of the ocean. Marine debris is transported by ocean currents, winds, waves, and turbulence. These factors dictate aggregation pathways and areas in the ocean and on the coastline. Unfortunately, the current level of understanding of sources, transport, fate, and impacts of marine debris is low. This knowledge gap not only impedes the identification of effective solutions for marine plastic debris, but it also prevents decision-makers from effectively mitigating emerging threats to human health, such as hazards from microplastics. Because of the global nature of the marine debris problem, satellite remote sensing is particularly poised to provide solutions in terms of tracking, assessing, and quantifying marine debris. However, remote sensing of marine debris is in its infancy. The ocean surface is tremendously complex, and the broad diversity of types of debris (e.g., chemical composition, geometric shape, etc.), coupled with the different factors controlling plastic distribution, make identification and tracking of floating marine debris a challenge.

While imaging spectroscopy offers great potential for the detection and characterization of marine debris, there is still a lot of work to be done in this arena (e.g., better characterizing reflectance properties with the degree of submersion of plastics, impact of weathering degree on reflectance magnitude, impact of biological growth on spectral signal, etc.). This sub-element seeks to advance the area of remote sensing of marine debris by specifically focusing on (1) developing new approaches that use passive or

active satellite and/or airborne radiometric techniques to detect and characterize marine debris, and (2) improvements to atmospheric correction approaches that take into consideration potential contributions of plastics in the open ocean. Of particular interest are investigations that will advance the potential capabilities of future missions described in the NASEM report, Thriving on Our Changing Planet: A Decadal Strategy for Earth Observations from Space, for the detection of marine debris. Also of interest are proposals that, as part of the research, will contribute to the expansion of spectral libraries of marine debris. Proposers are encouraged to use, in addition to NASA and non-NASA Earth observing satellite sensors currently in orbit, data acquired by the Commercial SmallSat Data Acquisition Program (CSDAP; see Section 3.1 below and A.1 the Earth Science Research Overview).

2.4 Preparing for New Ocean Measurements

Spectral radiometry is a very useful tool to infer many aquatic biogeochemical properties, and hyperspectral radiometry is particularly useful, especially in rapidly changing regions such as coasts and inland waters. Hyperspectral imaging data can delineate signatures of phytoplankton taxonomic diversity and particle size distribution, as well as the characteristics and conditions of shallow submerged systems such as coral reefs and seagrasses. In addition to hyperspectral imaging, active remote sensing such as lidar can provide information on phytoplankton composition and distribution, as well as organic carbon pools, down to three optical depths, complementing and expanding observations from passive radiometry.

The 2017 NASEM report, Thriving on Our Changing Planet: A Decadal Strategy for Earth Observations from Space, recommends Observing System Priorities to be developed over the next decade, beyond what is in the program of record (PoR). Surface Biology and Geology (SBG) is one of the identified designated observables, and its Science/Applications Objectives include surface biology, functional traits of inland and near-coastal aquatic ecosystems, and gross primary production (GPP). Aerosol and Cloud, Convection and Precipitation (A-CCP) is also one of the designated observables whose objectives include advancing seasonal and interannual climate variability and prediction (note that NASEM identified separate observables for Aerosols and for Clouds, Convection and Precipitation, but given the overlaps and synergy among the observables, NASA has chosen to combine the ongoing studies into a single integrated observable). In addition to the 2017 targeted observables, the NASEM report supports the implementation of the PoR, which includes the Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission. NASA is currently developing Agency Designated Observables (DOs) science, applications, and architecture options within the costing profiles identified by the NASEM report, including SBG and A-CCP, in preparation for potential future formulation activities. Research and applications studies and activities will be critical to provide the required information and material to achieve the PoR and DO objectives. This sub-element specifically seeks to advance preparatory work focused on aquatic biology and ecology in anticipation of PACE, SBG, and A-CCP.

2.4.1 *Plankton, Aerosol, Cloud, ocean Ecosystem Mission*

PACE science is expected to significantly advance aquatic ecology and biogeochemistry research both in the open ocean and in coastal and inland regions

(including estuaries, tidal wetlands, and lakes). In 2020, NASA selected the Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) Science and Applications Team; the team will develop and create data products to address basic and applied research, specifically exploiting the unique capabilities of the PACE observatory. This subelement welcomes research in ocean ecology that will lay the scientific groundwork in observations, modeling, and research for the new ocean measurements from PACE, in particular focusing on the PACE inherent optical properties – Gaps Matrix. Additional supporting PACE science publications are available on the PACE Website. Proposers must utilize data from precursors to the PACE instruments (Ocean Color Instrument [OCI], Hyper-Angular Rainbow Polarimeter [HARP]-2, and Spectro-polarimeter for Planetary Exploration [SPEXone]), such as HICO, DESIS, AVIRIS, PRISM, AirHARP, AirSPEX, Multi-angle Imaging SpectroRadiometer (MISR), Polarization and Anisotropy of Reflectances for Atmospheric Sciences coupled with Observations from a Lidar (PARASOL), and hyperspectral synthetic data sets developed prior to launch.

2.4.2 *Surface Biology and Geology*

Over the past year, the SBG Study Team has developed a Science and Applications Traceability Matrix (SATM), using input from a range of science communities and the four working groups within the SBG Study Team (Applications, Algorithms, Modeling and Calibration/Validation). It is anticipated that SBG science will provide critical information on aquatic biochemistry and ecosystems in coastal regions, estuaries, tidal wetlands, and lakes, as well as on functional traits and health of inland and near-coastal aquatic ecosystems such as macroalgae, seagrasses, and corals. This sub-element specifically solicits theoretical and analytical studies for the development of one or more algorithms or approaches - including cross-instrument approaches - for ocean color products that are analog to the anticipated hyperspectral data to be produced by the SBG mission. Example analog datasets include, but are not limited to, HICO, DESIS, AVIRIS, AVIRIS-NG, and PRISM.

2.4.3 *Aerosol and Cloud, Convection and Precipitation*

With input from the relevant scientific communities, the A-CCP team has developed a Science and Applications Traceability Matrix. The A-CCP mission is contemplating a variety of instruments for the mission architecture, including a lidar, which would be fundamental for observations of ice clouds and aerosols. As demonstrated by the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) instrument, these high-resolution measurements can also capture a variety of important aquatic biogeochemical and ecological characteristics, such as ocean carbon biomass and the vertical distribution of ocean primary producers through cloud and aerosol layers globally, year round, and trustworthy down to three optical depths—which is not possible using passive radiometry. Future ocean-optimized satellite lidars will be able to obtain vertically resolved profiles of phytoplankton biomass; potentially discriminate phytoplankton functional types, bloom phenology, and particle size distribution; and further improve retrievals of phytoplankton biomass at high-latitudes during winter, at night, and through clouds and thick aerosols. In addition, such measurements would provide complementary observations and added value to missions such as PACE. This sub-element welcomes research that advances theoretical and analytical studies focused on lidar for ocean biology measurements with an eye towards potential

contributions to the A-CCP mission. Examples of potential studies include furthering the current state of knowledge about the shape and concentration of marine particles, as well as the development of radiative transfer codes to better understand the laser path for diverse oceanic water types through the use of analog data sets such as HSRL and CALIOP.

2.5 Research to Advance Foundational Optical Oceanography With An Eye On The Next Decade Of Ocean Biology Remote Sensing

Over the past two decades, there have been significant advances in ocean color remote sensing and the foundational optical oceanography techniques that are needed to ensure that the variations of light in response to different constituents within the ocean surface layer are accurately interpreted to derive concentrations of biogeochemical constituents and inherent optical properties. Several methods have been developed to estimate the concentration and type of seawater constituents, size distribution of particles, and chemical composition of particulate and dissolved matter. As technological advances propel us into the next decade of biological and biogeochemical ocean measurements, novel core optical oceanography approaches are needed that will capitalize on the new technologies at our disposal. For example, there are fundamental geophysical properties that can only be retrieved with novel techniques such as polarimetry and lidar. These measurements will complement standard ocean color products and provide a more comprehensive view of our dynamic ocean. Research is solicited to further advance core optical oceanography related to biological and biogeochemical remote sensing, with an eye to new space-based measurements being developed over the next decade on missions such as PACE, and the designated observables currently under planning (e.g., SBG). Contributions to the recently selected Earth Venture Instrument Geosynchronous Littoral Imaging and Monitoring Radiometer (GLIMR) are also welcome. Areas of interest include, but are not limited to, studies to develop and evaluate algorithms and analysis strategies that address the utility of ultraviolet observations from space, complementary optical approaches in support of water quality measurements, remote sensing in polar seas, and determination of phytoplankton functional types.

2.6 Successor Studies

This sub-element provides opportunities for integrative research relevant to the goals and objectives of the OBB Program that will significantly advance the results of prior OBB-funded research toward addressing Science Mission Directorate goals and the Carbon Cycle and Ecosystem Focus Area research questions, and enhance current and future NASA missions. EXport Processes in the Ocean from Remote Sensing (EXPORTS) and EXPORTS-related research will not be considered under this sub-element. In 2020, EXPORTS will complete its second and last field campaign in the North Atlantic, and the synthesis phase of the project (Phase 2) is anticipated to be solicited no earlier than 2021. Successor proposals and follow-on research from past NASA OBB research projects submitted to this sub-element must (1) offer demonstrable scientific advances beyond the earlier study, and (2) explain the continuing relevance and priority of the research to be pursued within the framework of the OBB Program. If new studies do not cite the specific prior NASA OBB-funded study, do not document the progress made in that study, and do not provide explicit information on how the

continuation will significantly advance the understanding of the research question (beyond simply incremental science), then the proposed research will be considered nonresponsive to this element.

3. Programmatic Information

3.1 Required Elements for Proposals

All proposals submitted in response to this program element must include (1) a discussion in the Scientific/Technical/Management Section describing how errors and uncertainties will be addressed (see Section 3.2) and (2) a description in the Data Management Plan that addresses the dissemination and sharing of research results and compliance with NASA Earth Science data policy (see Sections 3.3). Unless specified in this section, proposals should follow the format and instructions provided in the NASA NRA/CAN Guidebook for Proposers, which describes the policies and procedures for submitting responses to the Agency's Broad Agency Announcements.

Substantive use of remote sensing data is required in all studies. Proposers are encouraged to use, in addition to NASA and non-NASA Earth observing satellite sensors currently in orbit, data acquired by the Commercial SmallSat Data Acquisition Program (CSDAP; refer also to A.1). Proposers may use the commercial data that have been previously acquired by NASA for scientific purposes at no cost to Principal Investigators (PIs), in adherence to vendor-specific terms and conditions and subject to scientific use licenses. An up-to-date list of available data and associated licenses can be found at https://earthdata.nasa.gov/csdap.

3.2 Requirement to Address Errors and Uncertainties

Characterization of uncertainties will be essential in all analyses proposed to be undertaken under this program element. For a proposal to be considered responsive to this element, it must explain how error and uncertainty will be considered, incorporated into results, and reported. This explanation must include characterization of uncertainties and quantification of errors associated with data, analytical approaches, model results, and scientific interpretations. This discussion must be described in the Scientific/Technical/Management Section of the proposal.

3.3 Requirement for a Data Management Plan (not to exceed two pages)

The data management plan (DMP) must be placed in a special section of the proposal, entitled "Data Management Plan." All proposals must contain this section. The DMP may not exceed two pages in length and must immediately follow the references and citations for the Scientific/Technical/Management Section of the proposal. The two-page DMP section does not count against the 15-page limit of the Scientific/Technical/ Management Section. Formatting requirements for DMPs are the same as for the Scientific/Technical/Management Section. The DMP section must include, as relevant to the type of study being proposed, the types of data and data products or other materials to be produced in the course of the project, the standards to be used for data and metadata formats, and plans for providing access to and/or archiving the data and other research products in compliance with NASA Earth Science Data and Information Policy. A valid DMP may include only the statement that no detailed plan is needed, as long as a clear justification is provided. The DMP must describe how errors and uncertainties

will be reported, including the data and products to be shared and archived. Additional information about data management is available at the Oak Ridge National Laboratory (ORNL) Distributed Active Arcive Center (DAAC) Web site. For any new data sets proposed, the DMP must include plans for quality assessment, timely public release, and long-term archive of the data set(s). Consistent with the DMP, costs needed to support all data management activities, including quality assessment, documentation, data and product sharing, and preparation for long-term archive, must be included in the budget presented in the proposal. In addition, the person(s) within the proposing team responsible for data management must be identified, and the time to be devoted to data management detailed in the table of personnel effort. NASA strongly encourages allocating resources within the proposal budget to adequately address data management needs.

If the data are to be archived in the SeaWiFS Bio-optical Archive and Storage System (SeaBASS), within the Ocean Biology Distributed Active Archive System (OB.DAAC), proposers are asked to provide, in addition to the types of data generated in the form of a list or table, plans and a timeframe for submission to SeaBASS; an example may be found in Table 1, below. If the dataset is not anticipated to be submitted within a year after collection, proposers must provide a brief explanation justifying the time needed for submission. For each dataset, proposers should identify the method for collection or instruments, briefly describe the data type, and specify the expected data size. Data collection and analysis methods are expected to follow community-vetted protocols, and datasets must be accompanied by complete documentation and calibration information (see "Contribute Data" sections of the SeaBASS website). Datasets will be reviewed for compliance after submission.

Table 1 Example of data table detailing the type of information that will be submitted to a data repository

Data Parameter	Instrument/ Method	Dataset size	Submission timeline (after collection)	Repository	Explanation/comments
Beam attenuation coefficient	AC-s[1]	<1Gb	4 months	SeaBASS	
Particle size distribution	UVP[2]	<1Gb	4 months	SeaBASS	
Particle images	UVP	1 TB	15 months	SeaBASS	Images require intense validation

[1]Spectral Absorption and Attenuation Sensor

[2]Underwater Vision Profiler

3.4 Requirement regarding the use of existing in situ/field data

Sub-element 2a requires the utilization of existing in situ/field data in conjunction with satellite and/or NASA airborne data. This approach includes data collected through past NASA projects, autonomous and ship-based time series, bio-optical and biogeochemical floats (e.g., the Southern Ocean Carbon and Climate Observations and Modeling project, SOCCOM), etc. NASA encourages the utilization of its repositories as sources of data, in particular SeaBASS, which archives in situ oceanographic and atmospheric data, and is maintained by the NASA Ocean Biology Processing Group (OBPG). Complementary data from other data repositories are also welcome.

4. Other Proposal Requirements

All proposals submitted in response to the OBB Program sub-elements of this program element must explain the significant advance in scientific understanding anticipated and its societal relevance. Substantive use of remote sensing data is required in all studies.

Investigators proposing high performance liquid chromatography (HPLC) phytoplankton pigment sample analysis must include the analytical cost for such measurements within their proposal budgets. The current cost for a complete suite of acetone-extractable HPLC pigment analysis is $100 per sample at the NASA-supported analytical facility. Approximately 5% of the pigment samples should be submitted in duplicate for assessment of replicate sample precision. Proposed budgets must also include shipping costs of samples and return of the shipping container. Investigators may make separate arrangements with a non-NASA-supported analytical facility for HPLC pigment sample analysis. However, investigators that do not use the NASA-supported facility must send a subset of duplicate samples (~10% of total) to the NASA GSFC facility and budget for these samples accordingly. This allows for lab-to-lab intercomparison of pigment results and assessment of uncertainties.

Proposers must budget to attend one Ocean Color Research Team (OCRT) meeting or equivalent each year in the United States (e.g., PIs should budget a four-day trip to the farthest coast once per year).

Any data collected will be subject to the standard NASA Earth Science Data and Information Policy. Proposals planning to collect field data should contain a table that, to the extent possible, details what data will be collected and specifies the cruise or field visit and date(s) when data will be collected. The table should also provide a detailed plan for data submission to a NASA data center, such as SeaBASS, within one year of collection or as soon as the data completes quality assurance/quality control (QA/QC). This table should be included in the Data Management Plan (See Section 3.3).

4.1 Requirement Regarding Duration of Study

The maximum duration of an award under this program element is three (3) years. Proposers must document and carefully justify the need for the amount of time requested. It is possible that many activities that exploit existing data sources, as well as some follow-on or successor studies, can be completed within a shorter amount of time.

4.2 Requirement for Proposals Requesting Acquisition of New Airborne or Shipborne Data, or Other Platform Needs.

Investigators should make clear any special requirements or platform needs, e.g., airborne data acquisition, ships/ship modifications, additional boats, and/or specific sampling requirements in a separate section of no more than one page immediately following the Data Management Plan. This special platform requirement section does not count against the 15-page limit of the Scientific/Technical/Management section.

To request NASA High-End Computing (HEC) resources for the proposed research, please refer to Section I(d) of the NASA Research Opportunities in Space and Earth Science (ROSES) Summary of Solicitation and the HEC website.

Proposals requiring data from airborne sensors must detail in the cost plan all costs for acquiring the new data sets, including costs for aircraft hours, deployment costs, mission-peculiar costs, data processing costs, and other costs associated with deploying the sensors and aircraft (including costs for NASA sensors and platforms, as well as non-NASA sensors and platforms). In addition, for any proposed activities requiring NASA aircraft or NASA facility sensors, proposers should submit a Flight Request to the Airborne Science Flight Request system at http://airbornescience.nasa.gov (click on "FLIGHT REQUEST"). Questions regarding the flight request system or process should be addressed to Marilyn Vasques, Flight Request Manager (Marilyn.Vasques@nasa.gov or 650-604-6120).

If the platform (e.g., vessel or aircraft) is not a NASA asset, proposers must take responsibility for making all arrangements to secure the availability of the needed platform and explain these plans in the proposal. Proposers should include any required supporting paperwork that provides insight into costs or requests in support of the use of the platform.

4.3 Work Effort Table and Current & Pending Support (no page limit)

Proposers must use the Earth Science Division's standard templates for detailing the level of work effort for project participants and for the current and pending support of project participants. These templates are available at https://science.nasa.gov/researchers/templates-for-earth-science-division-appendix-a-roses-proposals. The table of work effort must be placed immediately following the budget narrative.

5. Programmatic Information

5.1 Eligibility

This program element is open to all categories of institutions interested in conducting research that directly addresses the objectives of the Ocean Biology and Biogeochemistry Program. Proposals from non-U.S. organizations will be funded on a no-exchange-of-funds basis (see Appendix A of the NASA NRA/CAN Guidebook for Proposers). Collaborations between researchers at U.S. and non-U.S. organizations are welcome, but the portion of the work to be conducted by the non-U.S. institution must be funded through other sources in order to comply with NASA's no-exchange-of-funds policy.

5.2 Proposal Evaluation Criteria

Proposals will be evaluated according to the criteria defined in Appendix D of the NASA NRA/CAN Guidebook for Proposers and as specified in Section VI(a) of the ROSES *Summary of Solicitation*. In addition to the factors given in the NRA/CAN Guidebook for Proposers, the evaluation shall take into account the following considerations:

- The quality and completeness of the Data Management Plan
- The expertise of the investigators and their institutions in engaging in data sharing and providing timely access to data and research products on related and relevant projects

While it is expected that proposals will be selected in each of the sub-elements, the Earth Science Division reserves the right to select proposals in none, some, or all of the sub-elements, depending on the nature and distribution of proposals received and the outcome of the peer review process.

6. Summary of Key Information

Expected annual program budget for new awards	Up to $3.5 M
Number of new awards pending adequate proposals of merit	~ 10-15
Maximum duration of awards	Up to 3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 of this ROSES NRA.
Due date for Proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	February 2021
Page limit for the central Scientific/Technical section of proposal	15 pp; see also Table 1 of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the Earth science strategic goals and subgoals in NASA's Strategic Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section IV and Table 1 of the *ROSES Summary of Solicitation* and Section 3 of the *NASA Guidebook for Proposers*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of the *ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.

Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-OBB
points of contact concerning this program both of whom share this address: Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001	Laura Lorenzoni Telephone: (202) 358-1709 Email: laura.lorenzoni@nasa.gov ~~Paula Bontempi~~ ~~Telephone: (202) 358-1508~~ ~~Email: paula.bontempi@nasa.gov~~ **[Removed September 3, 2020]**

A.4 TERRESTRIAL ECOLOGY

NOTICE: The Terrestrial Ecology program does not currently plan to solicit proposals in ROSES-2020. We expect to solicit again in ROSES-2021.

NASA Terrestrial Ecology research addresses changes in Earth's carbon cycle and ecosystems using space-based observations. The goals of NASA's Terrestrial Ecology research are to improve understanding of the structure and function of global terrestrial ecosystems, their interactions with the atmosphere and hydrosphere, and their role in the cycling of the major biogeochemical elements and water. This program of research addresses variability in terrestrial ecosystems, how terrestrial ecosystems and biogeochemical cycles respond to and affect global environmental change, and future changes in carbon cycle dynamics and terrestrial ecosystems. The research approach combines (i) use of remote sensing to observe terrestrial ecosystems and their responses; (ii) field campaigns and related process studies to elucidate ecosystem function; and (iii) ecosystem and biogeochemical cycle modeling to analyze and predict responses. Research to establish a theoretical and scientific basis for measuring Earth surface properties using reflected, emitted, and scattered electromagnetic radiation and to develop the methodologies and technical approaches to analyze and interpret such measurements is an important component of the Terrestrial Ecology research program.

Priorities for new research within NASA's Terrestrial Ecology program derive from the goals and objectives for Earth Science in NASA's 2018 Strategic Plan (https://science.nasa.gov/about-us/science-strategy/), the research agenda of the U.S. Global Change Research Program (USGCRP) (http://www.globalchange.gov/), the science priorities of the U.S. Carbon Cycle Science Program (https://www.carboncyclescience.us), and some of the research gaps described in the State of the Carbon Cycle Report 2 (SOCCR-2) (https://www.globalchange.gov/content/about-soccr-2). A major recent emphasis within the Terrestrial Ecology program has been ecological field studies, airborne science studies, and ecosystem modeling activities for the Arctic-Boreal Vulnerability Experiment (ABoVE) (http://above.nasa.gov). The ABoVE Study Area encompasses much of the boreal and tundra area of Alaska and western Canada. The overarching science question for ABoVE is: How vulnerable or resilient are ecosystems and society to environmental change in the Arctic and boreal region of western North America?

For further information on this program, contact:

Hank Margolis, Program Manager
NASA Terrestrial Ecology Program
Earth Science Division
Science Mission Directorate
NASA Headquarters
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A.5 Carbon Cycle Science

NOTICE: Amended August 26, 2020. This amendment releases the final text for this program element. Optional notices of intent to propose are requested by September 28, 2020 and the due date for proposals is December 3, 2020.

A one-page Project Management Plan is mandatory (see Section 4.2). Proposers to this program element should not provide the Data Management Plan (DMP) via the NSPIRES cover page. Instead, the DMP must be included in the proposal after the Project Management Plan (see Section 4.3). Proposers must use the standard Earth Science template to detail project participants' level of work effort and current and pending support (see Section 4.4).

1. Scope of Program

This announcement offers opportunities for Carbon Cycle Science investigations within the NASA Earth Science Division Research and Analysis Program. NASA seeks proposals that make significant use of remote sensing data to improve understanding of changes in the distribution and cycling of carbon among the active land, ocean, coastal, and atmospheric reservoirs, and how that understanding can be used to establish a scientific foundation for societal responses to environmental change.

2. Background

The overall goals for NASA's Earth Science program are documented in the NASA Science Mission Directorate 2020-2024 Science Plan and NASA 2018 Strategic Plan. NASA Earth Science research focuses on using space-based observations to safeguard and improve life on Earth, often supplemented with other types of observations (e.g., aircraft and/or surface measurements) and then combined and synthesized in models. Carbon Cycle Science research is supported by many research and applied science programs at NASA, including, but not limited to, NASA's Carbon Cycle and Ecosystem (CCE) Focus Area and the individual research and analysis programs that support it; significant investments are also made by many of the CCE-related satellite programs, which have separate competed science teams for data exploitation.

The NASA Earth Science Program goals for Carbon Cycle Science are to improve understanding of the global carbon cycle and to quantify changes in atmospheric CO_2 and CH_4 concentrations, as well as terrestrial and aquatic carbon fluxes and storage in response to fossil fuel combustion, land use and land cover change, and other human activities and natural events. NASA carbon cycle research encompasses multiple temporal and spatial scales and addresses atmospheric, terrestrial, and aquatic carbon stocks and fluxes, their coupling within the global carbon cycle, and interactions with climate and other aspects of the Earth system. Observations from space provide a platform for NASA carbon cycle research; they contribute toward the goals of major U.S. Global Change Research Program (USGCRP) activities, including the Carbon Cycle Science program's U.S. North American Carbon Program (NACP) and the Ocean Carbon and Biogeochemistry (OCB) program. NASA carbon cycle research also

contributes toward the goals of the Ocean Policy Committee and the related activities of its member federal agencies.

3. Carbon Cycle Research Solicited

The Marine and Terrestrial Ecosystems and Natural Resources Management Panel of the 2017 Decadal Survey for Earth Science and Applications from Space (ESAS) of the National Academies of Sciences, Engineering, and Medicine (NASEM) *Thriving on Our Changing Planet: A Decadal Strategy for Earth Observations from Space* identified several science and application questions which are essential to understanding how the Earth system is changing, what the impact to ecosystems may be, how this may affect the services they provide (i.e., benefits people obtain from ecosystems, such as provisioning of water and food and absorbing human-generated carbon dioxide from the atmosphere), and how the structure of these ecosystems affects the fluxes of carbon, nutrients, and energy between and across the Earth system. In addition, recent investments in synthesis research, such as the Second State of the Carbon Cycle Report (SOCCR2), as well as recent meetings, for example the 2019 OCB Ocean-Atmosphere Interactions workshop and 2019 AGU Chapman Conference on Understanding Climate-Carbon Feedbacks, have highlighted key priority areas of research needed to fill important scientific knowledge gaps that will help inform decision-making stakeholders about carbon management and mitigation strategies and improved resilience.

This program element requests proposals for research focused on carbon stocks and fluxes between and within freshwater, marine systems, and land ecosystems, and their exchange with the atmosphere. It also targets improving understanding of carbon cycle processes and feedbacks in critical ecosystems, as highlighted by the research topics below, that are particularly vulnerable to environmental change.

Substantive use of remote sensing and/or airborne data is required in all studies. In addition to data from NASA and non-NASA Earth observing satellite and airborne sensors, proposers are also encouraged to also use data acquired by the Commercial SmallSat Data Acquisition Program (CSDAP; refer also to ROSES-2020 A.1 Earth Science Research Overview).

The research topics of interest for this program element are summarized below and described in detail in subsequent sections. They are divided into two sub-elements, which are further divided into five research topics.

3.1: Carbon Fluxes between and within Land, Freshwater, and Marine Systems
- 3.1.1. The Land-Ocean Continuum
- 3.1.2. Carbon Cycle of Critical Ecosystems: Vulnerability of Tropical Forests
- 3.1.3. Fluxes and Biogeochemistry of Carbon within Oceans

3.2: Carbon Fluxes between Ecosystems and the Atmosphere
- 3.2.1. Carbon Fluxes between Terrestrial Ecosystems and the Atmosphere
- 3.2.2. Carbon Fluxes between Oceans and the Atmosphere

Proposers will be asked in NSPIRES to identify a primary, and if appropriate, a secondary research topic for their proposal.

Proposers are cautioned that the current program element targets fundamental understanding of the carbon cycle and the processes that control it. In this respect, it is fundamentally different than the Carbon Monitoring System solicitations that target development of derived remote sensing products, and requires the engagement of stakeholders toward the development and implementation of prototype carbon monitoring systems.

3.1. Carbon Fluxes between and within Land, Freshwater, and Marine Systems

Carbon cycling dynamics across landscapes, inland water, and coastal and open ocean are complex and interconnected. Capturing and integrating fundamental processes as they change across scales of space and time are fundamental to understanding the complex linkages between carbon and ecosystems. There are significant gaps in our understanding of fluxes within and across ecosystems due to a combination of poor data coverage and methodological constraints; such gaps limit our ability to quantify accurately the global carbon budget and understand how ecosystems will respond to enhanced carbon dioxide levels in the atmosphere. This knowledge is also critical for better understanding the future evolution of the carbon cycle and how the sequestering of anthropogenic emissions by the terrestrial and aquatic biospheres may change.

Satellite remote sensing can provide simultaneous global observations of fundamental physical, chemical, and biological processes needed for quantifying large-scale carbon cycle processes. Further development of models based on a quantitative understanding of ecosystem function is essential to predicting how carbon fluxes within and across terrestrial and aquatic ecosystems will respond to perturbations.

Research is solicited to advance our understanding of carbon fluxes that will help answer the following questions: What are the fluxes of carbon between and within ecosystems, and across land, freshwater, and marine ecosystems? How and why are they changing?

3.1.1. *The Land-Ocean Continuum*

Aquatic ecosystems provide important ecosystem services, from water for human use to food, wildlife habitat, and economic sustenance in the form of tourism. Changes in land use impact inland aquatic and coastal ecosystems, and climate change has altered temperature and precipitation patterns, adding a layer of complexity to the understanding of how these aquatic systems have been altered and how their condition and functionality will continue to change over time. The high uncertainty and poor understanding of how carbon moves from land to the ocean has been identified as one of the critical knowledge gaps necessary to constraining the structure and functioning of the Earth system. However, quantifying these fluxes remains challenging, as it requires measurements covering a wide range of spatial and temporal scales.

Traditionally, the land-ocean continuum (e.g., carbon fluxes from land to rivers, freshwater wetlands, coastal wetlands, coastal areas, marshlands, etc.) has been partitioned into its individual components, which precludes viewing this continuum as a holistic entity. Understanding the fluxes of carbon within and between ecosystems, and across the land, freshwater, and marine systems, requires an integrated approach that looks at carbon as it moves and transforms through the Earth system. Fluxes of carbon

within ecosystems are related to the composition and functional traits of the organisms present and these in turn determine not only the structure of the system but the transfer of carbon across systems. To understand carbon fluxes from the land to the ocean, it is necessary to constrain the transport and transformation of carbon in riverine systems and upon reaching the ocean, the impact/influence of adjacent land characteristics and its coupling to climate and weather. Tracing the transport and transformation of carbon between and within these systems requires simultaneous observations of a number of factors including, but not limited to, the composition of aquatic and terrestrial ecosystems, land use, land cover change (including natural and human-induced disturbance, such as fire, agricultural practices, and human settlement patterns), temperature, and consequences of spatial and temporal variability in precipitation events, pre- and post-disturbance.

This research topic of the program element seeks integrative research that furthers our understanding of carbon as it moves from the land to the ocean. Preference will be given to projects that focus on strong potential feedbacks and that have wide geographic applicability (e.g., approaches that can be applied widely), as well as an emphasis on human influences. Research that will further constrain uncertainties in key carbon parameters and biogeochemical fluxes in the context of preparing for future sensors, such as the Surface Water and Ocean Topography (SWOT) and the Plankton, Aerosol, Cloud and ocean Ecosystem (PACE) missions, as well as the Geosynchronous Littoral Imaging and Monitoring Radiometer (GLIMR) instrument, is of particular interest. The SWOT altimeter will advance our understanding of freshwater fluxes to the coastal environments, providing much needed information about inland water. PACE is anticipated to quantify and characterize optical constituents of coastal and open ocean waters, thereby resolving spatiotemporal biogeochemical dynamics. GLIMR is anticipated to provide unique observations of ocean biology, chemistry, and ecology in the Gulf of Mexico, portions of the southeastern United States coastline, and the Amazon River plume.

3.1.2. *Carbon Cycle of Critical Ecosystems: Vulnerability of Tropical Forests*

The tropics cover approximately 40% of Earth’s land surface area and regulate many Earth system processes. Tropical terrestrial ecosystems contain great stores of biomass and they represent a major reservoir of the planet’s terrestrial carbon. These ecosystems also cycle more carbon dioxide (CO_2) and water than other biomes and play important roles in determining the Earth's energy balance, which drives global systems of temperature and precipitation. Large-scale changes in tropical terrestrial ecosystems have the potential to change global patterns of temperature and precipitation. Tropical ecosystems are under significant stress from a changing climate, changing disturbance regimes, and from anthropogenic land use changes. While accepted as a critical global system, there are major gaps in our knowledge about how the carbon cycle of tropical ecosystems responds to environmental change, causing corresponding limitations to their representation in ecosystem and global-scale carbon cycle and climate system models. Social, economic, and human activity can interact strongly with these processes, so incorporation of these processes into models and projections is needed to more fully understand how humid and seasonally dry tropical forests and savannas have evolved and might change in the future. Important questions

about carbon dynamics in tropical systems from microscale (microbial processes, soil, and biogeochemical processes), to macroscale (plants and plant systems), through landscape and watershed scale, up to regional and pan-tropical scales remain unanswered.

Proposals under this research topic must aim to improve understanding of major forest and/or savanna ecosystems in the tropics. This topic emphasizes research that combines remotely sensed and/or surface field observations with modeling to provide improved quantitative and predictive understanding of the coupled biological, chemical, and physical processes that represent potentially strong carbon cycle feedbacks from tropical terrestrial ecosystems in a changing climate. Processes of particular interest include those needed to explain the impacts on ecosystems caused by drought, temperature, disturbance regimes (e.g., fire, deforestation, insect infestations), and consequent changes in hydrology. Preference will be given to projects that address strong potential carbon-climate feedbacks and have wide geographic applicability.

There is particular, but not exclusive, interest in proposals that can make use of multiple sensors currently operating on the International Space Station (ISS; see Section 3.3). The objective of the ISS portion of this research topic is to offer an opportunity for exploratory studies designed to use a combination of these ISS sensors to advance our understanding of the terrestrial carbon cycle in tropical regions. To be considered in this ISS category, a proposal must make use of at least three of the four ISS sensors (i.e., GEDI, ECOSTRESS, OCO-3, and/or DESIS; see Section 3.3).

3.1.3. *Fluxes and Biogeochemistry of Carbon within the Ocean*

Marine ecosystems are of fundamental importance in the carbon cycle as they regulate and influence the transformation, fate, and storage of carbon in the ocean. However, our mechanistic understanding of the processes controlling carbon cycling and export in the ocean is limited, in part by the lack of observational data at the appropriate temporal and spatial scales. For example, the coupling between primary producers and consumers/decomposers varies seasonally and regionally, resulting in high carbon export heterogeneity across the ocean. Indeed, carbon export depends largely on upper ocean ecosystem structure.

Remote sensing observations are critical to elucidate carbon cycling and fluxes in the ocean and have the potential to transform our understanding and prediction capabilities of how anthropogenic disturbances and resulting ecosystem changes will impact the ocean's capacity to cycle and sequester carbon. PACE will be a critical mission for constraining uncertainties in key carbon parameters and biogeochemical fluxes and quantifying and characterizing optical constituents of coastal and open ocean waters. It is anticipated that it will help elucidate the links between ocean ecology and the biological pump, a key unknown in the global carbon cycle. The Export Processes in the Ocean from RemoTe Sensing (EXPORTS) project is already tackling part of this question and proposers are encouraged to take advantage of the data already produced by EXPORTS. EXPORTS will advance our quantitative understanding of the export and fate of global ocean net primary production and develop predictive tools to monitor these processes on global scales (Siegel et al., 2016). Data from the first EXPORTS field campaign are already available through SeaBASS.

Advances in biogeochemical models are also critical; there is considerable uncertainty in ocean carbon cycle projections, and adequate constrainment of carbon flux processes can help understand carbon-climate feedbacks. A more integrated representation of the biosphere within Earth System Models is needed, along with improved seasonal to annual forecasts and decadal climate predictions, to capture the complexity of ecosystems. This is critical to understanding the limits of and harnessing predictability so future projections of carbon flux processes can be used in ways that are more useful and relevant to policymakers.

This research topic seeks proposals that will further our understanding of the ocean carbon cycle, in particular connecting remote sensing and/or airborne data to *in-situ* measurements to elucidate processes that provide insight into the connection between ecosystems and carbon fluxes, reduce the current uncertainty of carbon sources and sinks in the ocean, and advance our predictive capabilities of the ocean carbon cycle in the context of climate change and multiple stressors. Utilization of NASA-supported biogeochemical and biophysical models is encouraged (e.g., ECCO). While collection of new field data is allowed, utilization of existing data is strongly encouraged. In addition, utilization of data from previous NASA campaigns is encouraged (e.g., CORAL, NAAMES, and various campaigns using the AVIRIS family of instruments).

3.2. Carbon Fluxes between Ecosystems and the Atmosphere

An important feature associated with the continuing emission of carbon dioxide (CO_2) into the Earth's atmosphere from human activities (e.g., fossil fuel emissions, land use, cement production) is that, on average, only about half of the increased emissions remain in the atmosphere; the remainder are taken up by biophysical processes in Earth's biosphere (land and ocean). The Global Carbon Program estimates that, between 2009 and 2018, terrestrial ecosystems have absorbed 25% to 30% of anthropogenic carbon emissions, although these estimates contain significant uncertainty and interannual variability. The ocean, during the same period, has absorbed roughly 25% of anthropogenic CO_2 through biophysical and biological processes. There are still significant gaps in our understanding of the processes controlling the fluxes and feedbacks of carbon between the atmosphere and Earth's ecosystems.

While ecosystem processes might continue to take up a significant fraction of fossil fuel and land use change emissions, it is also possible that these sinks might diminish, disappear, or reverse in the future as human activities influence environmental and climate change. While there has been considerable concern about the role of terrestrial and aquatic ecosystems in a world of increasing atmospheric CO_2 concentrations, it is also important to understand how ecosystem processes and C sinks might change if/or when atmospheric CO_2 concentrations continue to increase, decrease, or level off. One of the major sources of uncertainty in predicting and projecting future climate is the role of terrestrial ecosystems in carbon-climate feedbacks and their interactions with scenarios of atmospheric CO_2 such as the IPCC Representative Concentration Pathways (RCPs) and Shared Socioeconomic Pathways (SSPs). Similarly, some of the largest projection uncertainties in ocean CO_2 source/sink can be attributed to lack of constrained air-sea exchanges; these stem from an insufficient understanding of the physical and biogeochemical interactions and feedbacks between the ocean and

atmosphere, as well as the rapidly changing ocean-atmosphere dynamics. Furthermore, it is well established that certain regions and processes are particularly important sources of potential feedback to the atmosphere, such as tropical, boreal, and Arctic regions.

Accurate representation of the processes that govern the longer-term exchange of carbon between the atmosphere and the biosphere is needed. If the strength of the biospheric carbon sink changes, then the sensitivity of climate to fossil fuel and land use change emissions also changes. This has potentially large implications for public policy decisions, and scientific information is currently insufficient to support management and planning under multiple climate sensitivity scenarios. This sub-element focuses on the carbon cycle of ecosystems and their interaction with the atmosphere; we solicit proposals that address the following research topics: (a) Carbon Fluxes between Terrestrial Ecosystems and the Atmosphere, and (b) Carbon Fluxes between Oceans and the Atmosphere.

3.2.1. *Carbon Fluxes between Terrestrial Ecosystems and the Atmosphere*

In this research topic, proposals are sought that address the issue of the temporal and spatial variability of the uptake of carbon dioxide by the terrestrial biosphere. While there is a particular interest in addressing this phenomenon over a multi-decadal time frame, studies that make use of the inter-annual variability to gain insight into decadal and longer-term variability are also encouraged.

Studies proposed to this topic must include coupled analyses of both atmospheric carbon dioxide and the terrestrial biophysical processes that contribute to emissions and uptake, as well as their spatial and temporal distribution. Due to limited funding, the focus is only on carbon dioxide (i.e., methane and other greenhouse gases are not a priority for this program element). While studies could be global in extent, zonal, regional, and continental scale analyses that help determine the contributions and sensitivities of regional ecosystems to the global scale are also pertinent. Studies that address the impacts of large-scale deforestation, forest degradation, and afforestation on terrestrial-atmosphere fluxes are also of interest. Studies must use models that provide a representation of the relevant processes to integrate disparate data sets. Of particular interest are studies that link exchange processes controlling the linkages between the carbon and water cycles. Integration of isotopic measurements with remote sensing observations to gain new insights into the terrestrial carbon cycle is also of interest. Significant use of remote sensing data is essential and studies based simply on empirical relationships or correlations will be considered non-responsive.

3.2.2. *Carbon Fluxes between Oceans and the Atmosphere*

The exchange of carbon across the air-sea interface is significant, with the ocean having absorbed over 30% of the anthropogenic CO_2 that has been released since the industrial revolution. This exchange has significant impacts on ocean carbon biogeochemistry and ocean health. Indeed, ocean warming, stratification, acidification, deoxygenation, and changes in primary productivity by marine phytoplankton have been identified as key potential ocean ecosystem stressors that may challenge sustainable management of living marine resources under climate change.

The magnitude of ocean CO_2 uptake, as well as air-sea CO_2 fluxes, varies on seasonal to interannual scales. Large-scale oscillations, such as the El Niño Southern Oscillation (ENSO) and Atlantic Multidecadal Oscillation (AMO), also impact the lower atmosphere and surface ocean exchange across scales and ranges that are still largely not well understood. Improving the understanding of physical and biogeochemical processes across the air-sea interface, as well as the response of surface ocean carbon levels to changes in atmospheric forcing, has direct impacts on our capacity to manage ecosystems, and to adequately develop a sustainable blue economy. Further constraining surface physical and biogeochemical processes will enable better quantification of air-sea fluxes, improved estimates and forecast of the state of the ocean/atmosphere system, and enable better prediction of the ocean induced by climate variability.

Satellite observations of sea-surface temperature, wind, salinity, ice, biogeochemistry, and biology are critical to understand oceanic gas fluxes, complementing the often sparse *in-situ* measurements and enabling development of synoptic atlases and other synthetic products. This research topic solicits research that would advance our understanding in the following areas: (1) Greenhouse gases in the ocean (e.g., surface ocean exchange processes, feedback mechanisms, etc.), (2) Atmospheric deposition and ocean biogeochemistry, and (3) Ocean biogeochemical controls on atmospheric chemistry. Proposers are encouraged to use, in addition to NASA and non-NASA Earth observing satellite sensors currently in orbit, data acquired by the Commercial SmallSat Data Acquisition Program (CSDAP; see also A.1 Earth Science Research Overview).

3.3. Additional Information for ISS-Related Proposals on Tropical Forests

This section provides additional information for proposals responding to Section 3.1.2 that focus on using Earth observing sensors deployed on the ISS. The ISS is currently hosting four instruments that present a novel opportunity to advance our ability to monitor and model the carbon cycle of tropical ecosystems. Three of these are NASA instruments and include: (1) Global Ecosystem Dynamics Investigation (GEDI), (2) Ecosystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS), and (3) Orbiting Carbon Observatory 3 (OCO-3). All three are currently operating on the ISS and have released data products to Level 2 or higher. A fourth instrument, the DLR (German Aerospace Center) Earth Sensing Imaging Spectrometer (DESIS) is a visible to near-infrared imaging spectrometer (400-1000 nm) that has released Level 2 data. GEDI, ECOSTRESS, and DESIS all launched in 2018, while OCO-3 launched in 2019. A fifth ISS-based instrument for observing terrestrial vegetation, the Hyperspectral Imager Suite (HISUI) from JAXA, was launched in December 2019; however, since HISUI data are not yet readily available, these data should not be included in proposed analyses.

The four operating instruments are making observations that can reveal the three-dimensional structure of forests (GEDI), biochemical status and ecosystem composition at the canopy level (DESIS), photosynthetic function from solar-induced fluorescence (SIF) and air column CO_2 concentrations (OCO-3), and evapotranspiration and water-use efficiency (ECOSTRESS). This instrument suite offers a unique opportunity because the ISS platform and pointing capabilities of the instruments enable co-location

of high-spatial-resolution measurements in space and acquisition times covering portions of the diurnal cycle throughout the year.

To be considered in this ISS category, a proposal must make use of at least three of the four ISS sensors (i.e., GEDI, ECOSTRESS, OCO-3, and/or DESIS).

Data previously acquired during the evaluations of Planet, Maxar, and Spire Global (see the Commercial Smallsat Data Acquisition Program Pilot Evaluation Report) will be available at no cost to proposers selected for NASA funding. Through NASA ESD's collaboration with the ISS project, data from the DESIS hyperspectral instrument launched to the ISS in 2018 will also be available at no cost to all U.S. government-funded researchers. More information about access to DESIS and other very high resolution commercial data is available at the Commercial Smallsat Data Acquisition Program Commercial Database website and in the DESIS information presentation.

4. Additional Requirements for All Proposals

All proposals submitted to this program element must make significant use of remote sensing and/or airborne data.

Proposers are advised to take great care to match their proposed activities to the research themes solicited (see Section 3) and overall scientific goals (see Section 2). In addition to the requirements specified under each research theme, all proposals must adhere to the requirements detailed below.

The proposal budget section and proposal cover page must include budgetary information for all funded Co-Investigators (Co-Is). This information must appear in the separately uploaded total budget as well as the NSPIRES cover page budget. Involving students and postdoctoral scientists, where possible, is encouraged.

4.1 Error and Uncertainty

All proposals must address how error and uncertainty will be dealt with in the study and describe how an understanding of the errors associated with measurement, quantification, and/or interpretation will be conveyed along with the research results.

4.2 Project Management Plan (one page maximum)

Proposals must include a Project Management Plan (PMP) that presents a management structure describing roles and responsibilities of all co-investigators and Collaborators and how the research activities will be coordinated and integrated. The PMP does not count against the 15-page limit of the Scientific/Technical/ Management section; the PMP must immediately follow the references and citations for the Scientific/Technical/Management section of the proposal.

NASA recognizes that small-scale field studies may contribute significantly to the proposed research. However, the cost of such field work may not exceed 25% of the total project budget. Consistent with NASA Earth Science data policy, all data collected must be made freely and publicly available with no period of exclusive use beyond calibration and validation (see Section 4.3). If a project involves field work, the PMP should also address contingency plans in the event of a disruption to the planned activities due to COVID or other perturbation to the scheduled activities (see Section 4.6

for information on requirement regarding requests for acquisition of data using different platforms).

Proposers are strongly advised to include only the needed number of Co-Is and/or Collaborators. All team members should have specific, major responsibilities in the investigation and the role of each participant should be clearly defined in the PMP. Proposers should not include Collaborators whose only role is to facilitate access to publicly-available data or provide advice about how to use publicly-available data.

4.3 Data Management Plan (two-page maximum)

Proposals submitted in response to this program element must include a Data Management Plan (DMP) describing the proposer's data sharing plan. This includes data from measurements, observations, experiments, and model simulations that would be costly to duplicate. The DMP does not count against the 15-page limit of the Scientific/Technical/ Management section and must immediately follow the Project Management Plan. The DMP must also contain information about the standards used for data and metadata formats and plans for providing access to and/or archiving the data and other research products in compliance with NASA Earth Science Data and Information Policy. It is not necessary to identify the data archive in the proposal, but a process for determining the archive should be described. The data sharing plan called for in section 2.3.5 of the NASA *Guidebook for Proposers* should be included in the DMP.

4.4 Work Effort Table and Current and Pending Support (no page limit)

Proposers must use the standard Earth Science templates to detail project participants' levels of work effort and current and pending support. The Work Effort table must be placed immediately following the budget narrative.

4.5 Principal Investigator Meeting Attendance

Proposers must budget to attend one Principal Investigator (PI) meeting each year for the duration of the project. Travel funding should allow at least the PI to attend these meetings in the United States (e.g., include budget for one four-day trip to the furthest coast annually). If the PI is unable to attend a scheduled PI meeting, he/she is expected to contact the relevant program manager at the earliest opportunity to discuss alternatives (e.g., substitution of a key Co-I, virtual participation, etc.).

4.6 Requirement for Proposals Requesting Acquisition of New Airborne Data, New Shipborne Data, or Other Platform Needs

Investigators should clearly detail any special requirements or platform needs (e.g., airborne data acquisition, ships/ship modifications, additional boats, and/or specific sampling requirements) in a separate section of no more than one page immediately following the Data Management Plan. This special platform requirement section does not count against the 15-page limit of the Scientific/Technical/Management section.

To request NASA High-End Computing (HEC) resources for the proposed research, refer to Section I(d) of the *NASA Research Opportunities in Space and Earth Science (ROSES) Summary of Solicitation* and the HEC website.

Proposals requiring data from airborne sensors must detail in the cost plan all costs for acquiring the new data sets, including costs for aircraft hours, deployment, mission-specific requirements, data processing, and other costs associated with deploying sensors and aircraft (for NASA and non-NASA sensors and platforms). In addition, for any proposed activities requiring NASA aircraft or NASA facility sensors, proposers should submit a Flight Request to the Airborne Science Flight Request system at http://airbornescience.nasa.gov (via the Flight Request page). Flight request system or process questions should be addressed to Marilyn Vasques, Flight Request Manager (Marilyn.Vasques@nasa.gov or 650-604-6120).

If the platform (e.g., vessel, aircraft) is not a NASA asset, proposers are responsible for making all arrangements to secure the platform and explain these plans in the proposal. Proposers should include any required supporting documentation that provides insight into costs or requests in support of the use of the platform.

5. Programmatic Information

5.1 Evaluation of Proposals

Proposals will be evaluated versus the three standard criteria: intrinsic merit, relevance, and cost, as defined in the *NASA Guidebook for Proposers*. The general information provided in Section VI of the *ROSES-2020 Summary of Solicitation* about the proposal review and selection process applies to this program element. In addition, the standard evaluation criteria are modified as follows:

In addition to the definition in the guidebook, the evaluation of merit will include:

a. An assessment of the risk-reward balance for the project and the quality and appropriateness of the approach to characterizing uncertainties and quantifying errors.
b. The quality and completeness of the project management plan and data management plan.

As described in the guidebook, the evaluation of cost shall include the reasonableness of the proposed cost. Low cost, while desirable, does not offset the importance of reasonableness of the proposed budget. Review panels evaluate cost reasonableness; comparison of the proposed cost to available funds is performed by agency program personnel.

Additional details are available in Appendix D of the *NASA Guidebook for Proposers*. Proposers are encouraged to read the section on review criteria prior to writing their proposals.

5.2 NASA Programmatic Information

Those investigators whose research requires high-performance computing should refer to the *ROSES Summary of Solicitation*, Section I(d), "NASA-provided High-End Computing Resources." This section describes the opportunity for successful proposers to apply for computing time on either of two NASA computing facilities at Goddard Space Flight Center's Computational and Information Sciences and Technology Office or at Ames Research Center's Advanced Supercomputing Division.

6. Summary of Key Information

Expected total program budget for first year of all new awards	$4.5M/year
Expected number of new awards pending adequate proposals of merit	~15 to 25
Maximum duration of awards	3 years
Due Date for Notice of Intent to Propose (NOI)	See Tables 2 and 3 of this ROSES NRA
Due date for proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	6 to 8 months after proposal due date
Page length for the Science-Technical-Management section of proposal	15 pages; see also Section 4
Relevance	This program is relevant to the Earth Science questions and goals in the NASA Science Plan. Proposals that are relevant to this Program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See A.1 Earth Science Research Overview and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-CARBON

Points of contact, all of whom share the following postal address: Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001	Primary Point of Contact: Laura Lorenzoni, Program Manager Ocean Biology and Biogeochemistry Program Telephone: (202) 358-0197 Email: Laura.Lorenzoni@nasa.gov Hank Margolis, Program Manager Terrestrial Ecology Program Telephone: (202) 358-4760 Email: Hank.A.Margolis@nasa.gov Kathy Hibbard, Program Manager and Lead Carbon Cycle and Ecosystems Focus Area Telephone: (202) 358-0682 Email: Kathleen.A.Hibbard@nasa.gov Michael Falkowski, Program Scientist Terrestrial Ecology Program Telephone: (202) 358-4760 Email: michael.falkowski@nasa.gov Garik Gutman, Program Manager Land Cover and Land Use Change Program Telephone: (202) 358-0260 Email: garik.gutman@nasa.gov Richard Eckman, Program Manager Atmospheric Composition and Modeling Program Telephone: (757) 864-5822 Email: richard.s.eckman@nasa.gov

A.6 CARBON MONITORING SYSTEM: CONTINUING PROTOTYPE PRODUCT DEVELOPMENT

NOTICE: The data management plan must be included within the 15-page limit for the Scientific/Technical/Management section of the proposal as it will be evaluated as part of Merit. Proposers must use Earth Science division templates for the required Summary Table of Work Effort and Current and Pending Support sections of the proposal, see Section 2.2.8.

1. Scope of Program

The NASA Carbon Monitoring System (CMS) is a forward-looking initiative designed to make significant contributions to characterizing, quantifying, understanding, and predicting the evolution of global carbon sources, sinks, and fluxes through improved monitoring of terrestrial and aquatic carbon stocks and fluxes. Initially implemented in response to language in NASA's 2010 Congressional Appropriation, this program is now considered to be an important part of NASA's Carbon Cycle and Ecosystem focus area, and as presently implemented, supports research and coordinates projects for the development of prototype carbon monitoring systems.

NASA's approach toward a carbon monitoring system has emphasized exploitation of current and future satellite remote sensing resources, computational capabilities, scientific knowledge, airborne science capabilities, and end-to-end system expertise that are major strengths of the NASA Earth Science program. Significant effort is being devoted to rigorous evaluation of the carbon monitoring products being generated, as well as to the characterization and quantification of errors and uncertainties in those products. The initial emphasis has been on regional, national, and global satellite-based carbon monitoring products relevant to national needs for completely transparent carbon and terrestrial biomass inventory processes that provide statistical precision and accuracy with geospatially explicit associated attribute data. NASA's approach considers data and expertise that are the domain of other U.S. Government agencies, and anticipates continuing close communication and/or partnerships with those agencies and their scientific and technical experts as U.S. national efforts toward integrated carbon monitoring mature.

NASA also recognizes a need for complementary local-scale (airborne and *in situ*) information to demonstrate quantitative remote sensing methods to evaluate carbon source, sink, and flux estimates; to aid in scaling up from project, county, and/or state levels on land and within different aquatic regions; and for essential evaluation of regional-, national-, and global-scale carbon monitoring products. Such work is critically important for advancing research capabilities toward an understanding of Earth's carbon cycle that is relevant for decision-making communities. Additionally, the current approach lays the groundwork for CMS-related applications of NASA and non-NASA satellite sensors currently on orbit (i.e., Orbiting Carbon Observatory-2 (OCO-2); ESA's Sentinel 5-Precursor; ECOSTRESS (launched June 29, 2018); Ice, Cloud, and Land Elevation Satellite-2 (ICESat-2, launched September 15, 2018); Global Ecosystem Dynamics Investigation (GEDI, launched December 5, 2018), and the Orbiting Carbon Observatory-3 (OCO-3, launched in May 2019); missions in development (i.e., Plankton, Aerosol, Cloud, and ocean Ecosystem (PACE); NASA-ISRO Synthetic Aperture Radar

(NISAR); and ESA's Earth Explorer Biomass and FLuorescence EXplorer (FLEX) mission).

Accomplishments-to-date include the development of a continental U.S. terrestrial biomass data product and a global carbon flux product; demonstrations of local- and regional-scale carbon management projects; improvement of the CMS biomass and flux products; refinement and quantification of carbon in tropical peatlands relevant to "blue carbon"; assessing changes in terrestrial-ocean carbon fluxes and investigating global ocean CO_2 fluxes; and engagement of carbon monitoring stakeholders to better understand their needs for carbon data and information products. Projects supported by CMS have developed CMS-Flux, one of the most advanced carbon data assimilation systems in the world, which integrates satellite and surface observations related to anthropogenic, oceanic, terrestrial, and atmospheric carbon. For more information about the projects that have been funded through CMS, see the CMS website (https://carbon.nasa.gov/) and relevant links listed on that page (e.g., publications, documents).

NASA has established a Carbon Monitoring System Science Team (CMS ST) that will include members from all NASA CMS investigations. The CMS ST is responsible for providing broad research community involvement in the development and evaluation of NASA CMS products; coordinating their NASA-funded CMS activities to ensure maximum science, management, and policy return; and providing scientific, technical, and policy-relevant inputs to help identify potential future research topics for NASA CMS activities. As current proposals are completed, their Principal Investigators (PIs) will rotate off the CMS ST and be replaced by the newly selected investigators from this program element.

The work so far conducted in this CMS prototyping effort has leveraged the much larger investments currently made by NASA in remote sensing observations of carbon-related properties of the Earth, as well as in carbon cycle science research.

2. Research Solicited

NASA requests proposals for investigations that will advance products toward the CMS end goal: development of prototype carbon monitoring systems from an Earth's system perspective. Areas of interest include terrestrial, atmospheric, and aquatic realms. Proposal emphasis must be directed toward continued development of the established CMS pilot studies (see https://carbon.nasa.gov), synergistic advancements from past CMS activities, as well as acquisition, quantification, and development of prototype CMS system capabilities that can improve existing and develop new data products toward achieving the levels of precision and accuracy required by current carbon trading activities (e.g., certification of emissions reductions). Successful applicants will also become NASA CMS Science Team (ST) members.

2.1 Research Topics

With this program element, NASA CMS will continue to refine, evaluate, and integrate suborbital, airborne, and satellite data, providing products that overlay previous research within a user-defined prototype monitoring system. These data sources include, but are not limited to, field campaigns with extensive NASA support.

All proposals are required to target a CMS prototyping activity and not focus solely on carbon cycle science research. This requirement will be factored into the relevance criterion evaluation. Proposals that do not address a CMS prototyping activity and clearly show the use of derived remote sensing data will be considered non-responsive and thus may be returned without review.

NASA requests proposals for three types of carbon monitoring prototyping and product development activities. NASA is soliciting:

- Studies that address research needs to advance (a) remote sensing-based approaches to quantifying forest degradation and forest regrowth; (b) independent assessment of the accuracy of satellite or airborne remote sensing observations of biomass and carbon stocks; and (c) the use of satellite remote sensing as an alternative or a supplement to ground-based methods for quantifying net carbon emissions and/or storage; and (d) the accounting of blue carbon ecosystems (quantification and change - e.g. regional/global extent and temporal distribution).
- Studies that build upon, extend, evaluate and/or improve the existing CMS products for biomass and flux resulting from NASA's earlier phases of CMS pilot studies; such studies may include, for example, product improvements, refined characterization and quantification of errors and uncertainties, and/or preparation and delivery of a mature product for long-term archive at an established NASA DAAC or equivalent data center.
- Studies using remote sensing data that evaluate and enhance national reported carbon emissions inventories from bottom-up estimates from various sectors of emissions within the United States and have the potential to be applied to reported national inventories from other nations.
- Studies that build upon and improve quantification of terrestrial-ocean carbon fluxes in areas that have been subject to considerable perturbations for accounting purposes. Inclusion/delineation of anthropogenic carbon contributions to existing flux estimates are encouraged.

Data from airborne or spaceborne remote sensing is required as a primary research tool in all proposed carbon monitoring investigations. All sources of remotely sensed data must be well justified in terms of their importance and appropriateness for the work to be conducted, as well as their overall utility for monitoring carbon for science, management, and policy.

The NASA CMS program continues to emphasize the importance of characterizing and quantifying uncertainties and errors in all CMS products and analyses, and such work must be included in all investigations proposed (see Section 2.2.7).

Proposals must explain the societal relevance of the carbon monitoring activities proposed and provide justification regarding the importance of this work to U.S. national interests in current or potential carbon monitoring for science, management, and policy. Proposals must clearly explain how the proposed work will address stakeholder interests in their studies. Proposers are encouraged to work with stakeholders to better understand stakeholder interests and requirements. Stakeholders are defined as those that utilize products outside the normal scientific research realm. In addition, proposers must indicate how they will contribute to CMS ST activities to understand and engage

the user community for carbon monitoring products. Many of the studies funded through the ROSES-2018 CMS program element (A.7; see PDF document with titles and abstracts of ROSES-2018 awards) have two additional year of funding remaining. Proposals to further develop or expand upon funded ROSES-2018 activities are, therefore, not currently as high a priority as the research topics listed in this program element.

2.2 Additional Proposal Requirements

2.2.1 *Requirements Regarding the Duration of Award*

The proposed scientific tasks must be of no more than three years duration and proposers may not propose a study with a longer period of performance. If the proposed research can be conducted in less than three years, a shorter period of performance is encouraged.

2.2.2 *Carbon Monitoring System Science Team Membership*

All proposals must request CMS ST membership for one or more key investigators and include one to two paragraphs describing the contributions they anticipate making to the activities of the CMS ST. This section should address one or more of the following:

- Representing concerns of the broad carbon monitoring community with respect to the nature, quality, and utility of existing or new NASA CMS products;
- Coordinating their CMS activities to ensure maximum returns and enhance or create complementarity, integration, and synergy;
- Providing important perspectives on product development, implementation, and evaluation;
- Providing insights on the relative merits of alternative approaches and products;
- Making connections to ongoing and newly developing activities with similar and/or complementary objectives being undertaken by other entities, especially other U.S. agencies; and/or
- Providing scientific, technical, and policy-relevant inputs to help set priorities and directions for future NASA CMS activities, including with existing working groups within CMS.

The CMS ST will conduct its business through periodic meetings, with frequent interactions through monthly teleconference calls and frequent email communications.

2.2.3 *Carbon Monitoring System Science Team Leader*

Proposals are requested for a CMS ST Leader. CMS has had a Science Team Leader for the past six years and NASA desires to continue having an individual from among the Science Team serve in this role. The CMS ST Leader will be responsible for providing scientific leadership and direction to the CMS ST and scientific inputs regarding CMS activities to NASA management. He/she will be responsible for calling and organizing ST meetings and related activities in coordination with NASA CMS managers and Carbon Cycle and Ecosystems Office staff. He/she will be responsible for organizing and delivering to NASA a final report summarizing the findings of the CMS ST regarding CMS Phase 2 activities and recommended next steps.

Team Leader proposals should include a separate section of up to three additional

pages in the Scientific/Technical/Management section that describes only the activities to be undertaken as CMS ST Leader and addresses the following aspects of team leadership:

- The carbon science, carbon management, and/or carbon policy qualifications and leadership skills of the proposing Team Leader;
- A clear articulation of the proposed Team Leader's vision for the NASA CMS and its contribution to science and society;
- The ability of the proposing Team Leader to represent CMS's overall goals and objectives to the broader community and to decision makers in need of carbon monitoring information; and
- A management plan that describes the approach to science team leadership, how interactions with the ST and NASA management will be conducted, and how science team business and meetings will be organized and conducted.

In addition, the Budget Justification: Narrative and Details section of the proposal and/or the Total Budget file, as appropriate, must include a detailed budget for only the Team Leader activities and a narrative and justification for the Team Leader work that are separate from those for their CMS ST member activities. It is anticipated that the level of effort for Team Leader is one to three months per year.

Proposers who wish to be considered for CMS ST Leader also should indicate their candidacy by answering the relevant cover sheet question.

NASA reserves the option to select a Team Leader from among the existing ST members should new Team Leader proposals of adequate merit and suitability not be received in response to this solicitation.

2.2.4 *Requirements for the Cost Plan*

Given the varying types of investigations solicited, NASA expects to fund a range of investigation sizes. It is expected that proposals requiring acquisition of new airborne or commercial satellite data will have budget profiles that have a significant peak during the year of data purchase/acquisition, but for the other years of such studies and for all other investigation types, NASA would not expect the per year budget, even for the most ambitious of investigations, to exceed $500,000. However, lower cost proposals of high scientific merit are very much encouraged. All data purchases, including commercial, must be itemized and justified within the scope of CMS. Cost plans must include resources for activities undertaken as a CMS ST member, including funds for travel to ST meetings. The proposed budget should include funds to participate in two CMS-related meetings per year, each lasting three days. For planning purposes, proposers should budget each year for one meeting in the western U.S. and one meeting in the Washington, DC area.

2.2.5 *Requirements for Proposals Requesting Acquisition of New Airborne Data*

Proposals requiring acquisition of data from airborne sensors must detail in their budget all costs associated with data set acquisition, including costs for aircraft hours, deployment costs, mission peculiar costs, data processing, and other costs associated with deploying the sensors, aircraft, and personnel. (This provision applies to all sensors and platforms, including any NASA sensors and platforms, as well as non-NASA

sensors and platforms). If the instrument or aircraft platform is not a NASA asset, proposers must take responsibility for making all arrangements to secure the availability of the needed sensors and aircraft and explain these plans in the proposal.

All proposers must submit a Flight Request to the NASA Airborne Science Flight Request system at http://airbornescience.nasa.gov (and then click on "Flight Request"). This is required for all proposals, whether it involves NASA sensors, platforms, and personnel or not, because a flight request is used to help NASA understand and track all of the airborne science it supports. Address any flight request system or process questions directly to Marilyn Vasques, Flight Request Manager (Marilyn.Vasques@nasa.gov or 650-604-6120).

2.2.6 *Requirements for International Agreements, Permissions, and Flight Clearances*

CMS activities proposing airborne and *in situ* data acquisitions outside the U.S. and/or in cooperation with interagency and international activities and programs (e.g., SilvaCarbon, REDD, REDD+-related projects) may require international agreements, permissions (e.g., research/data collection permits), overflight clearances, or other formal arrangements. Proposals must detail plans for meeting such requirements.

Proposals requesting use of NASA aircraft, NASA sensors, and/or NASA personnel in international work are required to follow all relevant NASA policies and procedures. In some cases, it may either be required or preferable for NASA to lead securing all or certain types of required agreements, permissions, or clearances. In most cases, where the use of NASA aircraft or sensors is not requested and NASA personnel are not involved, proposers will be fully responsible for securing their own arrangements.

Research involving participants at foreign organizations must be proposed and performed on a no-exchange-of-funds basis, whether through a proposal from a foreign or a U.S.

2.2.7 Requirements to Address Errors, Uncertainties, and Instrument Calibration

Given the importance of carbon cycle data and information for decision-making, it is essential that the research supported under NASA's CMS program characterize uncertainties and quantify errors associated with data and derived information products, as well as with analytical approaches, model results, and/or scientific interpretations.

When new data are acquired as part of the proposed activities, it is equally important that instrument calibration be documented and traceable so different types of data and data products can be intercompared with a high degree of confidence. Therefore, all proposals submitted in response to this program element must describe how errors and uncertainties will be addressed within their research project, including, if relevant to their study, errors and uncertainties associated with instrument calibration. The characterization of errors and uncertainties must be described in a separate subsection of the Scientific/Technical/Management section of the proposal. If new observations are to be made in the study, then this subsection should also describe their calibration, accuracy, and traceability.

2.2.8 Work Effort and Current and Pending Support

Proposers must use The Earth Science Division's standard template for detailing the level of work effort for project participants and for the current and pending support of project participants. The template is available at

https://science.nasa.gov/researchers/templates-for-earth-science-division-appendix-a-roses-proposals

2.2.9 *Data Policy and Data Management Plan Requirements*

All data and information acquired and data products produced under the NASA CMS program must be made publicly available, with no period of exclusive use, in compliance with NASA's Earth Science data policy (http://science.nasa.gov/earth-science/earth-science-data/data-information-policy/). Any data proposed to be analyzed from any source, including NASA and other satellite data, ancillary data, and data from commercial sources, must use publicly-available data*,* in the sense that they are openly accessible. Commercial data need not be free, but it must be purchasable by all potential investigators. Proposals that utilize any data that is not, or not yet, publicly available will *not* be considered.

Proposals must include a data management plan of no more than two pages that addresses the dissemination and sharing of research results, how data and information will be provided, and the proposer's compliance with the NASA Earth Science data policy (https://science.nasa.gov/earth-science/earth-science-data/data-information-policy). The data management plan must include the types of data and data products, algorithms, models and model outputs, or other materials to be produced in the course of the project; the standards to be used for data and metadata formats; the types of errors and uncertainties to be quantified and how they will be reported; and plans for providing access to and/or archiving the data and other research products. For any proposed new data products, the data management plan must include provisions for quality assessment, timely public release consistent with NASA policies, and long-term archive of the data product(s).

The data management plan must be included within the 15-page limit for the Scientific/Technical/Management section of the proposal.

3. Programmatic Information

3.1 Funding Allocations

Of the $10M of Fiscal Year 2021 funding identified for CMS efforts, $5.6M is already allocated to ongoing research commitments from prior years. Therefore, $4.4M in FY 2021 funding is available to support new research under this program element.

3.2 Evaluation Criteria

Proposals will be evaluated according to the criteria specified in the *NASA Guidebook for Proposers*, with additional factors noted in this section.

In addition to the factors given in the *Guidebook for Proposers*, the determination of a proposal's intrinsic merit shall also consider the following:

- The quality and appropriateness of the proposed approach to product prototyping,

product evaluation, and/or characterization of uncertainties and quantification of errors, including those associated with instrument calibration, and

- The quality and completeness of the data management plan.

The determination of a proposal's relevance shall be based on the extent to which it applies to the topics listed in Section 2.1. NASA will consider the relative priority of the activities proposed for support of carbon monitoring-related decision-making.

4. Summary of Key Information

Expected program budget for first year of new awards	$~4.4M
Number of new awards pending adequate proposals of merit	~12-16
Maximum duration of awards	3 years
Due date for Notice of Intent (NOI) to propose	See Tables 2 and 3 of this ROSES NRA
Due date for proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	December 2020
Page limit for the central Science/Technical/Management section of proposal	15 pages; see also Table 1 of the ROSES *Summary of Solicitation* and the *NASA Guidebook for Proposers*.
Relevance	This program is relevant to the Earth Science questions and goals in the NASA Science Plan. Proposals relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*
Detailed instructions for the preparation and submission of proposals	See Table 1 of the ROSES *Summary of Solicitation* and the *NASA Guidebook for Proposers*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-CMS

Points of contact concerning this program, all of whom share the following postal address: Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001	Kathy A. Hibbard Telephone: (202) 358-0682 Email: Kathleen.A.Hibbard@nasa.gov Kenneth W. Jucks Telephone: 202-358-0476 Email: Kenneth.W.Jucks@nasa.gov Laura Lorenzoni Telephone: 202-358-0917 Email: laura.lorenzoni@nasa.gov Hank A. Margolis Telephone: (202) 358-4760 Email: Hank.A.Margolis@nasa.gov

A.7 BIODIVERSITY

NOTICE: Amended March 27, 2020. In Subsections 2.1 and 3.5, the requirement to combine observations from the ISS has been diminished from three to at least two of the four instruments mentioned. New text is bold and deleted text is struck through. The due dates are also changed. Notices of intent are now requested by May 27, 2020, and proposals are now due June 25, 2020.

Proposers must use Earth Science division templates for the required Summary table of work effort and current and pending support sections of the proposal, see Subsection 3.5.

1. Scope of Program

Biodiversity is the variety of life on Earth at all levels of organization. It encompasses ecosystems, communities of organisms, single species, and the genes carried by organisms. Biodiversity is the cumulative result of life's responses, by means of evolution, to the changing conditions of our dynamic planet. It encapsulates life's evolutionary history. Biodiversity provides all life, including humanity, with a tremendous resource of opportunities to survive and thrive on our evolving planet. And while elements of biodiversity drive many Earth system processes, life's variety or biodiversity is in itself a characteristic that underpins numerous, if not all, of these processes.

Myriad efforts tracking changes in biodiversity record significant declines throughout its levels of organization and across multiple taxa. Scientific consensus now posits that current biodiversity loss is on a par with the major extinction events documented in Earth's geologic record. Losses in species and reductions in the ranges and abundances of individual taxa are largely the result of human action. Ironically, reductions in the goods, services, and other benefits we derive from biodiversity undermine humanity's life support system.

This situation demands that greater attention be paid to biodiversity. Where on Earth is biodiversity located, in what numbers, and how and why are these changing over time? Remote sensing has an essential role to play in answering these questions. The combination of newly available instruments and advances in the practical and theoretical means of pairing biologically relevant datasets offer the possibility for new insights.

The NASA Biological Diversity Program focuses on understanding the composition of life on Earth and how it changes over time. This includes documenting and identifying factors that determine the distribution, abundance, movement, demographics, physical or genetic characteristics, behavior, and/or physiology of organisms on Earth. The program supports the development of remote sensing tools, techniques, and associated models that enable this understanding. The program also seeks to increase knowledge of how biodiversity drives the wider Earth System.

Research supported by this program combines observations from satellites, airborne platforms, and *in-situ* sensors to explore biodiversity patterns in terrestrial, freshwater, marine, and airborne ecosystems. NASA's macroscopic observations illuminate patterns of biodiversity through direct identification of ecosystems and certain species.

Understanding the processes behind these patterns along with the detection of finer-scale patterns typically requires either the direct integration of remote sensing observations with *in-situ* sensor data gathered across spatial and temporal scales or the application of various types of quantitative or qualitative modeling. This integration of observations across scales continues to be a major theoretical and technological challenge for the program.

2. Description of Solicited Research

This program element seeks two types of proposals. The first type asks proposers to combine measurements from selected instruments aboard the International Space Station and *in-situ* biodiversity observations (see subsection 3.2 for examples) to further understanding of the composition of life on Earth and how it changes over time (subsection 2.1).

The second type seeks proposals that combine satellite remote sensing (see subsection 3.1 for a description) and *in-situ* biodiversity observations (see subsection 3.2 for examples) to further understanding of the operational and/or the theoretical implications of combining observations at different spatial scales to further understanding of the composition of life on Earth and how it changes over time (subsection 2.2).

2.1 Combining Space Station and *In-Situ* Observations for Biodiversity Understanding

The International Space Station (hereinafter ISS) operates a suite of instruments that are extraordinarily powerful and complementary for characterizing life on Earth. As of this writing, the ISS carries a multispectral thermal infrared radiometer (the ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station or ECOSTRESS); a full-waveform vegetation lidar (the Global Ecosystem Dynamics Investigation or GEDI); a trio of high-resolution spectrometers, one of which infers photosynthesis more accurately than any spaceborne measurement to date through solar-induced fluorescence (the Orbiting Carbon Observatory-3 or OCO-3); and a visible to near-infrared imaging spectrometer (the DLR Earth Sensing Imaging Spectrometer or DESIS).

This program element ~~requests~~ **requires that** proposals combine ~~ing~~ observations from ~~three~~ **at least two** of the four ISS instruments mentioned above. This combination of ISS observations must also be used in conjunction with *in-situ* biodiversity observations (see subsection 3.2). **[Amended March 27, 2020]**

More information about the four ISS instruments relevant to this section of the program element may be found at the following websites:

- ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS) https://ecostress.jpl.nasa.gov
- Global Ecosystem Dynamics Investigation (GEDI) https://gedi.umd.edu
- Orbiting Carbon Observatory-3 (OCO-3) https://ocov3.jpl.nasa.gov
- DLR Earth Sensing Imaging Spectrometer (DESIS) https://www.nasa.gov/mission_pages/station/research/experiments/explorer/Investigation.html?#id=1778 (for information about access to DESIS and other commercial data please go to: https://earthdata.nasa.gov/esds/small-satellite-data-buy-program)

2.2 Scale

Life on Earth scales spatially by many orders of magnitude from the molecular scale of DNA and RNA to that of the global biome. NASA is a space agency. It makes observations from space-based platforms ranging in spatial extent from global to landscape and in grain (or pixel) sizes from 100s of kilometers (i.e., GRACE gravity maps) to 10s of meters (i.e., Landsat pixels; note: certain commercial satellite imagery ranges into sub-meter grain sizes). These observations are gathered at time steps that range in temporal scale from monthly to daily to even sub-hourly. In turn, biological phenomena scale across the orders of organization of biodiversity: biome, ecosystems, communities of organisms, single species, and the genes carried by organisms. NASA seeks to relate its satellite remote sensing products to biological phenomena to answer questions such as: how do we best link observations at disparate scales for specific applications? how do these observations relate to each other? To answer these and related questions, this subsection of the program element seeks to achieve two related but distinct goals:

1) To enhance our operational or technological ability to combine observations from satellite remote sensing (see subsection 3.1) with *in-situ* observations of biodiversity on the ground, in the water, and in the air (see subsection 3.2) for the purpose of advancing understanding of the composition of life on Earth and how it changes over time.

   The goal of this first topic is practical: to improve our ability to integrate observations made by different platforms covering different spatial extents at different grain sizes. NASA seeks to develop and enhance observational and model-based techniques that will allow us to use cross-scale information to advance understanding of the composition of life on Earth and how it changes over time. This includes documenting and identifying factors that determine the distribution, abundance, movement, demographics, physical or genetic characteristics, behavior, and/or physiology of organisms on Earth.

2) To advance our theoretical understanding with regard to how life scales spatially through the mechanism of combining satellite remote sensing with *in-situ* observations on the ground, in the water, and in the air. This work should build upon the rich literature over the past century from D'Arcy Wentworth Thompson to Geoffrey West, along with a number of others, regarding scaling rules for life. Efforts proposed may range from molecules to organisms to biomes. Whatever their inspiration, proposals must employ a combination of both satellite remote sensing (see subsection 3.1) and *in-situ* biodiversity observations (see subsection 3.2).

   The goal of this second topic is to increase theoretical knowledge of patterns and processes, which underpin our ability to advance understanding of the composition of life on Earth and how it changes over time, which includes documenting and identifying factors that determine the distribution, abundance, movement, demographics, physical or genetic characteristics, behavior, and/or physiology of organisms on Earth. NASA seeks refinement and further elaboration of the scaling rules of life: why life scales as it appears to scale.

Proposals may address one or both of the scale topics discussed above in this subsection. While these two topics are intimately connected, proposers are alerted that attempts to advance both technological ability and theoretical understanding within the same proposal may prove quite challenging and, as such, might constitute a “bridge too far” given the time and funding available for selected projects. Thus, choosing one or the other topic could result in a more focused and intelligible proposal. Nevertheless, fortune does, on occasion, favor the bold. While grander syntheses are welcome, they must still accord with the funding and time limits of the program element.

3. Important General Information for this Program Element

3.1 Relevant Satellite Remote Sensing

For the purposes of this program element, "satellite remote sensing" includes: measurements (i.e., data and information products) from NASA on-orbit satellites (including the ISS); simulated measurements from planned NASA satellites; measurements from commercial, foreign, and other U.S. Government satellites; outputs and predictive capabilities from models associated with NASA products; NASA algorithms; NASA visualizations; and other NASA geospatial products, including airborne products. The use of non-NASA satellite products is welcome - although, as this is a NASA solicitation, proposals must include specific NASA satellite remote sensing products in the overall mix of data products proposed. Satellite remote sensing data should be explicitly named within the proposal. The proposal will be evaluated as to how essential these data are to achieving the proposal’s goals.

Observations from suborbital airborne sensors may be included in proposals responding to this program element. That said, the use of suborbital airborne sensors should be clearly justified, scientifically complementary to, and, ideally, generate products coincident with the data from the ISS, other satellite, and *in-situ* observations forming the focus of this program element. Proposed suborbital airborne activities, for which NASA funding is sought, must fit within the funding limits of this program element and must also include a complete “includes-all-costs” cost estimate for the suborbital activities, including a full flight cost estimate (aircraft and instrument), data integration and analysis costs, etc. For proposed flights of NASA suborbital airborne platforms, a flight request should be submitted to the NASA Airborne Science Program at https://airbornescience.nasa.gov. NASA flight requests should result in that part of the "includes-all-costs" cost estimate focused on the use of the NASA suborbital airborne platform itself.

NASA has arrangements with certain commercial providers of satellite imagery allowing access to their commercial imagery by NASA-funded investigators. To learn more about this imagery, including DESIS imagery, and to determine the possibility of tasking certain commercial satellites, please visit https://earthdata.nasa.gov/esds/small-satellite-data-buy-program.

3.2 Relevant *in-situ* Biodiversity Observations

Examples of *in-situ* biodiversity observations include - but are not limited to - survey and census results, tracks of animal movement or other behavioral data from Global Positioning System tags or other biologging and biotelemetry devices, camera trap

imagery, information from acoustic sensors, various types of citizen science collections, and outputs from environmental DNA (eDNA). These observations may come from terrestrial, freshwater, marine, or airborne sources. The proposal will also be evaluated as to how essential these observations are to achieving the proposal's goals.

3.3 Scope of Submissions

A proposal must only address a topic described in either subsection 2.1 or subsection 2.2, i.e., a single proposal should not attempt to address topics from both of these subsections. However, an investigator may submit more than one proposal.

Proposals may focus on organisms in terrestrial, freshwater, marine, or airborne ecosystems - or some combination of terrestrial, freshwater, marine, and airborne ecosystems.

Proposals that do not focus on the overarching goal of advancing the use of satellite remote sensing in conjunction with *in-situ* biodiversity observations for understanding the composition of life on Earth and how it changes over time are discouraged. Encouraged topics include documenting and identifying the factors that determine the distribution, abundance, movement, demographics, physical or genetic characteristics, behavior, and/or physiology of organisms on Earth.

Also discouraged are proposals largely focused on topics central to other NASA Earth Science Division programs including biogeochemistry (e.g., the cycling of carbon or nitrogen), land cover and land use change, and the water cycle. Such proposals may be deemed non-responsive to this program element.

All proposals to this program element must be rooted in hypothesis-based research. A very important aspect of proposals to this program element will be identification of the scientific question(s) and issues to be addressed by the research. Proposals should describe:

- the current state of the science,
- the potential for a significant scientific advance, and
- the central and critical role for NASA satellite remote sensing.

Successful proposals may well arise from the assembly of teams of researchers with cross-sensor and cross-disciplinary skills.

Proposals must accord with the funding and time limits of the program element. Proposals with budgets or schedules that exceed guidance below (see section 4 Summary of Key Information) may be deemed non-responsive and may not be submitted for peer review.

3.4 NASA Biological Diversity and Ecological Forecasting Team Meeting

Funded Principal Investigators are expected to attend the annual NASA Biological Diversity and Ecological Forecasting Team Meeting (generally held each spring in the Washington, DC area) during each year of their award. Thus, proposals should budget for all costs needed for transportation, lodging, and per diem to attend these meetings.

3.5 Checklist of Solicitation-Specific Requirements

Proposers should check to determine whether their proposal meets the requirements of this program element, listed below.

- Is the proposed work aimed at understanding the composition of life on Earth and how it changes over time, which includes documenting and identifying the factors that determine the distribution, abundance, movement, demographics, physical or genetic characteristics, behavior, and/or physiology of organisms on Earth?
- The proposed work should not focus on a topic discouraged under this program element that is central to other NASA Earth Science Division programs including biogeochemistry (e.g., the cycling of carbon or nitrogen), land cover and land use change, and the water cycle?
- Does the proposal explicitly include a research hypothesis that will advance the understanding of the composition of life on Earth and how it changes over time?
- Does the proposal describe the current state of the science, the potential for a significant scientific advance, and the central and critical role for NASA satellite remote sensing?
- Does the proposed work include use of both NASA satellite remote sensing (subsection 3.1) and *in-situ* biodiversity observations (subsection 3.2)? Are these observations explicitly named? Are they integral to addressing the proposed hypothesis(-es)?
- Do any proposed suborbital airborne activities, for which NASA funding is sought, fit within the funding limits of this program element and is there a complete "includes-all-costs" cost estimate for the suborbital activities, including a full flight cost estimate (aircraft and instrument), data integration and analysis costs, etc.?
- Does the proposal accord with the funding and time limits of the program element?
- Has the team included budget for attending the NASA Biological Diversity and Ecological Forecasting annual team meeting?
- For proposals to subsection 2.1: does the proposal include ~~three~~ **at least two** of the four ISS instruments? Are the instruments explicitly named? Are they integral to addressing the proposed hypothesis(-es)? **[Amended March 27, 2020]**
- Does the proposal only address a topic described in either subsection 2.1 or subsection 2.2 and not in both?
- Does the proposal include all of the required sections listed in Table 1 of the *ROSES Summary of Solicitation*?
- Does the proposal adhere to formatting requirements (e.g., regarding font size, line spacing, and margins) in the *ROSES Summary of Solicitation*?
- Is the budget consistent with instructions from ROSES? (https://science.nasa.gov/researchers/sara/how-to-guide/nspires-CSlabor/)
- Are the required Summary table of work effort and current and pending support sections of the proposal based on the Earth Science division templates? (https://science.nasa.gov/researchers/templates-for-earth-science-division-appendix-a-roses-proposals)

4. Summary of Key Information

Expected annual total program budget for all new awards funded through this solicitation	$2,200,000 per year
Number of new awards pending adequate proposals of merit	7 to 15
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 of this ROSES NRA.
Due date for Proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	7 months after submission of proposal
Page limit for the central Scientific/Technical section of proposal	15 pp.; see also Table 1 of ROSES and the *NASA Guidebook for Proposers.*
Relevance	This program is relevant to the Earth science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section IV and Table 1 of *the ROSES Summary of Solicitation* and Section 3 of the *NASA Guidebook for Proposers*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of the *ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-BIODIV
Point of contact concerning this program	Woody Turner Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1662 Email: woody.turner@nasa.gov

A.8 GEDI SCIENCE TEAM

NOTICE: A one-page project management plan is mandatory (see Section 4.1). Proposers to this program element will not provide the Data Management Plan (DMP) via the NSPIRES cover pages. Instead, the DMP must be included in the proposal (see Section 4.2). Proposers must use the Earth Science standard template for detailing the level of work effort for project participants and for the current and pending support of project participants (see Section 4.3).

1. Overview

NASA launched the Global Ecosystem Dynamics Investigation (GEDI) instrument to the International Space Station (ISS) in December 2018 and GEDI's science data collection phase began in April 2019. This program element solicits proposals for studies that use GEDI data to address scientific questions in terrestrial ecology, carbon cycle science, biodiversity, and interactions of the biosphere with the atmosphere and hydrosphere. Selected principal investigators will become members of the GEDI Science Team.

NASA selected the GEDI instrument in July 2014 through the Earth Venture Instrument-2 solicitation. The GEDI instrument is mounted on the International Space Station's (ISS) Japanese Experiment Module – Exposed Facility (JEM-EF). It is a full-waveform lidar instrument that makes detailed measurements of the 3-dimensional (3-D) structure of the Earth's forests and land surface (Figure 1). The GEDI instrument is comprised of

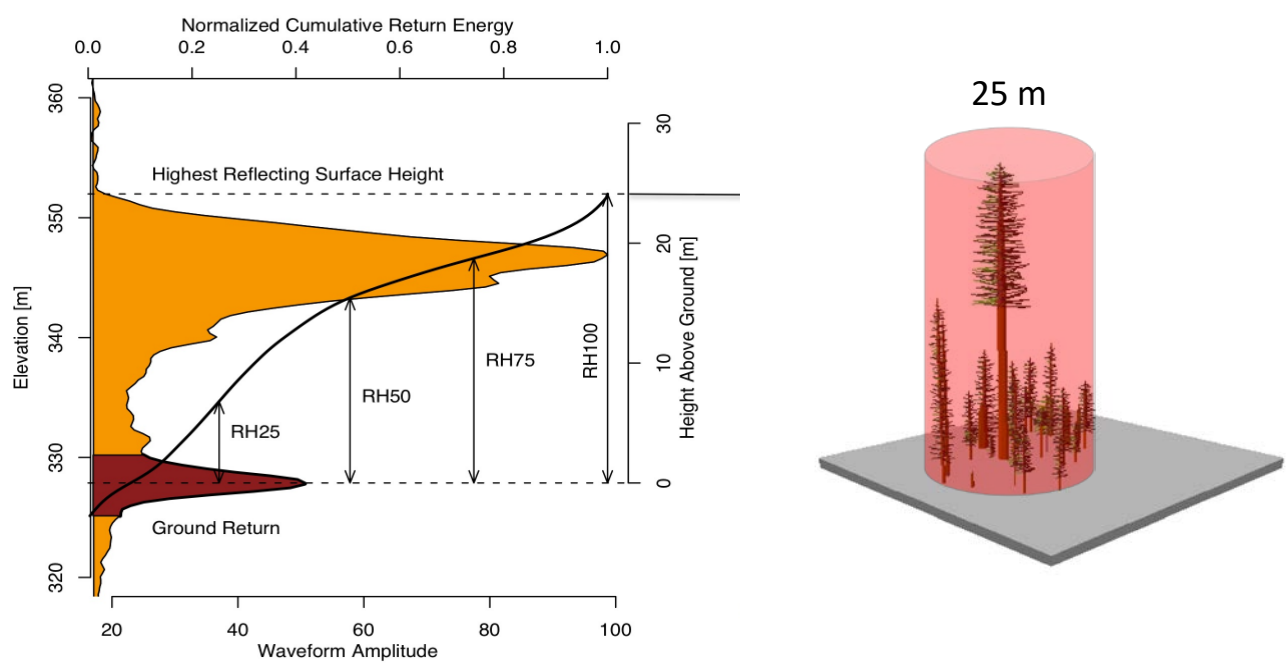

Figure 1. GEDI's sole observable is the lidar waveform which provides ground elevation, canopy height, canopy cover, and various canopy profile metrics, e.g. relative heights such as RH50.

three lasers that produce four beams (Figure 2). Each beam is dithered so that there are eight ground tracks (Figure 2). GEDI collects data for footprints averaging 25 m in

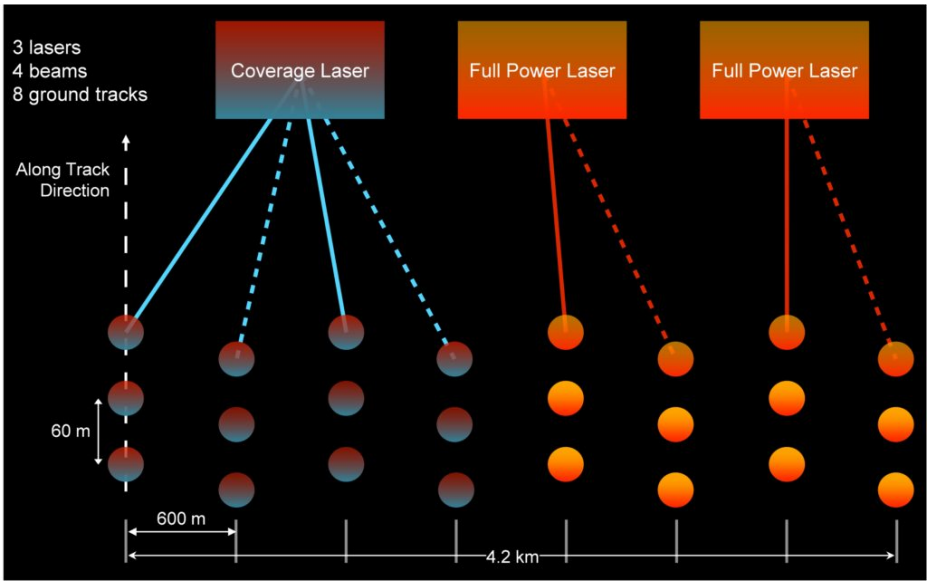

Figure 2. GEDI's ground track geometry.

diameter, separated by 60 m along-track and 600 m across track, with a horizontal accuracy generally within +/- 9 m (Figure 2). The ISS has an orbital inclination of 51.5 degrees, which prevents observations over high-latitude regions. Thus, GEDI measurements will be made over the Earth's surface between 51.6° N and 51.6° S. GEDI can be rotated on the JEM-EF by up to 6°, allowing the lasers to be pointed up to 40 km on either side of the ISS ground track. This capability allows greater sampling of the Earth's land surface. During GEDI's nominal two-year mission life, approximately 10 billion cloud-free observations of the Earth's surface will be acquired. As of December 2019, we estimate that over 1.5 billion science-quality observations have been collected.

The first two months of GEDI L1 data (calibrated geo-located waveforms) and L2 data (footprint level canopy height and canopy profiles), containing 350 million footprints, were released publicly in January 2020. Subsequent L1 and L2 data will be publicly released in monthly intervals with a maximum four-month latency.

2. Scope of Program Element

2.1 Science Priorities

Data collected by the GEDI mission will address three core science questions as defined in the original GEDI proposal submitted to the Earth Venture Instruments-2 (EVI-2) solicitation:

1. What is the aboveground carbon balance of the land surface?
2. What role will the land surface play in mitigating atmospheric CO_2 in the coming decades?

3. How does ecosystem structure affect habitat quality and biodiversity?

The GEDI proposal selected from EVI-2 solicitation had four science objectives designed to respond to these questions:

1. Quantify the distribution of aboveground carbon stored in vegetation.
2. Quantify the effects of vegetation disturbance and recovery on carbon storage.
3. Quantify the potential for existing, new and/or re-growing forests to sequester carbon in the future.
4. Quantify the spatial and temporal distribution of habitat structure and its influence on habitat quality and biodiversity.

NASA encourages proposals that address GEDI's core science questions and science objectives. Proposals should address regional scales or larger. Local-scale studies (e.g., county-level) are not solicited in this program element and will be considered non-responsive.

NASA particularly encourages proposals in the following areas:

- Efforts that address one or more of the three core GEDI science questions;
- Evaluation and improvement of existing GEDI data products;
- Innovative analyses using GEDI data products in combination with data products from other sensors (e.g., those from NASA, other U.S. entities, or international providers). Such studies should advance our understanding of important carbon and water cycling processes, biodiversity, and habitat dynamics. However, all such proposals must have a major focus on the use of GEDI data.
- Enhanced calibration and validation strategies and techniques for GEDI; and
- Use of GEDI data to improve understanding how the structure and function of global terrestrial ecosystems interacts with the atmosphere and hydrosphere.

Note that any proposers (either Principal Investigators or Co-Investigators) responding to this program element who are currently members of the funded GEDI Science Definition Team must explain in their proposal how the new proposed work goes beyond and is distinct from the work for which they are already funded. Additionally, current members of the funded GEDI Science Definition Team must demonstrate and certify that their proposal does not leverage or benefit from early access to GEDI data (i.e., pre-public data release) or non-public data resources.

2.2 GEDI Data Products

The GEDI project will produce GEDI waveforms, canopy height metrics, canopy profile metrics, and empirical estimates of footprint-level and gridded aboveground biomass. GEDI enables a wide range of other possible data products related to changes in carbon stocks, habitat and biodiversity metrics, and other land surface characteristics. Overall, GEDI's science data products will include footprint and gridded data sets that describe different 3D features of the Earth. The GEDI website at https://gedi.umd.edu has additional information on the GEDI instrument, mission specifications, calibration/validation strategies, Algorithm Theoretical Basis Documents and data products that address GEDI's three core science questions.

Proposals should focus on utilization of GEDI Level 1 (raw and geolocated waveforms), Level 2 (footprint level canopy and profile metrics), and Level 3 (gridded canopy and

profile metrics) for basic research of importance to meeting core GEDI questions and objectives. This program element is also open to the expansion or production of new higher-level (Level 4) data products.

2.3 Field Work and Airborne Data Collection

This program element will not support major field or airborne campaigns. However, small field programs to improve calibration and validation of GEDI data products may be considered, but proposers should review and consider the estimated budget in Section 6 (Summary of Key Information), when scoping such plans. Proposed investigations involving fieldwork must describe the field activities in the body of the proposal and include the full costs to NASA within the proposal budget.

Airborne waveform lidar data from the Land, Vegetation, and Ice Sensor (LVIS) have been collected at many vegetated locations across the world (https://lvis.gsfc.nasa.gov/Home/index.html). Additionally, LVIS data that specifically simulates the performance characteristics of GEDI was collected during 2019 in the southern US, Mexico, and Costa Rica (https://lvis.gsfc.nasa.gov/Data/Maps/GEDI2019Map.html) and during 2016 in Gabon, Africa as part of the AfriSAR campaign (https://lvis.gsfc.nasa.gov/Data/Maps/Gabon2016Map.html). LVIS data are available through the National Snow and Ice Data Center (NSIDC) Distributed Active Archive Center (DAAC) at https://nsidc.org/data/lvis.

3. GEDI Competed Science Team

Principal Investigators selected from this solicitation will become members of the GEDI Competed Science Team under the leadership of the GEDI Principal Investigator. They will join members of the original GEDI Science Team that were selected as part of the original GEDI proposal. It is expected that all Science Team members will work together seamlessly to advance GEDI science goals.

The role of members of the GEDI Science Team includes, but is not limited to, the following activities:

- Advance GEDI science goals with an open, respectful, and collaborative attitude;
- Report to NASA Headquarters on the impacts to GEDI science resulting from any problems with or changes to mission operations;
- Advise the GEDI Science Office on data collection strategies that maximize scientific gain;
- Provide guidance to the GEDI Science Office on other aspects of mission planning, as requested.

4. Proposal Requirements

Proposers must include each of the following three sections (4.1 to 4.3) in their proposals. These three sections are all separate from, and do not count against the 15-page limit of, the Scientific/Technical/Management (S/T/M) section of the proposal. The Project Management Plan and Data Management Plan must be place directly after the references following the 15-page S/T/M section of the proposal.

4.1 Project Management Plan (one-page maximum)

Proposals must include a Project Management Plan that presents a management structure and describes how the proposed research activities will be organized, who will do what work, and what procedures will be followed to ensure work is conducted safely and responsibly.

Proposers are strongly advised against including large numbers of co-investigators and/or collaborators on their proposals. All team members should have specific major responsibilities in the investigation and the role of each participant should be clearly defined in the Project Management Plan. Proposers should not include collaborators if their only role is to facilitate access to publicly available data or provide advice about how to use publicly available data.

4.2 Data Management Plan (two-page maximum)

All data and information acquired and data products produced as part of the solicited GEDI science must be made publicly available, with no period of exclusive use, in compliance with NASA's Earth Science data policy (http://science.nasa.gov/earth-science/earth-science-data/data-information-policy/). Any data proposed to be analyzed from any source, including NASA and other satellite data, ancillary data, and data from commercial sources, must be publicly-available data, in the sense that the data are openly accessible. Commercial data need not be free, but it must be purchasable by all potential investigators. The cost of all commercial data, if not openly available, must be included in the proposal even if it is not part of the budget request. Proposals that utilize any data that is not, or not yet, publicly available will not be considered for funding.

Proposals must include a Data Management Plan that addresses the dissemination and sharing of research results, how data and information will be provided, and the proposer's compliance with the NASA Earth Science data policy (https://science.nasa.gov/earth-science/earth-science-data/data-information- policy). The Data Management Plan must include the types of data and data products, algorithms, models and model outputs, or other materials to be produced in the course of the project; the standards to be used for data and metadata formats; the types of errors and uncertainties to be quantified and how they will be reported; and plans for providing access to and/or archiving the data and other research products. For any proposed new data products, the Data Management Plan must include provisions for quality assessment, timely public release consistent with NASA policies, and long-term archive of the data product(s). The quality and completeness of the Data Management Plan will be evaluated as a part of the Intrinsic Scientific Merit of the proposal.

4.3 Work Effort Table and Current & Pending Support (no page limit)

Proposers must use the Earth Science standard templates for detailing the level of work effort for project participants and for the current and pending support of project participants. These templates are available at https://science.nasa.gov/researchers/templates-for-earth-science-division-appendix-a-roses-proposals.

4.4 Approach to Errors, Uncertainties, and Instrument Calibration

The characterization of errors and uncertainties must be described in a separate

subsection of the Scientific/Technical/Management section of the proposal. If new observations are made in the study, then this subsection should also describe their calibration, accuracy, and traceability.

Given the importance of NASA data and information for decision-making, it is essential that the research supported under this GEDI Science Team program element characterize uncertainties and quantify errors associated with data and derived information products, as well as with analytical approaches, model results, and/or scientific interpretations.

Therefore, when new data are acquired as part of the proposed activities, it is important that instrument calibration be documented and traceable so different types of data and data products can be inter-compared with a high degree of confidence. Therefore, all proposals submitted in response to this program element must describe how errors and uncertainties will be addressed within their research project, including, if relevant to their study, errors and uncertainties associated with instrument calibration, analysis of existing data, and model output.

4.5. Science Team Meetings

All proposers should budget for two in-person, three-day Science Team Meetings to be held in varying locations within the United States. For budgeting purposes, proposers should assume that the location of GEDI Science Team Meetings will alternate between the Washington, DC region and Flagstaff, Arizona. We expect that at least some portion of these team meetings will be open, and other members of the proposer's team will be welcome to attend and participate. Proposers should include support in their proposal budget for themselves and critical team members to attend these meetings. The GEDI Principal Investigator will be responsible for initiating and organizing science team meetings and related activities.

5. Evaluation Criteria

All proposals with be evaluated for Intrinsic Merit, Cost, and Relevance, as defined in Appendix D of the *NASA Guidebook for Proposers* and consistent with Section VI(a) of the ROSES *Summary of Solicitation*. In addition, the evaluation of intrinsic scientific merit will include an assessment of the sufficiency of the Data Management Plan.

6. Summary of Key Information

Expected total program budget for first year of all new awards	Up to $2.5M
Expected number of new awards pending adequate proposals of merit	~15 to 20
Maximum duration of awards	3 years
Due Date for Notice of Intent to Propose (NOI)	See Tables 2 and 3 of this ROSES NRA.
Due date for proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	6 to 8 months after proposal due date.

Page length for the Science-Technical-Management section of proposal	15 pages; see also Section 4
Relevance	This program is relevant to the Earth Science questions and goals in the NASA Science Plan. Proposals that are relevant to this Program are, by definition, relevant to NASA.
General requirements for content of proposals	See Section 3 of the *NASA Guidebook for Proposers* and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-GEDI
Point of contact concerning this program	Hank Margolis, Program Manager NASA Terrestrial Ecology Program Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-4760 Email: Hank.A.Margolis@nasa.gov

A.9 PHYSICAL OCEANOGRAPHY

NOTICE: Proposers must provide a Data Management Plan and Software Development Plan. See Section 2.

1. Scope of Program

NASA's Physical Oceanography program supports basic research and analysis activities that enable development of NASA's current and future physical oceanography satellite missions and the scientific interpretation of data from them. The primary centers of support for the Physical Oceanography program are the NASA Jet Propulsion Laboratory Earth Science Directorate and the external (non-NASA) scientific community. This announcement serves as the vehicle for participation in the Physical Oceanography program for all institutions.

The primary scientific thrust for physical oceanography at NASA is toward understanding the ocean's role in climate variability and its prediction. Since the ocean general circulation plays a critical role in the global heat balance and materially changes atmospheric properties through air-sea exchange, understanding and modeling the state of the coupled ocean-atmosphere system are fundamental to climate studies. NASA utilizes the unique vantage point of space to enable rapid collection of global ocean data sets and contributes significantly to the World Climate Research Program's Climate Variability and Predictability (CLIVAR) Program (https://usclivar.org/).

The Physical Oceanography Program encompasses science teams supporting satellite altimetry (Ocean Surface Topography Science Team), ocean surface salinity via radiometry (Ocean Surface Salinity Team), sea surface temperature (Sea Surface Temperature Science Team), and ocean vector winds (Ocean Vector Winds Science Team). NASA recommends that proposals focused on a single variable that is already supported by a dedicated science team be submitted to those science team elements in ROSES. In this program element, NASA is looking for work that cuts across multiple variables and focuses on the ocean's role in climate and interaction with various components of the Earth system.

While NASA's focus remains global in nature, it is recognized that many of the practical problems with respect to human interaction with the ocean lie within the coastal seas. NASA welcomes compelling proposals that address physical characteristics of coastal oceans in a global context by demonstrating a broad impact of the proposed coastal studies on regional and global scales.

Three research themes are identified in the Physical Oceanography program and represent priority areas for proposals solicited through this announcement:

1. Analysis and interpretation of the ocean circulation using satellite and *in situ* data, data-derived products and NASA ocean state estimates (e.g. ECCO - Estimating the Circulation and Climate of the Oceans). Use of the extensive datasets collected and archived by NASA is required. When appropriate, use of data collected by NASA airborne remote sensing and ship-based field campaigns is recommended (e.g., EVS-2 Oceans Melting Greenland, SPURS-1, -2, etc.). All datasets are publicly available at the Physical Oceanography Distributed Active Archive Center

(PO.DAAC https://podaac.jpl.nasa.gov). Tailoring such proposals to support the objectives and priorities the U.S. CLIVAR Program is encouraged.

2. Development of novel remote sensing techniques for physical oceanography. NASA has successfully developed remote sensing techniques for ocean surface winds, sea level, sea surface temperature, and sea surface salinity. Each of these variables has a science team and dedicated research activity. NASA will support modest proposals that explore new concepts for remote sensing of interest to physical oceanography. This opportunity is not for technology or instrument development, but for concept articulation and exploration.
3. The intensity and location of mixing in the ocean remains an area of active research. The third priority area for this year's announcement is seeking proposals that expand our spatial and temporal estimates of ocean mixing through the use of remote sensing and likely the joint analysis of satellite data sets with *in situ* ocean mixing (microstructure) data.

The program's focus is on the use of remote sensing data to study the Earth's oceans, preferably using a synergistic approach among satellite and *in situ* observations, ocean state estimates, reanalysis, modeling, and field campaign data. Proposals to produce data products are out of scope of this solicitation.

2. Data and Software Policy

Data, model results, and other information created under this announcement are subject to NASA's Earth Science Data policy. Proposals must provide a Data Management Plan and Software Development Plan, identifying an open source software license and stating an open source software release milestones. Appropriate deliverables will be archived by ESDS at NASA Physical Oceanography Distributed Active Archive Center (PO.DAAC) in formats that meet applicable U.S. Government-mandated standards adhering to requirements by NASA Earth Science Data Products. Additional information about data management best practices is available at PO.DAAC website that lists file formats and metadata models, with recommended metadata attributes. Proposals that would not develop software should simply indicate that in the proposal. See Section 1.1 of A.1 the Earth Science Research Overview for more information on how to provide these plans.

3. Programmatic Information

Total funds available for work selected under this solicitation are approximately $1.5M per year for three years.

Proposers are encouraged to include travel funding for one domestic trip per year to support participation in a relevant NASA Physical Oceanography Program workshop or scientific meeting (e.g., AGU or Ocean Sciences Meetings, a U.S. CLIVAR workshop, a workshop on technology developments, or a workshop of investigators working on ocean mixing).

Programmatic priority will be given to those proposals making the strongest links to analysis of satellite data and addressing oceanographic problems at basin or global scales. Modeling of the Earth system, including data assimilation, model development, operational, and physical oceanography aspects, is ably covered by NASA's Modeling,

Analysis and Prediction Program and thus proposers should articulate special circumstances or situations where modeling-dominated proposals should be considered for Physical Oceanography Program funding. Based on the quality of proposals received, awards will be distributed across the three research themes identified in Section 1; although given the overall limited number of proposals to be funded, no commitment is being made to funding proposals in all three areas.

4. Summary of Key Information

Expected program budget for first year of new awards	~ $1.5M
Number of new awards pending adequate proposals of merit	~ 6-10
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 of this ROSES NRA
Due date for proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	January 2021
Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of ROSES and the *NASA Guidebook for Proposers*.
Relevance	This program is relevant to the Earth Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section IV and Table 1 of *the ROSES Summary of Solicitation* and Section 3 of the *NASA Guidebook for Proposers*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-PO

Point of contact concerning this program	Nadya Vinogradova Shiffer Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0976 Email: nadya@nasa.gov

A.10 OCEAN SALINITY SCIENCE TEAM

NOTICE: NASA does not intend to offer this program element in ROSES this year. The next expected solicitation of this element would be in ROSES-2021.

NASA Ocean Salinity Science Team (OSST) supports basic research and analysis activities associated with production, improvement, and understanding of sea surface salinity data. The overall goals of the OSST are to provide the scientific underpinning for production of the best possible satellite-derived ocean salinity data sets and to demonstrate the Earth science and applications arising from analyses of the ocean surface salinity data.

Point of contact concerning this program	Nadya Vinogradova Shiffer Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0976 Email: nadya@nasa.gov

A.11 SEA LEVEL CHANGE SCIENCE TEAM

NOTICE: NASA does not intend to offer this program element in ROSES this year. The next expected solicitation of this element would be in ROSES-2023.

This program element is intended to integrate research results, data sets, and model outputs to improve the accuracy of sea level estimates and its components, to integrate results into better forecasts of sea level rise, and to communicate the results of NASA's sea level research in a simplified manner to the science community and the public. It serves to continue the work of the NASA Sea Level Change Team initiated in 2014 and continued in 2017 and 2020. It also serves as a mechanism for the U.S. to make a substantial contribution to the World Climate Research Program (WCRP) Grand Challenge on Regional Sea Level Change and Coastal Impacts and various assessment frameworks, including the U.S. Global Change Research Program (USGCRP) National Climate Assessment (NCA) studies.

Point of contact concerning this program	Nadya Vinogradova Shiffer Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0976 Email: nadya@nasa.gov

A.12 SURFACE WATER AND OCEAN TOPOGRAPHY (SWOT) SCIENCE TEAM

NOTICE: NASA does not intend to offer this program element in ROSES this year. The next expected solicitation of this element would be in ROSES-2023.

Surface Water and Ocean Topography (SWOT) is a satellite mission being jointly developed by NASA and CNES (Centre National d'Études Spatiales), the French space agency, with contributions from the Canadian Space Agency (CSA) and the United Kingdom Space Agency (UKSA). At the time of writing, SWOT is currently scheduled for launch in 2021. The SWOT mission will be NASA's first global survey of Earth's surface water to observe ocean surface topography, major lakes, rivers, and wetlands with unprecedented resolution. Mission updates and current status can be found at https://swot.jpl.nasa.gov/.

Point of contact concerning this program	Nadya Vinogradova Shiffer Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0976 Email: nadya@nasa.gov

A.13 OCEAN SALINITY FIELD CAMPAIGN

Amended June 5, 2020. This amendment releases the final text for this program element. Optional notices of intent to propose are requested by August 27, 2020 and the due date for proposals is September 24, 2020.

1. Introduction

Climate change continues to reshape Earth's polar oceans, thinning sea ice cover at record rates, diminishing the cryosphere, changing the physical environment toward warmer and fresher seas, and stressing vulnerable polar ecosystems and biodiversity. Being an Arctic nation, understanding and predicting future Arctic climates, including that in Alaska, has direct implications for the United States economy, resource development, trade, transportation, and national security. On a global scale, polar oceans act as engines of the thermohaline conveyor belt movement of heat, oxygen, carbon, and nutrients around the globe, maintaining the planet's current climate and weather.

Over recent decades, NASA has invested in observing Earth's polar oceans, advancing our understanding of polar regions through space-based and aircraft-based approaches. These investments include the original ICESat satellite mission, the decade-long, now-completed Operation IceBridge aircraft mission, the recently-launched (2018) ICESat-2 satellite mission, and various interagency and international polar science initiatives supported by NASA's Cryospheric Science Program and Physical Oceanography Program. These programs have highlighted the importance of ocean-ice coupling, which affects the interaction between the polar environments and changing climate.

Ocean-ice interaction has traditionally focused on the effect of temperature variations, demonstrating a strong connection between ocean warming and cooling tendencies and ice dynamics (e.g., https://omg.jpl.nasa.gov/). In addition to temperature, salinity is another key player in high-latitude ocean dynamics, with theoretical evidence of its importance dating back to the 19th century. From basic thermodynamics, salinity changes dominate the equation of (seawater) state at cold temperatures. This rather rare dominance of salinity on ocean density means it is variations in salinity that set the upper ocean stratification, enabling subsurface heat to be stored and released, and thus allowing for sea ice to form and melt. What can be learned from salinity data about ice dynamics, its evolution, advance and retreat? How can we utilize salinity information to improve our understanding of sea-ice/ocean interactions, as well as processes along the margins of the ice sheets? Is the relationship between salinity change and ice dynamics observationally robust? Can it be modeled and predicted? Will the predicted salinity changes help us develop projections of future ice changes? Can we use salinity information as an ocean proxy for disappearing cryosphere?

To answer these questions, this program element solicits proposals to conduct a dedicated Ocean Salinity Field Campaign in the 2022-2023 timeframe, integrated with satellite observations and modeling studies in support of the salinity remote sensing missions and polar oceanography. The program will continue the legacy of NASA's salinity process studies SPURS-1 and SPURS-2, but shifts focus from the tropics

toward the polar regions. Specific research topics and investigation requirements are described in the following sections.

2. Program Scope

This program is intended to clarify the role of salinity in ocean-ice interactions by characterizing salinity signatures and possible salinity-ice feedback mechanisms in rapidly-changing polar environments. Outcomes of this field campaign are also expected to inform the development of new concepts of future remote sensing capabilities that improve salinity retrievals in cold waters. Sections 2.1-2.3 detail the specific science objectives that are identified for proposers.

2.1 Linking Salinity Signatures to Ice Dynamics

An important step to refining the relationship between ocean salinity and ice dynamics is improving our knowledge of salinity stratification in the polar regions. Previous studies demonstrate that strong salinity gradients at the ocean surface have a first-order impact on transfer of momentum, heat, and buoyancy across the air-ice-sea interface, implying that a good knowledge of near-surface salinity stratification can be a key to predicting when and where sea ice formation or ice melt might occur. Furthermore, the process of ice melt/formation itself impacts the near-surface salinity stratification by freshening/salinification of the surrounding waters, thus further affecting the exchange of heat between the air and sea or surface and deep oceans, fueling or slowing down ice melt. Untangling potential feedback mechanisms of salinity-ice coupling through dedicated process studies is a crucial step in unlocking the potential of salinity as an indicator of changing polar environments.

In particular, an observational campaign that helps characterize vertical salinity structure near the surface and the lateral and vertical processes that control salinity stratification and the depth of the mixed layer is desired. The potential output will be a detailed characterization of the structure and evolution of upper ocean salinity and temperature – under the sea, in open water, and at the ice edge – characterizing the role of near-surface stratification in air-sea and surface-deep ocean exchange of heat and momentum and linkages with ice dynamics. Capturing horizonal scales ranging from sub-km to 100-km near the ice edge and extending beneath the ice pack would be particularly valuable to understanding the extent to which satellite observations can represent conditions beneath the ice. Observations in multiple geographical locations can further improve our knowledge of salinity-ice coupling, which can be influenced by different ocean regimes responding to various wind and ocean circulation patterns.

2.2 Learning About Freshwater Balances from Salinity Information

With the expansion of remote sensing capabilities and subsequent launches of ESA’s Soil Moisture and Ocean Salinity (SMOS) mission in 2009, the NASA/CONAE Aquarius/SAC-D mission 2011-2015, and NASA's Soil Moisture Active Passive (SMAP) mission in 2015, we now have a continuous, near-global view of surface salinity patterns and their changes over the past decade. These salinity patterns reflect the changes in both ocean circulation and the ocean water cycle – the net sum of precipitation, evaporation, and terrestrial river and groundwater runoff, as well as the formation and melting of glacial and sea ice. Because of this sensitivity, salinity changes

are often explored as a marker of the changing hydrological cycle. Over the years, the original simplified concept of using salinity as a rain gauge has evolved into more sophisticated approaches that utilize salinity information to constrain the ocean water cycle, infer rainfall over the oceans, and even predict terrestrial floods and droughts. Another science application deserving a closer look is the use of salinity measurements to connect various water reservoirs – terrestrial, cryosphere, marine – in an attempt to better close the global freshwater budget.

A high-latitude salinity campaign can offer the opportunity to explore low-salinity signatures in various regimes and determine if salinity data could be a useful proxy of meltwater/riverine water discharge and their impact on ocean circulation. Depending on the campaign location, proposing teams could explore, for example, salinity signatures as a tracer of glacier meltwater, its transport by the coastal currents, and its impact on the ocean circulation in the far field. In other locations, proposers could explore salinity anomalies induced by the seasonal sea ice melt and formation and characterize the fate and the impact of the propagating salinity anomalies on the region's overall freshwater balance. Targeted observational and modeling studies are expected to help the teams develop practical approaches for using salinity as a marker of the changing freshwater budget in polar environments.

2.3 Enhancing Salinity Remote Sensing

Over the past decade, salinity remote sensing and measurements from SMOS, Aquarius, and SMAP missions enabled a myriad of new science applications (e.g., highlights at https://salinity.oceansciences.org/) in part due to continued improvements to the retrieval algorithms by the members of NASA Ocean Salinity Science Team (OSST) and international salinity community. Despite continued progress in salinity remote sensing, challenges remain, including the need to reduce large uncertainties of satellite salinity data in high latitudes, where sensitivity of L-band radiometers is degraded. The reduced sensitivity of the surface brightness temperatures in cold temperatures is a common problem for both past Aquarius and current SMOS and SMAP satellite missions, which are all based on L-band radiometric frequencies. New salinity observations from the dedicated salinity field campaign collocated with satellite salinity data will help elucidate the nature of salinity variations in various polar regimes, aiding the calibration and validation efforts of salinity retrievals from the existing satellite missions SMAP and SMOS.

This campaign is also intended to inform the development of future satellite salinity missions. Following recommendations of the OceanObs'19 decadal conference, the 2018 CEOS Working Group on Climate report, which advocates for the continuation and enhancement of salinity observations (see report page 88); and the 2017 Decadal Survey for the NASA Earth Science by the National Academies of Sciences, which identified surface salinity as one of the Targeted Observables (see Decadal Survey Table 3.5), NASA is investing in technology development that addresses the current capability gap in salinity remote sensing in a cost-effective way (see selections from 2018 A.9 Physical Oceanography). While this program element is not intended to support the development of new instruments, it is expected that the results of the observational and modeling campaign will inform ongoing OSST technology enhancement efforts, including wideband, multi-frequency instrument concepts that can

potentially enable simultaneous measurements of various parameters (e.g., salinity, temperature, winds, and sea ice properties).

3. Program Structure

To address the research questions detailed in Sections 2.1-2.3, proposers are expected to conduct an observational campaign carried out during 2022 (or 2023, if more time for planning is needed), complemented by use of existing satellite salinity data from SMAP and SMOS; design Observing System Simulation Experiments (OSSEs) to provide context and potential guidance; conduct modeling process studies to help explain observed phenomena and refine the linkages between salinity changes and ice dynamics; and archive the data and results as an active data management component. A complete investigation will thus contain activities related to campaign planning, data acquisition, data archiving, and scientific analysis within the lifetime of the investigation.

A high-latitude salinity campaign will build on achievements of several other large polar explorations, such as SODA, CODA, MOSAiC, AMOS, and others. The expected novelty of the observational campaign solicited through this announcement is a focus on characterizing the upper few meters of hydrographic change across the open water and into the ice pack at high northern latitudes, determining the relationship of this structure with surface forcing and the surface-deep ocean exchange, and translating this knowledge into practical approaches for using salinity information to constrain and/or predict cryospheric changes.

A brief description of program components and investigation requirements is provided in Sections 3.1-3.3.

3.1 Observational Component

The program shall take advantage of recent satellite and sub-orbital technologies, including satellite measurements of surface salinity from SMAP and SMOS that provide large-scale salinity signatures, and satellite observations of other geophysical variables (e.g., sea surface temperature, winds, sea ice concentration and thickness, sea surface height, etc.) necessary to achieve the program science objectives. In addition to the satellite capabilities, a number of *in situ* elements can be identified, including ship-based measurements, drifters equipped with salinity sensors, ice-tethered profiles, airborne observations to map surface currents or profiling floats deployed by aircraft, or underwater gliders that can navigate under ice using acoustic arrays, etc.

While NASA intends to provide full funding support for the program, investigators are encouraged to leverage existing polar initiatives and campaigns sponsored by other federal agencies and international partners. If any such partnerships are considered by proposers, NASA asks the proposer to identify such arrangements in the proposal text and provide letters of commitments from the identified partners.

In addition, each proposal must provide a detailed description of the observational component, including general campaign requirements; number, location, timing, and scope of field deployments throughout the lifetime of the investigation; milestones for the execution and accomplishments; and potential risks to successful achievement of the objectives and mitigation strategies, including descope options. Proposals must also articulate the use of satellite data (satellite salinity and other ocean state variables) in a

fundamental and integrated way.

3.2 Modeling Component

Field measurements must be complemented by modeling or data assimilation studies to best interpret the data collected and test potential mechanisms of salinity-ice coupling. It is expected that before the field work, the investigation will use modeling frameworks to perform OSSE studies to aid the observing system design. With the program's main objective is to test the utility of satellite observations for cryospheric science, investigators are encouraged to utilize dynamically consistent ocean-ice coupled systems.

3.3 Data Management Component

NASA promotes the full and open sharing of all data with the research and applications communities, private industry, academia, and the general public. Data, results, and other information created for this proposal are subject to NASA's Earth Science Data policy. Under this policy, there is no period of exclusive access to NASA Earth science data. All data shall be made publicly available at a NASA-approved data repository (PO.DAAC for this ROSES element) no later than six months after the end of the campaign or investigation (or earlier if any required post-mission validation and calibration activities are completed), along with the source code for algorithm software, coefficients, and ancillary data used to generate products.

After the data archive opens, investigators are encouraged to host a Community Data Workshop showcasing the data archive, answering questions about data collection, addressing potential issues and limitations, and encouraging the wider community to use it in their research.

Consistent with Section 1.1 of A.1 the Earth Science Research Overview all proposals must include a Data Management Plan (DMP) as a special section of the proposal, not to exceed two pages in length entitled "Data Management Plan" immediately following the references and citations for the Scientific/Technical/ Management (S/T/M) portion of the proposal. The two-page DMP section does not count against the 15-page limit of the S/T/M section. The DMP provides information about how data will be managed and shared throughout the project lifecycle in compliance with NASA's Earth Science data policy and following NASA standards and references (i.e., file formats, metadata standards, conventions) and shall be updated as needed. The DMP shall be provided to the NASA-approved data repository (PO.DAAC for this ROSES element), and the Principal Investigator shall collaborate with the data repository from the start of the award to ensure the data meet all standards for data format, metadata, and data quality.

All software developed with SMD funding for the production of data products, along with source code and associated documentation sufficient to enable use of the code, shall be made publicly available as Open Source Software (OSS) at https://github.com/nasa under an appropriately permissive license (e.g., Apache-2, BSD-3-Clause, GPL). Proposers should describe their plans for facilitating this availability as part of the DMP. Software is subject to the NASA Earth Science Alternate Data Rights language to be included into award documents for selected projects.

4. Team Structure

It is the responsibility of the Principal Investigator (PI) to assemble an appropriate team of experts to carry out all program components and accomplish the objectives in Section 2.1-2.3 of this solicitation. All science team Co-Investigators (Co-I) must be identified in the proposal by name and responsibility, clearly articulating their unique role and expertise in the investigation. When appropriate, the PI is encouraged to consider expertise and diversity in all its forms, including institutional. NASA also reserves the right to place additional members on the selected team if it identifies the lack of a particular expertise.

It is expected that the selected PI will have the experience and passion to lead an observational campaign and upon selection will act either as the campaign Chief Scientist or designate a Chief Scientist in the proposal who will lead the scientific efforts of the campaign. Proposers are encouraged to identify Deputy PIs who will support the PI by leading the modeling and data management components of the mission. In most cases, the PI should also identify a Project Manager, who will be responsible for the day-to-day planning and implementation of the campaign, although a PI may choose to identify herself/himself in this role.

In addition, the selected PI (or designated team member) is expected to work closely with the OSST science communication team and NASA Earth Science media team to inform the broader community about mission progress and accomplishments. Proposals must include a strategy to document their plans, accomplishments, and data archiving, ensuring timely announcements of the main milestones to the public.

Investigators selected under this announcement will be incorporated into OSST as full members and thus are encouraged to plan for participation in OSST-wide meetings and activities.

5. Programmatic Information and Evaluation

5.1 Evaluation

The three primary evaluation criteria (Merit, Relevance, and Cost) are detailed and defined in Appendix D of the *NASA Guidebook for Proposers*. Information about how they are evaluated is presented in the *ROSES Summary of Solicitation, Section VI.(a)*.

For this program element, these standard evaluation criteria are modified to include these additional factors:

Merit – The program's science objectives are identified in Sections 2.1-2.3; other proposed scientific objectives will have a lower programmatic priority. Assessment of merit will specifically include the feasibility and quality of the proposed methods and approaches (field work, modeling, incorporation of satellite data, scientific analysis) to best answer the program's main goal – assessing the potential of ocean salinity to constrain cryospheric changes. Priority will be given to investigations offering a way to build a comprehensive, fully-integrated observing and modeling program to address the specific objectives of this program element.

Relevance – This program element seeks only proposals supporting the salinity process studies in the polar environments, including field campaigns in 2022 (or 2023).

Proposals related to general analysis and exploitation of salinity data for ocean science will be considered non-responsive and instead may be submitted in response to OSST (when it is solicited in a future year).

Cost – While preparing a reviewer copy with redacted budget proposals, ensure that, in addition to the time/effort table for each member of the proposal team, all funding requirements for supporting, preparing, and using instrumentation, data acquisition, field operation, ship time, data archiving, transportation/travel and per diem costs, and other expenses related to the investigation, are included.

5.2 Award Type, Value, and Duration

Based on receipt of one or more compliant proposals of adequate merit, NASA intends to select one investigation and anticipates any award to a non-governmental organization will be as a grant. The total funds awarded will be ~$5.5M over 3 years to support mission planning, deployment in FY22-23, and data archiving and scientific analysis.

6. Summary of Key Information

Expected total program budget	~$5.5M over 3 years
Number of new awards pending adequate proposals of merit	1
Maximum duration of awards	3 years
Due date for Notice of Intent to propose	See Tables 2 and 3 of ROSES-2020
Due date for proposals	See Tables 2 and 3 of ROSES-2020
Planning date for start of investigation	March 2021
Page limit for the central technical section of the proposal	15 pp; see also Table 1 of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*
Relevance	Proposals that are relevant to this program are, by definition, relevant to NASA
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*
General requirements for content of proposals	See A.1 Earth Science Research Overview and Section IV and Table 1 of *the ROSES Summary of Solicitation*
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ and Section IV(b) of *the ROSES Summary of Solicitation*
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)

Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-OSFC
Point of contact concerning this program	Nadya Vinogradova Shiffer Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0976 Email: nadya@nasa.gov

A.14 OCEAN SURFACE TOPOGRAPHY SCIENCE TEAM (OSTST)

NOTICE: Proposers must provide a Data Management Plan and Software Development Plan. See Section 2. This program element mandates the use of templates for the Summary Table of Work Effort and list of Current and Pending Support. See Section 4.

1. Background

The Ocean Surface Topography Science Team (OSTST) brings together international scientists to understand Earth's oceans and their interaction within the climate system using ocean altimetry satellite observations. Over the past 28 years, measurements of ocean surface topography have been provided by the U.S.-European series of satellite missions, which began with the TOPEX/Poseidon satellite mission in 1992-2005 and continued through the Jason-1 in 2001-2013, OSTM/Jason-2 in 2008-2019, and currently by Jason-3 missions, with the latter launched in 2016. Preparations are also underway to support the Jason Continuity of Service (Jason-CS) mission on the two Sentinel-6 spacecraft (-6A & -6B) as a continued international partnership between the U.S. and Europe. Jason-CS will extend the time series to at least 2030.

Measurements of ocean surface topography from TOPEX/Poseidon and the Jason satellite series have been instrumental in a wide range of oceanographic and climate studies, including observing and quantifying the rise and acceleration of the global mean sea level; improving our understanding of the ocean's large-scale circulation and variability, understanding and prediction of interannual to decadal variability, characterization of the mesoscale eddy field, improving knowledge of the marine geoid and sea floor bathymetry, barotropic and internal tides, as well as supporting operational forecasts of regional currents, and hurricane intensity and marine wind and wave conditions. Many of those discoveries are made possible by the efforts of the previous OSTST members over the past 20+ years. With this announcement, NASA and the National Oceanic and Atmospheric Administration (NOAA) are soliciting proposals to continue the work of the Team to address remaining open questions as outlined below.

2. Scope of Program

The overarching goals of the OSTST are to produce the best possible satellite-derived altimetry data and to utilize the measurements of ocean surface topography for Earth science and applications. To achieve these goals, the following four research themes are identified and represent priority areas for proposals solicited through this announcement.

1. Support studies in physical oceanography that improve our understanding of large-scale processes, such as global ocean circulation and variability, redistribution of heat and mass in the upper ocean, ocean tides, gravity waves, wind/wave generation, global mean and regional sea level variations, among other topics. (NASA)
2. Support regional and coastal studies that focus on mesoscale processes using high-resolution merged altimetric data sets including the Jason-series as well as other altimetry missions such as NASA's ICESat-2, ESA's Sentinel-3 and

CryoSat-2, AltiKA, and future US/European Sentinel-6/Jason-CS missions. Potential topics include eddy dynamics, coastal dynamics, western boundary currents, Arctic ocean variability, and the ocean's role in impacting dynamics of the ice sheets in Greenland and Antarctica. Despite its regional focus, proposals in this category must demonstrate how addressing the processes of coastal oceans fits into a broader, global context. (NASA, NOAA)

3. Develop and evaluate new geophysical algorithms and/or models to improve the quality of the data, including contribution of scientific analysis and expertise to the preparation of future altimetry missions. Particular focus is on the assessment of the quality of Sentinel-6/Jason-CS altimeter data as compared with previous Jason missions, and exploitation of its along-track SAR and experimental high-frequency radiometer capabilities. Proposers in this category are expected to be engaged with international partners from ESA, CNES, and EUMETSAT to ensure consistency of Sentinel-6/Jason-CS validation metrics across the OSTST. (NASA, NOAA)
4. Research and develop operational applications of satellite altimetry for near real-time to interannual weather warnings and forecasts. These include but are not limited to hurricane intensity forecasting, wind/wave monitoring, coastal inundation/storm surge, operational data assimilation, extreme sea level and coastal inundation, lake and inland water studies, sea ice monitoring, search and rescue, tracking harmful algal blooms, oil exploration and operations, oil spill mitigation, coastal currents, fisheries, as well as seasonal-to-interannual prediction. Proposers in this theme should identify the applications' Readiness Levels as defined in the NOAA Policy on Research and Development Transitions (NOAA only).

For scientific analysis, the use of the full 25+ year altimetric time series is encouraged (e.g., doi:10.5067/SLREF-CDRV2), preferably jointly with other satellite and *in situ* data, or data-derived products, ocean state estimates (e.g., ECCO - Estimating the Circulation and Climate of the Oceans), and models. When appropriate, the use of NASA data collected during airborne and field campaigns is also encouraged (e.g., Earth Venture Sub-Orbital missions such as Oceans Melting Greenland). All altimetry and other datasets are publicly available via the Physical Oceanography Distributed Active Archive Center (PO.DAAC https://podaac.jpl.nasa.gov).

While included in the previous ROSES announcements, the following topics are outside of the current solicitation and have been incorporated in the project infrastructure. Proposals addressing the topics below will be considered unresponsive to this announcement:

- Calibration of the baseline measurements of the Jason series of missions;
- Precise orbit determination for the Jason series of missions;
- Production of climate records based on Level 2 altimetry data.

3. Data and Software Policy for NASA Investigators

Data, model results, and other information created under this announcement are subject to NASA's Earth Science Data policy. Proposals must provide a Data Management Plan and Software Development Plan, identifying an open source software license and

stating an open source software release milestones. Appropriate deliverables will be archived by ESDS at NASA PO.DAAC in formats that meet applicable U.S. Government-mandated standards adhering to requirements by NASA Earth Science Data Products. Additional information about data management best practices is available at PO.DAAC website that lists file formats and metadata models, with recommended metadata attributes. Proposals that would not develop software should simply indicate that in the proposal. See Section 1.1 of A.1 the Earth Science Research Overview for more information on how to provide these plans.

4. Budgetary and Programmatic Guidance

Total funds available for work selected under this program element are approximately $3.5M per year for four years. Based on the quality of proposals received, awards will be distributed across the four research themes identified in Section 2. Proposals outside these research themes may be considered but must be highly meritorious.

Proposers must budget for mandatory project representation at annual Science Team meetings (odd years in North America and even years in Europe). Proposers are also encouraged to include travel funding for one domestic or foreign trip per year to support participation in a relevant OSTST mission activity, workshop or scientific meeting. Proposers that are selected for funding by NOAA may be required to submit additional documentation in order to implement the awards through a NOAA Cooperative Institute. Details will be discussed at the time of selection.

ROSES requires that all proposals include a Summary Table of Work Effort and a list of Current And Pending Support. This program element mandates the use of the templates from the SARA web page.

5. Summary of Key Information

Expected program budget	NASA: ~$3M/year; NOAA: ~0.5M/year
Number of new awards pending adequate proposals of merit	NASA: ~10-15; NOAA: ~3
Maximum duration of awards	4 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 of this ROSES NRA.
Due date for proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	April 2021 (NOAA in July 2021)
Page limit for the central technical section of the proposal	15 pp; see also Table 1 of ROSES and the *NASA Guidebook for Proposers*
Relevance to NASA	Proposals that are relevant to this program are, by definition, relevant to NASA
General requirements for content of proposals	See Section IV and Table 1 of *the ROSES Summary of Solicitation* and Section 3 of the *NASA Guidebook for Proposers*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for*

	Proposers and Section IV(b) of *the ROSES Summary of Solicitation*.
Documenting Work Effort and Current and Pending Support	Work Effort and Funding Support for PIs and Co-Is must be documented using the templates available on the SARA webpage
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-OSTST
Points of contact concerning this program	Nadya Vinogradova Shiffer Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Phone: (202) 358-0976 Email: nadya@nasa.gov Eric Leuliette NESDIS/STAR Laboratory for Satellite Altimetry NOAA Center for Weather & Climate Prediction E/RA3 5830 University Research Court College Park, MD 20740 Phone: (301) 683-3380 Email: Eric.Leuliette@noaa.gov

A.15 OCEAN VECTOR WINDS SCIENCE TEAM

NOTICE: NASA does not intend to offer this program element in ROSES this year. The next expected solicitation of this element would be in ROSES-2022.

The Ocean Vector Winds Science Team (OVWST) supports the analysis and interpretation of ocean vector winds and other applications derived from Earth-observing missions carrying scatterometers and polarimetric radiometers. Extensive background on NASA's ocean vector winds science team and missions are available at http://winds.jpl.nasa.gov/.

Point of contact concerning this program	Nadya Vinogradova Shiffer Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0976 Email: nadya@nasa.gov

A.16 MODELING, ANALYSIS, AND PREDICTION

NOTICE: Amended May 28, 2020. This Amendment delays the proposal due date for MAP: Proposals are now due July 14, 2020

1. Overview

NASA's Science Mission Directorate (SMD) supports a broad portfolio of research in the Earth Science Research Program. Key questions that drive the core research efforts of the Earth Science Division within SMD include:

- How is the Earth system changing?
- What are the sources of change in the Earth system and their magnitudes and trends?
- How will the Earth system change in the future?
- How can Earth system science improve mitigation of and adaptation to global change?

NASA ESD has an end-to-end strategy for addressing these questions, one component of which is a strong, sustained commitment to Earth system modeling in concert with observations. Within ESD Earth Science Research, the Modeling, Analysis, and Prediction (MAP) program seeks to develop an understanding of the Earth as a complete, dynamic system, to represent that understanding in comprehensive, physically-based models of the Earth system and observation/model syntheses, and to utilize the models and syntheses to answer the key questions listed above.

The modeling and data assimilation supported by the MAP program is observation driven. That is, the direction of the modeling and assimilation work is guided by available and anticipated observations, and its goal is to extract from the observations as much value as possible. For MAP-supported investigations, this involves rigorous examination and utilization of observations in a global Earth system context. The modeling integrates across all the research activities in NASA's Earth science research program, and both spans and connects the spatial and temporal scales that characterize satellite observations and observations from ground- and air-based campaigns. This approach facilitates the validation of the satellite observations and observationally-based improvements of Earth system model components, leading to models that accurately represent the Earth system with diagnostic and predictive skill. MAP strives to generate models and model components that are well documented, thoroughly evaluated, interoperable, robust, and consistent with current coding standards and practices.

2. Background

MAP funds two primary projects that comprise the core activities of the program. These projects are:

NASA Goddard Institute for Space Studies Global Modeling. The global modeling effort at GISS engages in research on global Earth system change occurring on the decadal to centennial timescales, focusing in particular on quantifying global change drivers and their past and potential future effects. GISS makes use of analyses of comprehensive global datasets and develops and utilizes integrated global models of the Earth system.

GISS has a long-term involvement in the Coupled Model Intercomparison Project (CMIP) that forms the basis of International Panel on Climate Change (IPCC) assessments of climate change. The primary GISS modeling tool supported by the MAP program is the GISS Model E, a coupled atmosphere-ocean Earth system model (ESM).

NASA Goddard Global Modeling and Assimilation Office (GMAO). GMAO addresses the optimal use of satellite and *in situ* observations to generate research quality data sets for analyses and reanalyses, and also for weather, climate, and air quality forecasts. The modeling and assimilation research includes coupling to and assimilation of atmospheric aerosols and chemistry and ocean biology and carbon. GMAO focuses on developing and maintaining world-class data assimilation systems in order to maximize satellite data utility and serve as a centralized resource for testing and validating as wide a range of modeling and observational efforts as possible. The goal is to undertake modeling and assimilation as components of an end-to-end process, from defining an instrument, characterizing its in-flight performance, through to the development of algorithms and forward models for data assimilation, integrating the data into assimilation products, and finally assessing the impact of the data on the products of the assimilation system. GMAO is supported by MAP to develop and utilize the Goddard Earth Observing System. GEOS includes both a coupled atmosphere-ocean GCM and a data assimilation system (DAS).

MAP also funds several smaller but still substantial projects that further core program interests. These efforts include:

NASA GEOS chemistry/climate and transport modeling. Projects in chemistry-climate modeling with the GEOS CCM chemistry-climate model and in chemistry-transport modeling with the GEOS and GMI CTMs investigate the roles and interactions of chemical and aerosol species as components of the global Earth system. This includes investigations of the consequences of changing emissions on atmospheric composition and stratospheric and tropospheric ozone distributions.

NASA Unified Weather Research Forecast Model (NU-WRF). The NU-WRF model is a comprehensive regional Earth system model and data assimilation system developed by combining the Weather Research and Forecasting (WRF) model - a next-generation multiagency-supported mesoscale NWP system - with NASA-developed modeling tools such as the Land Information System (LIS), the Goddard Chemistry Aerosol Radiation and Transport Model (GOCART), NASA-Goddard radiation and microphysics codes, and the Goddard satellite data simulator unit (SDSU). NU-WRF can be applied to fully coupled aerosol-cloud-precipitation-land simulations at kilometer length scales. This allows robust connection of the global scale to the regional and mesoscale, while maintaining the focus on comprehensive Earth system modeling, as well as the use of NASA high-resolution satellite data for research into short-term climate, weather, and integrated Earth system processes.

3. Modeling, Analysis, and Prediction Research Themes

The specific research themes included in this Modeling, Analysis, and Prediction (MAP) program element are listed here, to be addressed using available and anticipated observations as discussed in Section 4 below. The approximate number of proposals MAP expects to fund in each area are listed in parenthesis.

- Clouds in Earth System Models: Representations of clouds and cloud systems in Earth system models (ESMs), particularly global ESMs, remain a large source of uncertainty. This situation is exacerbated by efforts to increase resolution in models toward the cloud-permitting regime, where parameterized and explicitly represented cloud processes can coexist. Proposals addressing cloud processes and their representation in ESMs are requested. Topics of special interest include the representation of low clouds in ESMs, in particular the proper representation of features that determine model climate sensitivity. Addressing proper representation of precipitation processes is also a priority. MAP also seeks proposals to investigate the role played by clouds in driving atmospheric circulation patterns, connecting across length scales from local to regional to global. Studies which outline a path to implementable improvements in current model representations of clouds and cloud-related processes or new parameterizations are requested, including the cloud-permitting length scales and nonhydrostatic assumptions. (~6 proposals)
- Extremes in the Earth System: Extreme events such as hurricanes and other intense storms, floods and droughts, wildfires, heat waves and outbreaks of intense cold can cause great damage and are the subject of much concern in the context of climate change. Extremes present a difficulty for Earth system modeling because of their rarity - which complicates evaluation of frequency of occurrence - and the length and temporal scales at which they typically occur. Additionally, such events are emergent phenomena which depend on the interactions of multiple processes within the Earth system and within Earth system models, complicating identification of the primary drivers of overall model behavior. Proposals are solicited to evaluate the degree to which these phenomena and their impacts are properly represented in Earth system models, to understand the interconnections in the Earth system which result in the extreme behavior, and to improve the model representation of the key underlying processes. (~6 proposals)
- Constituents in the Climate System: Constituents in the atmosphere (aerosols and chemical species) will respond to climate change, and changes in constituent concentrations can have climatic consequences as well. A MAP program goal is to expand our understanding of the role of atmospheric constituents (aerosols and chemical species) in the context of the climate system, as well as utilization of constituent observations to better understand global processes and their model representation. Proposals are sought to understand the role of climate change on atmospheric constituent distributions, and the influences of constituent change on climate. This area includes proposals that address emissions parameterizations, specifically the development and implementation of physically-based interactive emissions parameterizations which can respond to climate change and other sources of variability in the Earth system. (~5 proposals)
- Coupling in the Earth System: A long-standing goal of the MAP program is developing an understanding of the Earth as a complete, dynamic system. Such an understanding would be reflected in Earth system models that accurately capture the couplings between its different interacting components, as well as coupling in scale from local to global or the reverse. As described in the 2017 Decadal Survey, better understanding and representation of coupling in the boundary layer is key to

improving weather and climate model predictions, in particular better understanding and representation of the coupling among the atmosphere, surface waves, ocean, sea ice, land, and biosphere. Therefore, of particular interest are investigations which lead to an improved understanding and representation of the interactions between different Earth system components and their influence on boundary layer structure and function. (~5 proposals).

- Assimilation: A long-term goal of the MAP program is the development of an Integrated Earth System Analysis (IESA) capability. IESA is the process of consistently combining all available observations of the Earth System (atmosphere, ocean, land surface, sea-ice, and biogeochemistry) at some time with a model of the Earth System in such a way to produce a best estimate of the state of the Earth System at that time. This capability is not currently available given the start-of-the-art in modeling the global Earth System and the high computational requirements necessary for such a task. This program element seeks proposals that are directed at addressing outstanding assimilation issues and methods for assimilating new NASA observations that are not currently assimilated in NASA data assimilation systems. Note that proposals for modification of NASA modeling systems to enable assimilation of new observations are acceptable. Of particular interest are proposals which address issues related to coupled data assimilation (e.g., weak vs strongly coupled) leading toward IESA, and improved predictive skill at longer than weather timescales. (~4 proposals)
- Predictability in the Earth System: The MAP program has an interest in understanding the behavior and evolution of the Earth system on timescales spanning the weather timescale of hours to days up to multidecadal time periods. On longer timescales, one topic of interest under the heading of predictability is the improvement of global model capabilities for predicting change at regional and local scales. At the subseasonal to seasonal (S2S) timescales, NASA is currently a partner in a multiagency activity with a stated goal of developing an "Earth System Prediction Capability" (ESPC), to improve our national capability for eventually operational and societally useful Earth system prediction beyond the weather timescale. Proposals specifically addressing prediction and predictability at subseasonal to seasonal (S2S) timescales are requested here in support of developing the ESPC, particularly of societally important phenomena. This includes in particular prediction of precipitation at S2S timescales and improved representation of processes that would increase predictive skill for precipitation, because predictive skill for precipitation lags that of temperature at S2S timescales. There is also interest in studies of the representation of slow modes of variability within the Earth system and how they generate predictability at S2S timescales. (~6 proposals)

4. Programmatic Priorities

Characterizing the limits of validity of models and model components and identifying the sources of uncertainties is important to realizing the goal of enabling whole Earth system models. Therefore, preference will be given to proposals that: 1) characterize and/or help reduce uncertainties in the models and products; 2) extend the range of model or product validity by using new components; 3) exploit these products to

address NASA Earth Science Division (ESD) research questions; 4) are in alignment with the goals and objectives of the core MAP elements described above; and 5) enable independent community validation and characterization of the core MAP elements leading to improvement of the models or products. Proposals must explicitly discuss the observations that will either be used in the proposed investigation (including the manner of their use), or whose use will be facilitated by the proposed investigation. Preference will be given to proposals utilizing or enabling analysis of NASA satellite and suborbital observations. A discussion of how the proposed investigation will utilize, interact with or inform the core modeling efforts discussed in Section 2 is also required.

Note also that programmatic balance is an important consideration. Approximate numbers of proposals that are expected to be selected in each area are shown in Section 3. To achieve this balance, it may be the case that some high-ranking proposals may not be selected in areas that are significantly overweighted. However, even though approximate numbers of proposals for each area are given as a guide in Section 3, this program element does not guarantee the selection of at least one proposal for every topic (in the case that there are no proposals of sufficient merit for that topic), nor does it guarantee that any of the topics will be limited by the number shown.

New model components that are proposed shall be Earth System Modeling Framework (ESMF) compliant and make use of ESMF utilities where appropriate. A discussion of the software engineering aspects of the proposed work should be included in the proposal. Components shall be "seamless" in the sense that they are capable of spanning the weather to climate continuum of timescales. Proposals to develop and implement new parameterizations in MAP-supported models should demonstrate awareness of the parameterization to be replaced (if there is one), the code that implements it, and how it interacts with other parts of the model. They should discuss why the new parameterization is expected to improve model simulations relative to the existing parameterization, include an implementation plan, and propose observationally-based metrics based on NASA data that will diagnose the improvement. They should discuss the nature and extent of the interaction with the core model team. Proposals for new model component capabilities must include an evaluation activity that characterizes its limits of validity by comparing to observational data. In all cases, the proposer must explain how the validation methodology will help identify the source of uncertainty within the model or analysis product. Proposals for new or improved model components for NASA MAP supported models and proposals that utilize NASA MAP-supported models or model output will be preferred over those that do not. Proposed evaluations of the MAP-supported models mentioned in Section 2 should consider the use of appropriate existing simulations, including those contained in the CMIP (Coupled Model Intercomparison Project) archives or simulations that have already been conducted by the NASA modeling teams. If new simulations are required, resources to support those simulations should be included in the proposal, as well as the agreement of the modeling team to provide the needed simulations (if the proposing team is unwilling or unable to conduct the simulations themselves).

5. <u>MAP Infrastructure</u>

As mentioned above, a MAP program goal is a set of models and model components that are well documented, thoroughly evaluated, interoperable, robust, and consistent

with current coding standards and practices. Therefore, code development proposals should adhere to the multiagency Earth System Modeling Framework (https://www.earthsystemcog.org/projects/esmf/), which provides a robust software infrastructure for coupling model elements. Proposals should identify resources to provide the software engineering and interface support necessary to assure that the final product meets ESMF standards and investigator verification that the ESMF-compatible product yields desired results.

High-end computing (HEC) support is available from the NASA Center for Computational Sciences (NCCS, https://nccs.nasa.gov/) and the NASA Advanced Supercomputing facility (NAS, http://www.nas.nasa.gov/) (see Section I(d) of the *ROSES Summary of Solicitation*). Proposers who require computing time at NCCS or NAS must follow the instructions in the *Summary of Solicitation* for requesting HEC resources. Note that the availability of computing resources will be considered in the evaluation process.

6. Summary of Key Information

Expected program budget for first year of new awards	~ $7M
Number of new awards pending adequate proposals of merit	~32; See parentheticals in Section 3.
Maximum duration of awards	4 years
Due date for Notice of Intent	See Tables 2 and 3 of this ROSES NRA.
Due date for Proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	January 1, 2021
Page limit for the central Science/Technical/Management section of proposal	15 pp.; see also Table 1 of ROSES and the *NASA Guidebook for Proposers.*
Relevance	This program is relevant to the Earth science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See A.1 Earth Science Research Overview and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)

Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-MAP
Point of contact concerning this program	David B. Considine Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: 202-358-2277 Email: david.b.considine@nasa.gov

A.17 CRYOSPHERIC SCIENCE

NOTICE: Amended May 21, 2020. This Amendment delays the due date for proposals for this program element by one month to avoid overlap with two other Earth Science research programs. Proposals are now due July 30, 2020.

Proposers must use Earth Science division templates for the required Summary Table of Work Effort and Current and Pending Support sections of the proposal.

1. Scope of Program

Polar ice is a key component of the global climate system, interacting with the biosphere, atmosphere, ocean, and solid earth. It is sensitive to changing atmospheric and oceanic conditions and currently undergoing rapid change. Melting ice from the Antarctic and Greenland ice sheets contributes to sea level rise while changes in sea ice impacts ocean biology, air-sea exchanges, and ocean circulation. Ice at the poles is highly reflective and changes to the surface area impact radiation balance. Several feedback mechanisms amplify the impact of the polar regions on the global climate. Thus, monitoring the cryosphere, and understanding the underlying physical processes that govern its behavior are critical to understanding recent and future global change.

Despite the importance of polar observations, the remote and harsh nature of these regions means *in situ* measurements are often sparse. Therefore, satellite and airborne based observations are the only means to provide large-scale and continuous measurements of the polar regions.

The Cryospheric Sciences Program supports investigations of polar ice, including the Antarctic and Greenland ice sheets, polar glaciers, and sea ice in the Arctic and Southern Oceans, that are based on satellite and airborne remote sensing. The program seeks to improve our understanding of cryospheric processes, link the cryosphere to the global climate system, and/or advance predictive capabilities.

Specifically, this opportunity seeks proposals that utilize remote sensing data to:

- Improve our understanding of ice-ocean-atmosphere interactions and their impact on the global climate.
- Improve our understanding of ice sheet, ice shelf, and glacier processes and how those processes affect ice mass balance and ultimately sea level rise.
- Establish time series of ice sheet and sea ice geophysical parameters and investigate trends and variabilities, and their drivers to aid model predictions.
- Develop new data sets needed to improve sea ice and ice sheet models or the representation of polar processes in global climate models.

NASA expects synergy among observations, modeling, and field campaigns, and encourages all projects to consider recommendations identified by the various polar research organizations in their white papers and reports. Some recent examples are as follows:

- *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate* (2019);

- *Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space* (2018) from the National Academies of Sciences, Engineering, and Medicine;
- *Antarctic Sea Ice Variability in the Southern Ocean-Climate System* (2017) from the National Academies of Sciences, Engineering, and Medicine;
- *IARPC Research Plan* from the Interagency Arctic Policy Committee (IARPC);
- *Climate and Cryosphere (CLiC)* of the World Climate Change Research Program;
- *SEARCH 5-year Science Goals* from The Study of Environmental Arctic Change (SEARCH).

Proposers are reminded that use of satellite and/or airborne remote sensing is required. Appropriate data from any NASA or non-NASA satellite or aircraft mission is permitted. Proposers are encouraged to consider the extensive data holdings of, for example, NASA's Distributed Active Archive Centers (DAAC), including the:

- National Snow and Ice Data Center (NSIDC, https://nsidc.org/), which hosts a wide range of data and products from satellite and aircraft missions, including ICESat-2 (https://nsidc.org/data/icesat-2), ICESat (https://nsidc.org/data/icesat), and Operation IceBridge (OIB, https://nsidc.org/data/icebridge). The OIB mission collects altimetry, radar, gravity, bathymetry and other data over ice in the Arctic and Antarctic.
- Alaska Satellite Facility (https://www.asf.alaska.edu/), which hosts satellite radar data.
- Polar Geospatial Center (https://www.pgc.umn.edu), which hosts a variety of polar data from commercial satellites.
- Oceans Melting Greenland (OMG) mission portal (https://omg.jpl.nasa.gov/portal/) which includes radar altimetry, gravity, bathymetry and other oceanographic data in and around Greenland that was collected as part of the NASA *Earth Ventures Suborbital* mission.
- Making Earth System Data Records for Use in Research Environment (MEaSUREs) Program (https://earthdata.nasa.gov/community/community-data-system-programs/measures-projects). MEaSUREs supports the development of several cryosphere-relevant data products.

Work Effort and Funding Support for PIs and Co-Is must be documented using the templates available on the SARA webpage.

2. Computing and Code Considerations

Proposers are encouraged to address how they will comply with NASA's Open Data, Services and Software Policies" https://earthdata.nasa.gov/collaborate/open-data-services-and-software . If the proposal includes the generation of data please refer to the data management plan guidelines in A.1.

As data volumes can be prohibitively large when analyzing high resolution data, long time series, or multiple data sets, cloud-based computing may offer critical efficiencies to proposed investigations and should be considered. To facilitate such work, NASA's Advanced Data Analytics Platform (ADAPT) (https://www.nccs.nasa.gov/services/adapt) will be made available to investigations selected under this element. ADAPT offers cloud storage and access to high-performance computing resources. ADAPT hosts

ICESat-2 data products (https://icesat-2.gsfc.nasa.gov/science/data-products), as well as related satellite and aircraft altimetry products, including data from ICESat and IceBridge.

Proposers who would like to use ADAPT are encouraged to incorporate it in their proposed work plans.

3. Acquisition of New Data and Field Work

Projects may include field work but must include all costs in their budgets.

Projects utilizing the National Science Foundation's (NSF's) Arctic Program resources for fieldwork in Greenland must obtain a cost estimate as discussed in NSF's *Arctic Research Opportunities* solicitation.

Projects requiring Antarctic fieldwork are required to review the information at http://www.usap.gov/proposalInformation/ and provide enough information to allow for adequate review of the fieldwork plan, its utility, and expected costs. For projects that receive assistance from the U.S. Antarctic Program, acknowledgements should include: "Logistical support for this project in Antarctica was provided by the U.S. National Science Foundation through the U.S. Antarctic Program."

For proposals that require the acquisition of new airborne data proposers are encouraged to contact the program manager prior to submitting such proposals. See also A.1 for details.

4. Summary of Key Information

Expected program budget for first year of new awards	~$2M
Number of new awards pending adequate proposals of merit	~13
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 of this ROSES NRA
Due date for proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	October 1, 2020
Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of ROSES and the *NASA Guidebook for Proposers*.
Relevance	This program is relevant to the Earth Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section 3 of the *NASA Guidebook for Proposers* and Section IV and Table 1 of *the ROSES Summary of Solicitation*.

Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-CRYO
Point of contact concerning this program	Thorsten Markus Earth Science Division Science Mission Directorate National Aeronautics and Astronautics Administration NASA Headquarters Washington, DC 20546 Telephone: (202) 358-3860 Email: thorsten.markus@nasa.gov

A.18 ATMOSPHERIC COMPOSITION: UPPER ATMOSPHERIC COMPOSITION OBSERVATIONS

NOTICE: Proposers must use Earth Science division templates for the required Summary Table of Work Effort and Current and Pending Support sections of the proposal, see Section 3.

1. Scope of Program

Atmospheric composition changes affect air quality, weather, climate, and critical constituents, such as ozone. Atmosphere-biosphere exchange links terrestrial and oceanic pools within the carbon cycle and other biogeochemical cycles. Solar radiation affects atmospheric chemistry and is thus a critical factor in atmospheric composition. Atmospheric composition is central to Earth system dynamics, since the atmosphere integrates surface emissions globally on time scales from weeks to years and couples several environmental issues. NASA's research for furthering our understanding of atmospheric composition is geared to providing an improved prognostic capability for such issues (e.g., the recovery of stratospheric ozone and its impacts on surface ultraviolet radiation, the evolution of greenhouse gases and their impacts on climate, and the evolution of tropospheric ozone and aerosols and their impacts on climate and air quality). Toward this end, research within the Atmospheric Composition Focus Area addresses the following science questions:

- How is atmospheric composition changing?
- What trends in atmospheric constituents and solar radiation are driving global climate?
- How do atmospheric trace constituents respond to and affect global environmental change?
- What are the effects of global atmospheric chemical and climate changes on regional air quality?
- How will future changes in atmospheric composition affect ozone, climate, and global air quality?

NASA expects to provide the necessary monitoring and evaluation tools to assess the effects of climate change on ozone recovery and future atmospheric composition, improved climate forecasts based on our understanding of the forcings of global environmental change, and air quality forecasts that take into account the feedbacks between regional air quality and global climate change. Achievements in these areas via advances in observations, data assimilation, and modeling enable improved predictive capabilities for describing how future changes in atmospheric composition affect ozone, climate, and air quality. Drawing on global observations from space, augmented by suborbital and ground-based measurements, NASA is uniquely poised to address these issues. This integrated observational strategy is furthered via studies of atmospheric processes using unique suborbital platform-sensor combinations to investigate, for example: (1) the processes responsible for the emission, uptake, transport, and chemical transformation of ozone and precursor molecules associated with its production in the troposphere and its destruction in the stratosphere and (2) the formation, properties, and transport of aerosols in the Earth's troposphere and stratosphere. NASA's research strategy for atmospheric composition encompasses an end-to-end approach for instrument design, data collection, analysis, interpretation, and

prognostic studies.

2. Upper Atmosphere Research Observational support

The principal area of research solicited through this section is for operational support of atmospheric field measurement systems that monitor trace gas composition in the stratosphere and tropical upper troposphere from the ground, aircraft, and balloons. These types of measurements include those associated with (i) the long term monitoring of ozone and ozone- and climate-related trace gases via remote sensing techniques, and (ii) support of key observational field missions designed to address chemical and dynamical processes that influence upper tropospheric and stratospheric composition. In this solicitation section, NASA is not seeking proposals for instrumentation designed to make atmospheric boundary layer measurements or measurements of cloud/aerosol radiative or microphysical properties. Proposed investigations may include, but are not limited to:

- Long term ground-based remote sensing network observations of atmospheric trace gas composition, such as those prioritized under the Network for the Detection of Atmospheric Composition Change (http://www.ndacc.org/);
- Airborne *in situ* and remote sensing observations of the tropical upper troposphere and stratosphere that are key to current and potential future airborne campaigns;
- Small and large balloon observations of atmospheric composition for maintaining continuity of satellite calibration/validation capabilities.

With respect to the balloon-borne measurements, high-altitude/heavy-lift research balloons have been an important component of the Aura validation program over the last few years. Future balloon measurements should focus on validation and collaborative observations for the SAGE-III instrument on the International Space Station after 2016 and the continued ozone mapping and profiler suite (OMPS)-Limb observations on S-NPP and JPSS-2 to ensure continuity from Aura. We anticipate that this need can be addressed at a reduced scope and level of effort. Priority will be given to proposals that directly address the science priorities of NASA's atmospheric composition focus area, have the potential to be used in planned future airborne field campaigns (such as Asian summer monsoon Chemical and Climate Impact Project, ACCLIP) in the tropical upper troposphere and lower stratosphere that can address key open questions as defined in the Atmospheric Composition community white paper available at https://espo.nasa.gov/home/content/NASA_SMD_Workshop, and can be used to enhance data products from EOS Aura, SAGE-III, and OMPS-Limb. Due to budget limitations, proposals that enhance and maintain the abilities of existing established measurement techniques and recent observations will be given priority over those proposing development and construction of new instruments and technology or data sets that have not been obtained over the past 3 years. For proposals to support airborne instrument activity, proposals should include activity and budgets to support the personnel for maintenance of the instruments and data analysis of past campaigns. Funds to support participation in future campaigns will be made available separately in future solicitations.

Those researchers already funded though the NASA Internal Model Funding Model (ISFM) for work that fits within the above described tasks should not submit a proposal to this solicitation for that activity.

3. Summary Table of Work Effort and Current and Pending Support

Proposers must use the Earth Science standard templates for detailing the level of work effort for project participants and for the current and pending support of project participants. This section of the proposal does not have a page limit. These templates are available at https://science.nasa.gov/researchers/templates-for-earth-science-division-appendix-a-roses-proposals.

4. Summary of Key Information

Expected annual program budget for first year of new awards	~ $4.2 M
Number of new awards pending adequate proposals of merit	~ 12-15
Maximum duration of awards	4 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 of this ROSES NRA
Due date for proposals	See Tables 2 and 3 of this ROSES NRA.
Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of ROSES and the *NASA Guidebook for Proposers*.
Relevance	This program is relevant to the Earth Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section 3 of the *NASA Guidebook for Proposers* and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)

Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-UACO
Point of contact concerning this program	Kenneth W. Jucks Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0476 Email: Kenneth.W.Jucks@nasa.gov

A.19 ATMOSPHERIC COMPOSITION: LABORATORY RESEARCH

NOTICE: Proposers must use Earth Science division templates for the required Summary Table of Work Effort and Current and Pending Support sections of the proposal, see Section 3.

1. Scope of Program

Atmospheric composition determines air quality and affects weather, climate, and critical constituents such as ozone. Exchanges with the atmosphere link terrestrial and oceanic pools within the carbon cycle and other biogeochemical cycles. Solar radiation affects atmospheric chemistry and is, thus, a critical factor in atmospheric composition. Atmospheric chemistry and associated composition are a central aspect of Earth system dynamics, since the ability of the atmosphere to integrate surface emissions globally on time scales from weeks to years couples several environmental issues. NASA's research for furthering our understanding of atmospheric composition is geared to providing an improved prognostic capability for such issues (e.g., the recovery of stratospheric ozone and its impacts on surface ultraviolet radiation, the evolution of greenhouse gases and their impacts on climate, and the evolution of tropospheric ozone and aerosols and their impacts on climate and air quality). Toward this end, research within the Atmospheric Composition Focus Area addresses the following science questions:

- How is atmospheric composition changing?
- What trends in atmospheric constituents and solar radiation are driving global climate?
- How do atmospheric trace constituents respond to and affect global environmental change?
- What are the effects of global atmospheric chemical and climate changes on regional air quality?
- How will future changes in atmospheric composition affect ozone, climate, and global air quality?

NASA expects to provide the necessary monitoring and evaluation tools to assess the effects of climate change on ozone recovery and future atmospheric composition, improved climate forecasts based on our understanding of the forcings of global environmental change, and air quality forecasts that take into account the feedbacks between regional air quality and global climate change. Achievements in these areas via advances in observations, data assimilation, and modeling enable improved predictive capabilities for describing how future changes in atmospheric composition affect ozone, climate, and air quality. Drawing on global observations from space, augmented by suborbital and ground-based measurements, NASA is uniquely poised to address these issues. This integrated observational strategy is furthered via studies of atmospheric processes using unique suborbital platform-sensor combinations to investigate, for example: (1) the processes responsible for the emission, uptake, transport, and chemical transformation of ozone and precursor molecules associated with its production in the troposphere and its destruction in the stratosphere and (2) the formation, properties, and transport of aerosols in the Earth's troposphere and stratosphere. NASA's research strategy for atmospheric composition encompasses an

end-to-end approach for instrument design, data collection, analysis, interpretation, and prognostic studies.

2. Atmospheric Composition Laboratory Research Activities

The principal area of research solicited through this program element is for laboratory investigations that supply basic spectroscopic, chemical, and physical measurements that are currently needed to interpret NASA-generated atmospheric composition data sets. In particular, laboratory studies that contribute to a process level understanding of atmospheric variability as discerned from space-based measurements, such as performed by the Aura suite of instruments, as well as from the broad range of complementary suborbital measurements, are solicited. Proposed investigations that will be given priority may include, but are not limited to:

- Laboratory kinetic and photochemical studies over the range of Earth atmospheric (primarily stratospheric) temperature and pressure that describe the atmospheric transformations of trace species involved in ozone chemistry or directly affecting climate. Proposals that support the activities of the NASA Panel for Data Evaluation (http://jpldataeval.jpl.nasa.gov/) or address priority needs identified by this panel in the chemical kinetics and photochemistry areas are of particular interest. Selected proposals relating to kinetics and photochemistry will be funded primarily by the Upper Atmosphere Research Program.
- Laboratory spectroscopic studies that directly improve the precision and accuracy of data products from NASA Atmospheric Composition satellites, such as Aura, or from suborbital and ground network atmospheric observations supported by NASA. Of particular interest are measurements of the spectral properties of observed quantities or of any interfering quantity, emphasizing the temperature and pressure conditions needed to assure the accuracy of retrievals. Selected proposals relating to this spectroscopy will be funded by the Upper Atmosphere Research Program.

3. Summary Table of Work Effort and Current and Pending Support

Proposers must use the Earth Science standard templates for detailing the level of work effort for project participants and for the current and pending support of project participants. This section of the proposal does not have a page limit. These templates are available at https://science.nasa.gov/researchers/templates-for-earth-science-division-appendix-a-roses-proposals.

4. Summary of Key Information

Expected annual program budget for first year of new awards	~ $1.3 M
Number of new awards pending adequate proposals of merit	~ 5-6
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 of this ROSES NRA.
Due date for proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	6 months after proposal due date.

Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Table 1 of the ROSES *Summary of Solicitation* and the *NASA Guidebook for Proposers*.
Relevance	This program is relevant to the Earth Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section 3 of the *NASA Guidebook for Proposers* and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-ACLS
Point of contact concerning this program	Kenneth W. Jucks Upper Atmosphere Research Program Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0476 Email: Kenneth.W.Jucks@nasa.gov

A.20 ATMOSPHERIC COMPOSITION: RADIATION SCIENCES PROGRAM

NOTICE: This Program element will not be competed in ROSES-2020. Instead, the Radiation Sciences program is participating in a focus area wide program element A.23 Atmospheric Composition Campaign Data Analysis and Modeling.

1. Scope of Program

The Radiation Sciences Program (RSP) strives to develop a quantitative and predictive understanding of how aerosols, clouds, and radiatively active gases scatter and absorb radiation (including both solar and terrestrially originated radiation) in the Earth's atmosphere, especially as it relates to climate variability and change. The program supports studies to improve the theoretical understanding of radiative transfer, as well as field measurements of aerosol and cloud particle concentration, composition, microphysics, and optical properties. These measurements include both airborne and surface-based remote and *in situ* measurements. The program also supports the analysis of satellite remote sensing and field data, as well as the development of process models, which contribute to an Earth system modeling capability.

2. Point of Contact

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A.21 ATMOSPHERIC COMPOSITION: MODELING AND ANALYSIS

NOTICE: The Atmospheric Composition Modeling and Analysis Program (ACMAP) is soliciting for proposals in ROSES-2020 for the modeling and analysis of tropospheric and stratospheric composition airborne data sets via element A.23 Atmospheric Composition Campaign Data Analysis and Modeling. ACMAP will be solicited no earlier than ROSES-2022.

The Atmospheric Composition Modeling and Analysis program (ACMAP) addresses the issues of tropospheric air quality and oxidation efficiency, pollution sourced aerosol and its impact on cloud properties, stratospheric chemistry and ozone depletion, and chemistry/climate interactions. Studies of long-term trends in atmospheric composition (potentially using both current and past mission data sets) are also of interest to the program, where the connection between cause and effect is elucidated using models. The program is interested in studies that integrate observations from multiple instruments with models to address attribution and predictions. The use of satellite and suborbital data sets and ground based measurements are encouraged for modeling constraints and verification where applicable.

For further information about this program, contact:

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A.22 ATMOSPHERIC COMPOSITION: TROPOSPHERIC COMPOSITION PROGRAM

NOTICE: This program will not solicit proposals in a separate element in ROSES-2020. Instead, it is participating in a focus area wide program element A.23 "Atmospheric Composition Campaign Data Analysis and Modeling".

1. Scope of Program

The Tropospheric Composition Program (TCP) seeks to improve the utility of satellite measurements in understanding of global tropospheric ozone and aerosols, including their precursors and transformation processes in the atmosphere. Ozone and aerosols are fundamental to both air quality and climate. The program emphasizes suborbital and ground-based measurements acquired during focused field deployments. Along with the other Atmospheric Composition programs, TCP also sponsors interpretation of these comprehensive, but infrequent, measurements to improve the continuous monitoring of tropospheric ozone, aerosols, and their precursors from space and the improvement of atmospheric composition prognostic models. TCP also supports limited laboratory studies that are directly relevant to improved understanding of tropospheric chemistry.

2. Point of Contact

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A.23 ATMOSPHERIC COMPOSITION CAMPAIGN DATA ANALYSIS AND MODELING

1. Scope of Program

Atmospheric composition changes affect air quality, weather, climate, and critical constituents such as ozone. Atmospheric exchange links terrestrial and oceanic pools within the carbon cycle and other biogeochemical cycles. Solar radiation affects atmospheric chemistry and is thus a critical factor in atmospheric composition. Atmospheric composition is central to Earth system dynamics, since the atmosphere integrates surface emissions globally on time scales from weeks to years and couples several environmental issues.

NASA's research for furthering our understanding of atmospheric composition is geared to providing an improved prognostic capability for key processes and issues such as the recovery of stratospheric ozone and its impacts on surface ultraviolet radiation, the evolution of greenhouse gases and their impacts on climate, and the evolution of tropospheric ozone and aerosols and their impacts on climate and air quality. Toward this end, research within the Atmospheric Composition Focus Area addresses the following science questions:

- How is atmospheric composition changing?
- What trends in atmospheric composition and solar radiation are driving global climate?
- How does atmospheric composition respond to and affect global environmental change?
- What are the effects of global atmospheric composition and climate changes on regional air quality?
- How will future changes in atmospheric composition affect ozone, climate, and global air quality?

Objectives of NASA’s Atmospheric Composition Focus Area include monitoring and assessing the coupled effects of changes in ozone depleting substance emissions and climate variations on ozone recovery and future atmospheric composition; enabling more accurate climate forecasts based on improved understanding of the forcings of global environmental change; and developing and refining better air quality forecasts that take into account the feedbacks between regional air quality and global climate variations. Achievements in these areas via advances in observations, data assimilation, and modeling enable improved descriptions and predictions of how changes in atmospheric composition affect ozone, climate, and air quality.

An integrated observational strategy involving global observations from space augmented by suborbital and ground-based measurements is key to NASA’s scientific approach to analyzing and predicting atmospheric composition. This integrated observational strategy is furthered via studies of atmospheric processes using unique suborbital platform-sensor combinations to investigate, for example: (1) the processes responsible for the emission, uptake, transport, and chemical transformation of ozone and precursor molecules associated with its production in the troposphere and its destruction in the stratosphere and (2) the formation, properties, and transport of aerosols in the Earth’s troposphere and stratosphere, as well as aerosol interaction with clouds. NASA’s research strategy for atmospheric composition encompasses an end-to-

end approach for instrument design, data collection, analysis, interpretation, and prognostic studies.

2. Description of Solicited Research

The Atmospheric Composition research programs are soliciting proposals for data analysis and modeling of NASA supported airborne campaign data. NASA's Earth Science Division has supported a number of airborne campaigns in Atmospheric Composition during the last few years. Some recent airborne campaigns include, but are not limited to:

- Mid-latitude Airborne Cirrus Properties Experiment (MACPEX)
- Studies of Emissions and Atmospheric Composition, Clouds and Climate Coupling by Regional Surveys (SEAC^{4}RS)
- Airborne Tropical Tropopause Experiment (ATTREX)
- Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE)
- Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality (DISCOVER-AQ)
- Atmospheric Carbon and Transport (ACT-America)
- Atmospheric Tomography Mission (ATom)
- North Atlantic Aerosols and Marine Ecosystems Study (NAAMES)
- Observations of Aerosols above Clouds and their Interactions (ORACLES)
- Korea-United States Air Quality Study (KORUS-AQ)
- Pacific Oxidants, Sulfur, Ice, Dehydration, and Convection Mission (POSIDON)
- Lake Michigan Ozone Study (LMOS)
- Fire Influence on Regional to Global Environments Experiment - Air Quality (FIREX-AQ)
- Cloud, Aerosol and Monsoon Processes Philippines Experiment (CAMP^{2}Ex)
- Long Island Sound Tropospheric Ozone Study (LISTOS)

The list above is meant to be illustrative, but not exclusive. While some analyses of the data obtained from these campaigns has occurred, much more interpretation and modeling will be worthwhile.

Through this call, the Atmospheric Composition Modeling and Analysis Program (ACMAP), the Radiation Sciences Program (RSP), and Tropospheric Composition Program (TCP) seek proposals for the analysis and modeling of the data produced as part of these airborne campaigns. The use of NASA sponsored airborne data is required. Preference will be given to proposals that also use satellite remote sensing data. The use of data from other sources (e.g., surface-based data, data from non-NASA airborne campaigns) is encouraged.

While the subject area for proposals is unrestricted, proposals must address one or more of the Atmospheric Composition Focus area science questions listed in Section 1. Preference will be given to proposals that address the stated scientific objectives of the airborne campaigns. Proposals primarily focused on algorithm and model development will be deemed nonresponsive.

3. Programmatic Information

Proposals may request up to three years of funding to cover the costs of personnel, computing, publication, and travel associated with the data analysis and modeling activities. CAMP^{2}Ex Principal Investigators who have 5-6 years of CAMP^{2}Ex funding should not apply to this solicitation.

4. Summary of Key Information

Expected program budget for first year of new awards	~ $5M
Number of new awards pending adequate proposals of merit	~25-30
Maximum duration of awards	3 years
Due date for Notice of Intent	None requested
Due date for Proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section 3 of the *NASA Guidebook for Proposers* and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-ACCDAM

Points of contact concerning this program all of whom share the following address: Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001	Richard Eckman - ACMAP Telephone: 202-358-2567 Email: richard.s.eckman@nasa.gov Barry Lefer - TCP Telephone: 202-358-3857 Email: barry.lefer@nasa.gov Hal Maring - RSP Telephone: 202-358-1679 Email: hal.maring@nasa.gov

A.24 TERRESTRIAL HYDROLOGY

NOTICE: Amended October 5, 2020. NOI and Proposal due dates have been delayed: NOIs are requested by December 2, 2020, and proposals are now due January 14, 2021. The planning date for start of investigation has also been changed to July 2021. New text is in bold and deleted text is struck through.

Proposers must use Earth Science division templates for the required Summary Table of Work Effort and Current and Pending Support sections of the proposal, see Section 3.

1. Scope of Program

The NASA Terrestrial Hydrology program (THP) has the scientific objective to use remote sensing to develop a predictive understanding of the role of water in land-atmosphere interactions and to further the scientific basis of water resources management. The NASA THP is a component of the Global Water and Energy Cycle Focus Area (see Section 2.4 of program element A.1).

THP uses NASA's unique view from space to study hydrologic processes associated with runoff production, hydrologic fluxes at the land-air interface, and terrestrial water stores. THP works in concert with other Earth Science Division (ESD) programs, also studying the global water cycle (e.g., precipitation, physical oceanography), to describe and understand the connections between the cycle's different parts. THP fosters the development of hydrologic remote sensing theory, the scientific basis for new hydrologic satellite missions, hydrologic remote sensing field experiments, and the interface of hydrology with other disciplines, such as those addressed by the Terrestrial Ecology program (see program element A.4). Particular emphasis is placed on the application of satellite-based remotely sensed data for characterizing, understanding, and predicting the terrestrially linked components of the hydrologic cycle and the dynamics of large-scale river basins. THP furthers study of the relationship between satellite interferometric measurements of surface deformation and changes in underground water stores. THP is currently focused on research relating to multiple missions, either currently operating, such as Global Precipitation Measurement (GPM), Soil Moisture Active Passive (SMAP) and the Gravity Recovery and Climate Experiment Follow-On (GRACE-FO); or in planning and development, such as Surface Water Ocean Topography (SWOT). THP projects are also extensively using data collected at previous or current field campaigns and projects, such as SMAPVEX (http://smap.jpl.nasa.gov), AirMOSS (http://airmoss.jpl.nasa.gov), SnowEx (https://snow.nasa.gov/campaigns/snowex), or numerous others, both national and international.

THP continues to encourage use of NASA investments to improve the use of remote sensing information in weather and climate models, primarily through data assimilation approaches involving land surface models. The Land Information System (LIS; http://lis.gsfc.nasa.gov) provides a modeling test bed for potential investigations of this domain, along with an entrée into activities of other U.S. agencies.

THP is one of the nation's programs supporting the Global Energy and Water Cycle Exchanges Project (GEWEX) and the U.S. Global Research Program (USGCRP).

More information on current THP projects and plans, as well as links to related field campaigns, can be found at mission and project specific websites, e.g., http://smap.jpl.nasa.gov/, http://snow.nasa.gov, http://swot.jpl.nasa.gov/.

2. Description of Solicited Research

The importance of water requires no preamble. As a nation and a global community, our ability to measure and predict water in all its forms and locations must improve to better assess and understand our changing environment and demands of human society and ecosystems. In particular, through this solicitation, the program seeks to make improvements in our understanding of and ability to assess the seasonal snow portion of the water cycle.

Numerous approaches to space borne remote sensing are sensitive to different aspects of the land surface snowpack (e.g. snow depth, albedo, water equivalent, etc.) Yet, no one approach appears to be fully capable across the different snow types and climates.

Proposers are encouraged to consider how best to advance any and all forms of remote sensing that are currently space ready. For example, proposers may focus on advancing the capability of a single channel-based algorithm or may instead advance multiple source algorithms, numerical techniques, modeling and data assimilation approaches, etc. Satellite remotely sensed data should be the backbone of any investigated approach.

Proposers should consider the current state of the art of snow remote sensing and document the motivation for their study and chosen approach to improving snow characterization. It is strongly suggested that proposers ground this motivation in preliminary numerical analysis. Results of proposed studies should provide NASA with global maps of performance of the investigators' chosen technique that would be suitable to document potential satellite mission performance.

Proposers are encouraged to use recently acquired data from NASA's SnowEx campaigns, or other similar snow field campaigns. Proposers may express intent to use data that would become available via future SnowEx field campaigns; although the proposal should clearly outline the impact to the study if those field campaigns are altered or delayed.

3. Programmatic Information and Requirements

Funds available for work selected under this program element are $1.25M per annum to support 8-10 projects. Project start dates will be no earlier than April 1, 2021.

Proposals must contain the Earth Science standard template for detailing the level of work effort of project participants and for the current and pending support of project participants. These templates are available at https://science.nasa.gov/researchers/templates-for-earth-science-division-appendix-a-roses-proposals.

4. Table of Key Information

Expected total program budget for lifecycle of new awards	~ $3.75 M
Number of investigator awards pending adequate proposals of merit	~8-10
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 of this ROSES NRA.
Due date for proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	~~April~~ **July** 2021 **[Changed October 5, 2020]**
Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of the *ROSES Summary of Solicitation*.
Relevance	This program is relevant to the Earth Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section IV and Table 1 of *the ROSES Summary of Solicitation* and Section 3 of the *NASA Guidebook for Proposers*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-THP

Point of contact concerning this program	Jared Entin Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: 202-358-0275 Email: jared.k.entin@nasa.gov

A.25 WEATHER AND ATMOSPHERIC DYNAMICS

NOTICE: The Atmospheric Dynamics program will not be competed in ROSES-2020. It is tentatively scheduled to next solicit proposals in ROSES-2022.

1. Scope of Program

The study and analysis of the dynamics of the atmosphere and its interaction with the oceans and land is an important component of the Weather Focus Area. Improvement of our understanding of weather processes and phenomena is crucial in gaining an understanding of the Earth system. This component of the Weather Focus Area is primarily designed to apply NASA scientific remote sensing expertise to the problem of obtaining accurate and globally distributed measurements of the atmosphere and the assimilation of these measurements into research and operational weather forecast models in order to improve and extend U.S. and global weather prediction. NASA-sponsored research continues to gain new insight into weather and extreme-weather events by the utilization of data obtained from a variety of satellite platforms (Tropical Rainfall Measuring Mission (TRMM), Global Precipitation Measurement (GPM), Aqua, Terra, Suomi National Polar-orbiting Partnership (Suomi NPP), CloudSat, CloudAerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO), Soil Moisture Active Passive (SMAP), and Cyclone Global Navigation Satellite System (CYGNSS)) and hurricane-themed tropical field experiments. This involves remote sensing and utilization of meteorological parameters such as temperature and moisture profiles, precipitation and 3-D winds and also the interaction of these parameters with the oceans and land.

2. Point of Contact

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A.26 EARTH SURFACE AND INTERIOR

NOTICE: This program element requires use of the Earth Science Division templates for reporting Work Effort and Current and Pending Support, see Section 3.6.

1. Scope of Program

NASA's Earth Surface and Interior (ESI) focus area (http://science.nasa.gov/earth-science/focus-areas/surface-and-interior) supports research and analysis of solid-Earth processes and properties from crust to core. The overarching goal of ESI is to use NASA's unique capabilities and observational resources to better understand the structure and dynamics of the core, mantle, and lithosphere, and interactions between these processes and Earth's fluid envelopes.

ESI studies provide the basic understanding and data products needed to inform the assessment, mitigation, and forecasting of natural hazards, including earthquakes, tsunamis, landslides, and volcanic eruptions. These investigations also exploit the time-variable signals associated with other natural and anthropogenic perturbations to the Earth system, including those connected to the access and management of natural resources.

ESI's Space Geodesy Program (SGP) produces observations that refine our knowledge of Earth's shape, rotation, orientation, and gravity, advancing our understanding of the motion and rotation of tectonic plates, elastic properties of the crust and mantle, mantle-core interactions, solid-Earth tides, and the effects of surface loading resulting from surface water, ground water, glaciers, and ice sheets. SGP infrastructure enables the establishment and maintenance of a precise terrestrial reference frame that is foundational to many Earth missions and location-based observations.

2. Description of Solicited Research

ESI requests the following types of research investigations this year. Pending sufficient availability of funds, it is NASA's intent to update these foci and compete this element on an annual basis to best address scientific and programmatic priorities:

1. Innovative Solid-Earth Science: innovative hypothesis-driven scientific research addressing the seven scientific challenges from NASA's *Challenges and Opportunities for Research in ESI (CORE) Report* (2016) (http://go.nasa.gov/2hmZLQO), or the ESI science objectives identified in the National Academy of Sciences (NAS) *Decadal Survey*, *Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space* (2018) (https://www.nap.edu/catalog/24938);
2. Solid-Earth Observing System Studies: proposals for Observing System Simulation Experiments (OSSEs) that optimize system design or collection strategies for acquiring data to help achieve ESI community science objectives. Results should help inform the design of new capabilities or optimize existing capabilities, including assessments of science value and feasibility across a range of potential approaches, to address specific solid-Earth science questions. Proposers are encouraged to contact the program point of contact to assess whether their concept is responsive to this topic. Proposals that include

instrument or technology development will be considered nonresponsive and returned without review.

Further details on this year's solicited topics are described in Sections 2.1 and 2.2 below. Additional context for research under these topics continues to derive from the objectives for solid-Earth science presented in several strategic documents. In particular, the *CORE Report* and the *Decadal Survey* provide the latest comprehensive input to ESI's vision.

The *CORE Report* identifies seven scientific challenges: 1) what is the nature of deformation associated with plate boundaries and what are the implications for earthquakes, tsunamis, and other related natural hazards; 2) how do tectonic processes and climate variability interact to shape Earth's surface and create natural hazards; 3) how does the solid Earth respond to climate-driven exchange of water among Earth systems and what are the implications for sea-level change; 4) how do magmatic systems evolve, under what conditions do volcanoes erupt, and how do eruptions and volcano hazards develop; 5) what are the dynamics of Earth's deep interior and how does Earth's surface respond; 6) what are the dynamics of Earth's magnetic field and its interactions with the rest of Earth system; and 7) how do human activities impact and interact with Earth's surface and interior?

These and other ESI interests underpinning this year's solicited topics 2.1 and 2.2 are described in greater detail in the strategic documents listed below:

- The NAS report *Evolving the Geodetic Infrastructure to Meet New Scientific Needs* (2020) (https://www.nap.edu/catalog/25579/evolving-the-geodetic-infrastructure-to-meet-new-scientific-needs)
- The report *Measuring the Restless Earth: Grand Challenges in Geodesy* (2019) (https://www.unavco.org/community/publications_and_reports/community-vision/geodesy_science_plan/measuring-the-restless-earth.pdf)
- The NAS Decadal Survey, *Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space* (2018) (https://www.nap.edu/catalog/24938)
- The NAS report *Volcanic Eruptions and Their Repose, Unrest, Precursors, and Timing* (2017) (https://doi.org/10.17226/24650)
- The NASA *CORE Report* (2016) (http://go.nasa.gov/2hmZLQO)
- The NASA 2014 Science Plan (https://science.nasa.gov/about-us/science-strategy)
- The NASA report highlighting future pathways for GRACE, *Responding to the Challenge of Climate and Environmental Change: NASA's Plan for a Climate-Centric Architecture for Earth Observations and Applications from Space* (2010) (https://science.nasa.gov/about-us/science-strategy)
- The NAS report *Precise Geodetic Infrastructure: National Requirements for a Shared Resource* (2010) (http://www.nap.edu/catalog.php?record_id=12954)

2.1 Innovative Solid-Earth Science

This subsection seeks innovative hypothesis-driven scientific research addressing the *CORE Report's* seven scientific challenges. Overarching themes of interest include leveraging advances in technology and associated data to address new solid-Earth

science questions, or revisit existing paradigms. These themes also include advancing our understanding of how the solid Earth is linked to and interacts with the broader Earth system, including understanding the impact of human activities and their interaction with the solid-Earth, which can both benefit society and provide avenues for innovative research. Within this theme, proposals that develop new and innovative geodetic analysis techniques that utilize satellite data from missions prioritized for other disciplines or result in data streams or products that may also benefit other disciplines, are also welcomed. All studies must still demonstrate a focus for the proposed work on advancing the understanding of the solid Earth. Proposals that employ new approaches to addressing questions focused on a particular component of the solid-Earth system described in the *CORE Report* or *Decadal Survey* are also welcomed.

Submissions to this subsection may include high-risk, high-return research. High-risk research tests novel and significant hypotheses for which there is limited precedent or preliminary data, or that are counter to the existing scientific consensus. High-return research has outcomes, if confirmed, that would have a substantial and measurable effect on current thinking, methods, or practice. Proposals are required to identify potential risks and mitigation strategies.

Successor proposals submitted under this subsection must describe relevant achievements made during the course of the previous awards, new approaches to interpreting remote sensing data or improving knowledge of the solid Earth not employed during those prior studies, demonstrable scientific advances anticipated from the follow-on work, and continued relevance and priority of the research to ESI.

2.2 Solid-Earth Observing System Studies

This subsection welcomes theoretical, modeling, and analysis efforts that explore the tradeoffs between different data collection strategies, and the viability of those schemes for capturing specific solid-Earth processes of interest. It is expected that proposals to this subsection will address observing systems that serve ESI community scientific interests that are broader than an individual investigator-led study. Proposers are encouraged to contact the program point of contact to assess whether their concept is responsive to this topic. Proposals to address focused scientific questions using specific, pre-defined observational approaches will be assessed under the guidelines provided for topic 2.1 Innovative Solid-Earth Science.

Space-based and airborne platforms, in combination with geodetic ground networks, are the foundation of the ESI research program. Developing an effective data collection strategy requires careful consideration of the spatial and temporal nature of the anticipated signals of interest, availability of historical and/or ongoing observations, and practical limitations on acquisition strategies, geographic distribution, and resources. Proposals to conduct OSSEs that consider real and simulated observations and errors associated with solid-Earth science questions and inform remote-sensing observational strategies for solid-Earth research are encouraged under this subsection. Such studies may address the development of future remote-sensing and geodetic observational systems, or the optimization of existing systems. This could include exploring combinations of data/imagery collected from different sensors to maximize scientific benefit, or the evaluation of tradeoffs associated with the downsizing of a network while

maintaining sufficient density to capture the targeted signals. Partnerships with experts from disciplines outside the traditional ESI community that help bring OSSE or related modeling approaches to bear on solid-Earth research are welcomed.

One- to two-year efforts are encouraged under this subsection. All proposals should justify the duration needed to meet proposed objectives and include clearly defined sub-annual to annual milestones. Proposals that address ESI science objectives and associated remote sensing observations as identified in the *CORE Report* and *Decadal Survey* will receive higher priority under this subsection. Submissions to this subsection that complement NASA's ongoing studies for observing systems associated with *Decadal Survey*-recommended Designated or Incubation Observables are welcomed (https://science.nasa.gov/earth-science/decadal-surveys). Proposals addressing topics related to these or other funded NASA observing system studies should seek to clearly articulate how the proposed effort will complement these studies and further benefit solid-Earth objectives, and investigators already involved in those studies must clearly demonstrate that the proposed effort is not duplicative of existing funded work. Proposals that include instrument or technology development will be considered nonresponsive and returned without review.

3. Programmatic Guidelines

3.1 Solid-Earth Research Focus

A clear focus on advancing scientific understanding of solid-Earth processes and/or properties is required in all proposals.

3.2 Remote Sensing Focus

Substantive connection to remote sensing data is required in all proposals. Proposers are encouraged to utilize existing or planned ground, airborne, and space-based observational capabilities and their associated data sets. These resources include the existing high-resolution SRTM dataset and ongoing satellite and airborne Lidar such as ICESat-2, GEDI, and LVIS; forthcoming solid-Earth products from EarthDEM; and satellite and airborne spectral imaging such as ASTER, MODIS, ECOSTRESS, MASTER, HyTES, and AVIRIS, that provide structural and compositional imaging to inform tectonic and climatic influences on evolving terrains. Geodetic observations utilizing GPS/GNSS, SAR, and InSAR, including the airborne UAVSAR facility (L-band, P-band AirMOSS, and Ka-band GLISTIN-A) and the Indian Space Research Organisation's L+S band Airborne Synthetic Aperture Radar (ASAR), provide insights into dynamic processes. Ongoing and future missions such as ALOS-2/4, Sentinel-1, TerraSAR-X, COSMO-SkyMed, RCM, and NISAR provide additional and upcoming opportunities in this realm. Magnetic and gravity missions, such as the historical SAC-C, Ørsted, CHAMP, and GOCE, and ongoing SWARM and GRACE-FO, offer long-term geopotential records that inform models of the geodynamo and the structure, composition, and dynamics of the Earth's mantle, lithosphere, and fluid envelopes. These and other NASA datasets are cataloged in the Earth Observing System Data and Information System (EOSIDS) (https://earthdata.nasa.gov) and provided by the DAACs.

3.3 Proposals Requesting Acquisition of New Airborne Data

Proposals requiring data from airborne sensors must detail in their cost plan all costs for

acquiring the new data sets, including costs for aircraft hours, deployment costs, mission peculiar costs, data processing costs, and other costs associated with deploying the sensors and aircraft (this includes NASA and non-NASA sensors and platforms). In addition, for any proposed activities requiring NASA aircraft or NASA facility sensors, proposers should submit a Placeholder Flight Request to the Airborne Science Flight Request system (https://airbornescience.nasa.gov). Funding associated with the use of NASA aircraft and facility sensors will be sent directly to the responsible NASA center, and not to the awardee. If the instrument or aircraft are not NASA facilities, proposers must take responsibility for making all arrangements to secure the availability of the needed sensors and aircraft and explain these plans in the proposal.

3.4 Proposals Requesting NASA High-End Computing Resources

Interested proposers should consult A.1 the Earth Science Research Overview, Section 5.4 High-End Computing, Networking, and Storage; and the *Summary of Solicitation*, Section I(d), for a summary of HEC offerings and guidance on requesting computing time.

3.5 Participation in the NASA Solid-Earth Team Meeting

All proposals should include funds for participation in a biennial two-day NASA solid-Earth team meeting to be held on the west coast. This meeting will bring together current and prospective ESI investigators, technologists, and related members of the scientific community to report on research results and engage in strategic workshops to advance opportunities for the solid-Earth and geodesy research communities. Awardees are required to attend.

3.6 Documenting Work Effort and Current and Pending Support

Work Effort and Current and Pending Support for PIs and Co-Is must be documented using the templates available on the SARA webpage (https://science.nasa.gov/researchers/templates-for-earth-science-division-appendix-a-roses-proposals).

4. Summary of Key Information

Expected annual program budget for new awards	~$2.5M
Number of new awards pending adequate proposals of merit	~12-16
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 of this ROSES NRA.
Due date for proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	January 1, 2021
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Table 1 of the ROSES *Summary of Solicitation* and the *Guidebook for Proposers*.

Relevance	This program is relevant to the Earth science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section IV and Table 1 of *the ROSES Summary of Solicitation* and Section 3 of the *NASA Guidebook for Proposers*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-ESI
Point of contact concerning this program	Benjamin R. Phillips Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-5693 Email: ben.phillips@nasa.gov

A.27 CYGNSS COMPETED SCIENCE TEAM

NOTICE: Amended July 2, 2020. NOI and Proposal due dates have changed: NOIs are requested by October 2, 2020, and proposals are now due November 6, 2020. Section 4 has been modified to include new information about additional eligible datasets. New text is in bold.

1. Background

The Cyclone Global Navigation Satellite System (CYGNSS) was successfully launched into low Earth orbit on 15 December 2016. CYGNSS consists of a constellation of eight satellites, each carrying a four-channel bistatic radar receiver that measures GPS signals scattered by the Earth's surface. The common orbit plane of the constellation is inclined by 35 degrees from the equator, resulting in Earth coverage from ~38 N to 38 S latitude. The satellites produce four primary science data products. A Level 1 product is the scattering cross section of the surface over both the ocean and land, with 10-15 km spatial resolution; a Level 2 product is the 10 m referenced neutral stability wind speed over the ocean, with 25 km spatial resolution; a Level 2 product is the sensible and latent heat flux at the ocean surface, with 25 km spatial resolution; and Level 3 products are gridded versions of the Level 2 products, with 0.25 deg lat/lon resolution. In each case, temporal sampling is characterized by a median revisit time of 3 hours and a mean revisit time of 7 hours. Use of the GPS L1 navigation signal at 1575 MHz (19 cm wavelength) scattered from the ocean surface results in measurements that are largely insensitive to scattering or attenuation by intervening precipitation. Further details about the CYGNSS mission are available at http://cygnss-michigan.org. The CYGNSS Level 1, 2 and 3 data are being archived at the Physical Oceanography Distributed Active Archive Center at the NASA Jet Propulsion Laboratory https://podaac.jpl.nasa.gov/CYGNSS.

2. Scope of Program

CYGNSS science objectives during its prime mission phase centered around ocean wind observations, in particular in and near the inner core of tropical cyclones. A summary of mission performance relative to those objectives is provided in (Ruf et al., 2019). In addition, the Level 1 measurements over land have been shown to contain useful information about soil moisture and inland water extent (Ruf et al., 2018). CYGNSS entered its extended mission phase in 2019 and all eight spacecraft and their science payloads continue to operate and produce bistatic radar data nominally. This ROSES element seeks to support the continued use of both the ocean and land data products through scientific investigations and end-user applications; successful proposers will become members of the Competed CYGNSS Science Team.

This program element has eligibility requirements involving the type of data that may (and must) be used in the proposed activities and there are special requirements on current science team members and proposers from federal agencies other than NASA. All proposers are strongly encouraged to carefully read Section 4 Eligibility and Evaluation Criteria.

Selected examples of research foci that are relevant to this call are provided in Section 3. Please note that this is not an exclusive list. As the amount of funding available for

this opportunity is limited, it is unlikely that the set of proposals selected for funding will address all of the example areas listed in Section 3.

Proposals relating to science studies or applications must clearly address the unique contributions made possible by the improved spatial and temporal sampling of the CYGNSS constellation.

In all areas, strong preference will be given to proposals that identify at least one testable hypothesis and describe the process and NASA data to be used to test the hypothesis.

3. Example Research Areas

3.1 Atmospheric River Generation and Development

Our understanding of the generation and development of atmospheric rivers over ocean basins is limited by sparse observations. While ground and airborne field campaigns have primarily focused on landfalling events over the North Pacific, their limited spatial and temporal scope preclude improvements in the predictability of extreme precipitation events associated with atmospheric rivers at the global scale. Many observationally-based atmospheric river studies at this scale rely on vertically integrated water vapor, e.g. from Special Sensor Microwave Imager (SSM/I) satellite data, which only provide a proxy for moisture transport within atmospheric rivers, and reanalyses, which are limited in resolution. The utility of CYGNSS measurements to measure surface wind speeds under a variety of precipitating environments at high sub-daily intervals presents an opportunity to expand the study of atmospheric river generation and development. Proposals that use CYGNSS measurements to improve our understanding of atmospheric river lifecycle are of interest.

3.2 Wetland Methane Emissions

CYGNSS has the ability to resolve inland flood inundation and under-canopy wetlands. Data products based on this capability have the potential to improve our representation and understanding of wetland methane emissions. For example, such CYGNSS products could be used to drive process or empirical wetland methane models, compare with other products, connect to atmospheric methane, and evaluate implications for seasonality and magnitude of wetland methane emissions. Regions with under-canopy wetlands are of particular interest given the capability of CYGNSS to observe inundation state in spite of canopy cover. Proposals that use CYGNSS measurements to address the question of wetland methane emission are of interest.

3.3 Dynamic Inland Water Mask Development

The location and extent of inland water bodies is a fundamental property of any landscape which has a critical influence over its ecosystem. Two prominent global water mask products currently used are derived from MODIS and Landsat optical imagery. They are characterized by high spatial resolution but low (yearly) temporal resolution, and by a lack of adequate coverage in persistently vegetated or cloudy regions. They have a limited ability to resolve inland water body dynamics of both an episodic nature, such as flood events or seasonal changes, and due to longer term trends in the climate or human development. The ability of CYGNSS observations to detect and geolocate

small inland water bodies suggests that it should be possible to produce associated water mask products at higher temporal resolution. The sampling nature of the observations is such that the spatial and temporal resolution of such masks need to be balanced against one another. Proposals that use CYGNSS measurements to develop dynamic inland water masks to address end-user needs not well met by current global water mask products are of interest.

3.4 Process, Coupling and Feedback Studies

A science goal of CYGNSS is to better understand tropical cyclone physical processes. As such, investigations of tropical cyclone lifecycle processes using CYGNSS data are of interest. In addition, the coupling and feedback mechanisms between wind-driven surface fluxes and tropical convection in general, and mesoscale convective systems in particular are also of interest. For example, combining CYGNSS gridded wind speed products with GPM gridded precipitation products (e.g. IMERG) might be used to characterize empirical constraints on the behavior of the coupling and feedback mechanisms.

3.5 Weather and Storm Surge Data Assimilation Studies

Also of interest are the development of optimized data assimilation schemes for weather prediction and storm surge models. The sampling properties of the CYGNSS constellation are significantly different than those provided by traditional low-Earth orbiting wind-measuring instruments such as scatterometers. Data assimilation schemes adapted to, and optimized for, the unique spatial and temporal sampling characteristics of CYGNSS data can maximize the impact of CYGNSS data. These should make the best use of the spatial and temporal sampling properties of the CYGNSS ocean surface wind speed science data products.

4. Eligibility and Evaluation Criteria

The proposal must be focused on the use of CYGNSS data. The use of any other freely available satellite (U.S./non-U.S.) and *in-situ* data that is relevant to the proposal is allowed. Studies that are not based on the use of on-orbit CYGNSS data products will be considered nonresponsive to this announcement and may be returned without review.

The only CYGNSS data that may be used are those that are publicly available at or through the Physical Oceanography Distributed Active Archive Center at the NASA Jet Propulsion Laboratory https://podaac.jpl.nasa.gov/CYGNSS. Proposals that rely on data products that do not meet this eligibility requirement will be considered nonresponsive to this announcement and may be returned without review.

Please note the following new products available on the PO.DAAC:

1. **Level 1 Raw Intermediate Frequency (IF) (release scheduled July 2020), Special science operating mode over hurricanes and flood zones supporting high spatial and temporal resolution and coherent signal processing;**
2. **Level 1 Full Delay Doppler Map (DDM) (release scheduled July 2020), Special science operating mode over hurricanes supporting high wind retrievals with wide glistening zone response;**

3. **NOAA-developed wind speed (release scheduled August 2020), Blended CYGNSS+ECMWF wind speed with improved L1 calibration;**
4. **Level 3 UCAR-developed soil moisture (release scheduled September 2020), Global soil moisture product. [New text added July 2, 2020]**

For all proposals from all categories of organizations, proposed projects that complement rather than duplicate work being done by the existing team may be given programmatic preference. A list of the current projects may be found at: https://clasp-research.engin.umich.edu/missions/cygnss/science-investigations.php

Current CYGNSS science team members who propose to this ROSES element must explain how the proposed work is distinct from, and/or extends, activities included as part of the original CYGNSS mission proposal. Furthermore, in proposing to this announcement, current CYGNSS science team members should only use the CYGNSS data products that are publicly available to all potential proposers.

Employees of federal agencies other than NASA and their associated cooperating entities, must document clearly how the work proposed to NASA goes beyond the work that they would be doing for their present employer in the absence of any potential NASA support.

Consistent with Section VI(a) of the *ROSES Summary of Solicitation*, proposals will be evaluated on intrinsic merit, relevance, and cost. The evaluation of relevance will be based on the extent to which proposers would use CYGNSS data products for uses and applications that are consistent with the Earth science questions and goals in the NASA Science Plan.

5. Notice of Intent to Propose

A Notice of Intent (NOI) to propose is strongly encouraged for the submission of proposals to this program element. The information contained in the NOI is used to help expedite proposal review activities and, therefore, is of considerable value to both NASA and the proposer. NOIs should be submitted electronically via the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES; http://nspires.nasaprs.com/) by the due date given in Tables 2 and 3 of ROSES. Since NOIs submitted after the deadline may still be useful to NASA, late NOIs, as well as an indication of intent not to propose on an earlier NOI submission, should be submitted by email directly to the point of contact for this program element (see Section 6, below).

6. Summary of Key Information

Expected program budget for new awards	~$2.5 in each year (see Section 2)
Number of investigator awards pending adequate proposals of merit	~14 total
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 of this ROSES NRA.
Due date for proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	Six months after due date for proposals

Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of the ROSES *Summary of Solicitation* and Section 3.7 of the *Guidebook for Proposers*.
Relevance	See Section 4. This program is relevant to the Earth Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See A.1 Earth Science Research Overview and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-CYGNSS
Point of contact concerning this program	Gail Skofronick-Jackson Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: 202-358-2045 Email: gail.s.jackson@nasa.gov

A.28 RAPID RESPONSE AND NOVEL RESEARCH IN EARTH SCIENCE

NOTICE: Before any is begun on a proposal to this program, potential proposers should read the first section entitled Important Caveat to Potential Proposers.

1. Important Caveat to Potential Proposers

Before any effort is expended in preparing a proposal, potential proposers should:

- Read this solicitation in its entirety. It has a number of specific requirements. Failure to meet them will result in a proposal being returned without review.
- Understand that NASA reserves the right to return or decline proposals to this solicitation based on internal review with limited feedback to the proposers.
- The Earth Science Division (ESD) has not reserved any funds dedicated to this solicitation, but anticipates that its individual programs will consider support of a very small number of meritorious proposals each year.
- Prior to proposal submission, contact the most relevant NASA program officer (http://science.nasa.gov/researchers/sara/program-officers-list/#earth) and the current Rapid Response and Novel Research in Earth Science (RRNES) program officer (listed below). Proposers that forego this step run an increased risk of having their proposals declined or returned without review.
- Proposals should normally be for support of one year or less, under the assumption that further work will be proposed to another program.
- This solicitation is not intended to support mitigation of active disasters or immediate hazards. Contact the Disasters Program Manager in NASA's Applied Sciences Division and/or the other most relevant NASA program manager directly to discuss expedited options (http://science.nasa.gov/researchers/sara/program-officers-list/#earth).
- While the ESD does its best to review proposals quickly, because of the funding nature of this solicitation sometimes a response may take longer than anticipated.
- Note that support for "limited duration opportunity for an unanticipated research collaboration," which had been included in earlier versions of the RRNES solicitation, has been eliminated. Proposers interested in support for such activities should contact their NASA program manager directly to see if support can be arranged by another method.

2. Introduction

In order to address its strategic goals and objectives (see Section I of the *ROSES Summary of Solicitation*), the ESD of the Science Mission Directorate (SMD) acknowledges that there are important and highly relevant research topics and opportunities that cannot be anticipated in the annual ROSES solicitation. In particular, it is usually not possible to solicit the following two types of activities:

- Immediate research activity to take advantage of a target of opportunity due to an unforeseen event in the Earth system,
- Exceptionally novel and innovative ideas to advance Earth remote sensing that do not fit within ESD's current slate of solicitations and/or programs.

ESD has not reserved any funds dedicated to this solicitation, but anticipates that its individual programs will consider support of a very small number of meritorious proposals each year.

3. Scope of Program

This program element solicits proposals that advance the goals and objectives of NASA's Earth Science Division by conducting unique research to investigate 1) unforeseen or unpredictable Earth system events and opportunities that require a rapid response, and 2) novel ideas of potential high merit and relevance for ESD science to advance Earth remote sensing that have not otherwise been solicited by NASA in the past three years.

3.1 Rapid Response to Earth System Events

This subelement is focused on research proposals having great urgency for action involving quick-response research on natural or anthropogenic extreme events and/or similar unanticipated or unpredictable events that fall outside the norm. Examples are major fires, volcanic eruptions, 100-year floods, episodes of severe and large-scale environmental pollution, harmful algal blooms, coral bleaching events, and other unexpected large-scale events causing rapid environmental change.

The research activities proposed must require rapid, near-term data acquisition, field work, and/or other such research activities. Given the significance of these events, rapid sharing of data and results are expected. Proposers are strongly encouraged to contact the NASA program officer(s) whose expertise best matches the proposal topic before submitting a proposal, in order to determine whether the proposed work is appropriate for this ROSES program element and if funding is likely to be available for a meritorious proposal.

The proposal must include clear statements as to 1) why the proposed research is of an urgent nature, 2) why the proposed research is of high significance and likely to have a long-lasting impact, 3) why this ROSES program element is the only feasible mechanism to request NASA support for the proposed work, and 4) a detailed plan on data dissemination and sharing.

Please note that this element is not intended to support mitigation of active disasters or immediate hazards. Please contact the Disasters Program Manager in NASA's Applied Sciences Division and or the other most relevant NASA program manager directly to discuss expedited options (http://science.nasa.gov/researchers/sara/program-officers-list/#earth).

3.2 Novel Ideas in Earth Remote Sensing

This subelement is intended to provide an open, systematic, competitive process for NASA's ESD to consider proposals for exceptionally novel scientific research that includes remote sensing of the Earth which cannot be considered relevant to any other NASA solicitation. ESD recognizes that such proposals offer the possibility for major scientific breakthroughs and new approaches to remote sensing and knowledge of the Earth system. ESD offers this subelement as a mechanism for researchers to develop

their ideas and justify near-term investment through an important new capability or scientific application that will advance ESD goals and objectives.

Proposals must focus on topics that offer fundamental scientific research to advance Earth remote sensing, including new ways of interpreting remote sensing data or improving knowledge of the Earth system and its processes. Proposals may include calibration and validation work, as appropriate.

Proposals that focus on instrument or technology development, data and information systems research, or educational activities are strongly discouraged.

If the topic is relevant to any other ESD ROSES program element(s), it should not be submitted here, but should be submitted to the relevant element. In addition, in order for a proposal to be considered responsive as novel Earth science, the topic and approach must not have been solicited or have been considered responsive under any NASA solicitations during the past three years (this includes ROSES, NASA Announcements of Opportunity, etc.). Any proposal that contains research that in the view of cognizant NASA managers violates one or both of these requirements will be considered as nonresponsive and declined without further review.

NASA anticipates that only a very small number of proposals will meet these criteria each year and that selection and funding of such proposals will be a rare, but a strategically important occurrence.

4. Relevance to SMD's Goals and Objectives

Proposals submitted in response to this solicitation must demonstrate the relevance of the proposed activity to ESD by showing how the Scientific/Technical area(s) to be covered will advance not only high-level ESD goals and objectives, but also specific (existing or anticipated) outcomes identified in ROSES program elements, ESD roadmaps, other ESD program documents, the *NASA Science Plan*, findings in decadal surveys, or the reports of NASA advisory bodies or groups relevant to NASA. Proposers must explicitly state from what source (e.g., ROSES program element, roadmap, or decadal survey) the claim of relevance derives. Proposers are referred to A.1 the *Earth Science Overview* in this solicitation for a description of the scope of NASA Earth Science activities and the research programs areas and topics of interest. To be relevant under this program element, proposals must take into consideration ESD's defined scope and its focus on the use of airborne and/or space-based measurements to provide information about the Earth system.

5. Programmatic Information and Additional Requirements

5.1 Proposal Structure, Content, and Budget Requests

Prior to any submission, proposers are encouraged in the strongest possible terms to contact the ESD program managers (http://science.nasa.gov/researchers/sara/program-officers-list/#earth) whose expertise are most germane to the proposal topic to determine the appropriateness of the work for consideration under this program element. This may include consideration of whether funding is potentially available.

5.1.1 *Proposals for Rapid Response to Earth System Events*

The Technical Plan for proposals submitted for rapid response is limited to a maximum of five pages and must include clear statements as to why the proposed research is of an urgent nature and why this solicitation is the only feasible mechanism to request NASA support for the proposed work, as well as the other requirements listed in the text of the subelement. The bulk of the Technical Plan should be devoted to describing the core scientific objectives and anticipated scientific return, the research work to be done, and the timetable for rapid actions. If NASA facilities will be required to conduct the research (e.g., NASA aircraft or airborne sensors), proposers should contact the relevant facility managers to develop feasibility and cost estimates in parallel with the preparation of their proposal. Feasibility and cost estimates should be submitted as part of the budget justification.

Questions regarding the NASA flight request system or processes should be addressed to Marilyn Vasques, Flight Request Manager (Marilyn.Vasques@nasa.gov or 650-604-6120).

To ensure timely processing of the submitted proposal, "Rapid Response" must be selected as the Primary Investigation Type on the proposal cover sheet. On the cover sheet, the relevant program manager/program under which the proposal should be considered should also be indicated.

NASA will initially conduct an internal review of each proposal that may result in a decision, and there may be limited feedback to the proposer. Some proposals may be declined simply for lack of available funding. However, proposals may also be subject to external peer review at the discretion of NASA. The larger the requested funding, the more comprehensive (e.g., the use of external mail review) the review is likely to be.

Budget requests should be commensurate with the nature of the rapid response work to be conducted and, if no other research projects are being leveraged, include sufficient funding for processing of the data and its public distribution, as well as minimal data analysis to achieve the core, near-term objectives of the rapid response. Full exploitation of a successfully acquired data set can be included in future competitive ROSES disciplinary program elements and should not be requested here.

Proposals should normally be for support of one year or less, under the assumption that further work will be proposed to one of the ongoing research programs or one of the other periodic ROSES elements (e.g., competed mission science teams, Interdisciplinary Science, etc.). Up to three years of funding may be requested, but proposals requesting more than one year of funding must provide specific and compelling justifications as to why the core, rapid response science objectives require a longer duration for completion.

5.1.2 *Proposals for Novel Ideas in Earth Remote Sensing*

The Technical Plan for Novel Ideas in Earth Remote Sensing proposals is limited to a maximum of 15 pages and must include clear statements as to why the proposed scientific research is novel and not responsive to any other NASA solicitations released in the past three years. The technical plan should emphasize the initial research activities needed to explore the feasibility of the new idea, prove the concept, and/or

provide a first demonstration of the potential utility and benefits to NASA Earth science, as well as the other requirements listed in the text of the subelement. Potential proposers are encouraged to pay close attention to the types of research that are discouraged for this area as noted in Section 3.2 ("instrument or technology development, data and information systems research, or educational activities").

It is anticipated that most such studies will be conducted in one year at modest cost (e.g., ~$75-$150K), and that continued funding would be sought from proposals submitted to open research programs or periodic ROSES elements (e.g., competed mission science teams, Interdisciplinary Science, etc.). However, up to three years may be requested, but the proposal must fully justify the need for that length of time. In addition, all proposals must describe plans for the publication/documentation/dissemination of their results at the earliest possible date.

NASA will initially conduct an internal review of each proposal that may result in a decision, and there may be limited feedback to the proposer. Some proposals may be declined simply for lack of available funding. In some cases, NASA will, at its discretion, conduct a full peer-review of the proposal, most likely involving individual evaluations submitted through NSPIRES. However, if sufficient proposals are received, NASA reserves the right to convene a peer review panel. NASA's standard evaluation criteria will be used in reviewing these proposals. The uniqueness of the research proposed and the degree of innovation will be weighed heavily under the intrinsic merit criterion, as well as under relevance.

5.2 Availability of Funding

No specific budget is identified for this program element; selected proposals will be funded by the ESD program managers in the disciplines most closely related to or benefitting from the proposed work. The number of proposals selected will be dependent on the availability of funds, as well as the number and quality of proposals submitted.

Potential proposers should contact both the NASA Point of Contact for this solicitation and the ESD Program Officers in the disciplines and programs most germane to the proposed investigations to discuss the proposed work and the availability of funds. Contact information for SMD Program Officers is available at http://science.nasa.gov/researchers/sara/program-officers-list/#earth or in the Summary Information table at the end of a ROSES program element description.

5.3. Award Instruments

Awards selected under this solicitation will only be supported as a grant, a cooperative agreement, an interagency agreement, or internal funding to a NASA Center. Contracts will not be used for these awards.

6. Summary of Key Information

Expected annual program budget for new awards	No specific budget is identified; selected proposals will be funded by the relevant program(s).

Number of new awards pending adequate proposals of merit	The number of proposals selected will be dependent on the availability of funds from the relevant program(s), as well as the number and quality of proposals submitted.
Maximum duration of awards	3 years (but see Sections 5.1.1 and 5.1.2)
Due date for Notice of Intent to propose (NOI)	No Notices of Intent are requested for this program element.
Due date for proposals	Proposals may be submitted at any time until 11:59 PM (Eastern time) on March 29, 2021.
Planning date for start of investigation	No sooner than 1 ½ months after proposal receipt for Rapid Response, and 6 months after proposal receipt for Novel Earth Science.
Page limit for the central Science/Technical/Management section of proposal	5 pp for Rapid Response and 15 pp for Novel Earth Science; see also Table 1 of ROSES *Summary of Solicitation* and the *Guidebook for Proposers*.
Relevance	See Section 4. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section 3 of the *NASA Guidebook for Proposers* and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-RRNES
Point of contact concerning this program	Laura Lorenzoni Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0917 Email: laura.lorenzoni@nasa.gov

A.29 AIRBORNE INSTRUMENT TECHNOLOGY TRANSITION

NOTICE: The Airborne Instrument Technology Transition program will not be competed in ROSES-2020. The program may next solicit proposals in ROSES-2021.

1. Scope of Program

NASA's Earth Science Research Program is a comprehensive effort that develops observational techniques and instrument technologies needed to implement them. These instruments are operated in the laboratory and from suborbital (i.e. surface, balloon, and aircraft) and space-based platforms to support science investigations. In many cases, airborne data are used to increase basic process knowledge and, in other applications, airborne data products are incorporated into complex computational models that characterize the present state and future evolution of the Earth System.

Within the Earth Science Division, the Airborne Science Program is responsible for providing airborne instrument systems capable of delivering data products that advance science and that complement other observing assets, such as satellites. This is accomplished primarily through focused field experiments for process studies, evaluation and risk retirement of new instrument concepts, and calibration and validation of space-based sensors.

This announcement seeks to upgrade mature instruments developed under NASA's Instrument Incubator Program, or by similar NASA programs or activities, for operation from various platforms supported by the Airborne Science Program. This opportunity provides for engineering activities leading to the integration of instruments to airborne platforms that will deploy them as part of organized airborne science campaigns which typically involve multiple instruments and/or platforms. The goal is to upgrade existing operating instruments (with little-to-no previous flight testing) to campaign-ready airborne configuration(s). No funding is available for research and development of new instrumentation. No AITT funding is available to upgrade or downsize existing flight instruments. Management of the tasks selected in response to these Airborne Instrument Technology Transition calls is carried out in conjunction with the Earth Science Technology Office (ESTO), that has significant experience in management of technology-oriented tasks through programs such as the Instrument Incubator Program. A fuller description of ESTO and its activities is included in Appendix A.1.

Proposals submitted to this announcement shall support the objectives of one or more of the Earth science focus areas. Earth science focus areas include: Carbon Cycle and Ecosystems, Climate Variability and Change, Water and Energy Cycle, Atmospheric Composition, Weather, and Earth Surface and Interior (see Appendix A.1 for descriptions of the focus areas). Relevance to these focus areas is indicated by the degree to which instrument products (i.e., science and engineering data) support the goals and activities of existing and future field campaigns sponsored by the NASA Research and Analysis program; it may also be demonstrated by relevance to the goals and activities of NASA's Applied Science Program. Examples of previous field campaigns can be found at the Airborne Science Website.

Proposers may find information on selections from previous calls for this element at NASA's NSPIRES web site.

The following documents identify the relevant missions and programs for this program:

1. *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond* may be accessed on the web at http://www.nap.edu/catalog/11820.html. This report is hereinafter referred to as the "*Decadal Survey*."
2. *Responding to the Challenge of Climate and Environmental Change: NASA's Plan for a Climate-Centric Architecture for Earth Observations and Applications from Space* accessible on the web at https://science.nasa.gov/about-us/science-strategy.
3. NASA missions listed in the table found at http://science.nasa.gov/earth-science/missions/.

2. Point of Contact for Further Information

Barry Lefer
Earth Science Division
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546-0001
Telephone: (202) 358-3857
Email: Barry.Lefer@nasa.gov

A.30 EARTH SCIENCE U.S. PARTICIPATING INVESTIGATOR

NOTICE: Clarified June 25, 2020. The summary table of the key requirements for anonymized proposals, reproduced from the "Guidelines for Anonymous Proposals" in Section 2.4 has been modified to indicate that not just the budget justification but also the (redacted) budget numbers should be included in the anonymized proposal. New text is in bold.

Starting this year proposals submitted to this program will be evaluated using a dual-anonymous review process. Proposals must be prepared according to the guidelines in Section 2.4 and in the associated "Guidelines for Anonymous Proposals" document under "Other Documents" on the NSPIRES page for this program element.

1. Scope of Program

NASA makes use of space-based, surface-based, airborne, and balloon-based measurements, as well as a broad suite of observations (both space-based and other) made by our interagency and international partners to address the science questions articulated in the 2014 Science Plan for NASA's Science Mission Directorate (hereafter, the NASA Science Plan). Particular interest is given to having close connections with the satellite observations of international partners, especially as coordinated through the Committee on Earth Observation Satellites (http://www.ceos.org/), as well as other international bodies, such as the Coordination Group for Meteorological Satellites (http://www.cgms-info.org/) and the World Meteorological Organization (http://www.wmo.int/pages/prog/sat/).

NASA solicits proposals for U.S. Participating Investigator (USPI) investigations on a foreign space mission that address the Earth Science Research Program objectives listed in the NASA Science Plan. This solicitation is for Earth science investigations that address the science questions listed in the NASA Science Plan and that contribute and facilitate access to foreign space agencies' assets.

2. Programmatic Considerations

2.1 Type of Investigation

A proposed investigation as a USPI on a foreign space mission may be as a Co-Investigator (Co-I) for an instrument, experiment, or technology demonstration that is being built and flown by a sponsor agency other than NASA. The Co-I role can include, but is not limited to, instrument design, modeling, and simulation of the instrument's operation and measurement performance; calibration of the instrument; and/or development of innovative data analysis techniques. A USPI may also serve as a member of a foreign space mission science or engineering team and participate in science team activities such as mission planning, mission operations, data processing, data analysis, and data archiving.

No matter what the nature of the USPI role, an investigation proposed under this category must be for a science or technology investigation that clearly and demonstrably enhances the scientific output of the mission and benefits the U.S. scientific community. The

investigation must include a meaningful contribution to the development of products, including, but not limited to, algorithm development and/or testing, calibration/validation, and/or requirements definition (especially as may be carried out in Observing System Simulation Experiments). If the performance period of the task would include the launch of the mission, then the task should demonstrate a contribution to the production of data products from the mission that will be made widely available to the U.S. Earth Science research community. All aspects of the investigation must be within the proposed cost.

Investigations requiring the provision of flight hardware are not solicited through this USPI solicitation. Investigations requiring in-field calibration/validation resources are not solicited through this solicitation. However, the utilization of existing networks to support calibration/validation activities for temporary deployment is acceptable, as long as their cost is not a major component of the overall proposal.

Involvement in the mission during its development phase is preferred. Missions to launch during or after 2022 are encouraged, in order to maximize work done during a mission's development phase.

Investigations focused principally on analysis and interpretation of the data products produced by this effort or analysis of data from a foreign mission already on orbit should be proposed separately through the ROSES call in response to an appropriate element, e.g., Land-cover and Land-use change (Program element A.2), Ocean Biology and Biogeochemistry (Program element A.3), Carbon Cycle science (Program element A.5), Carbon Monitoring System (Program element A.6), Biodiversity (Program element A.7), Physical Oceanography (Program element A.9), Cryospheric Science (Program element A.17), Terrestrial Hydrology (Program element A.24), and Earth Surface and Interior (Program element A.26).

This program element solicits new individual investigations only (potentially with some Co-Investigator or Collaborator support). Large team investigations would be considered nonresponsive to this call. Proposals to extend or directly supplement existing investigations already funded for approved space flight missions or other Earth Science Division research programs are not appropriate for this program element. Investigators who are members of the science teams of ongoing missions and who propose to use data from those missions must clearly demonstrate that the proposed research is distinct from their existing efforts. This discussion should be included in the separately uploaded "Expertise and Resources - Not Anonymized" document (see Section 2.4).

2.2 Duration of Award

Awards will be for a maximum of five years. If the proposed investigation is for more than five years, then a continuation proposal may be submitted in response to a future ROSES element for a new award covering a period of up to five additional years. The progress and accomplishments of the initial five years of the investigation will be reviewed as part of the decision-making process for the continuation award in the context of the future solicitation. If the foreign mission is already in orbit, the continuation proposal must be focused on the continuing production of data products and associated calibration/validation activities that would benefit the U.S. Earth science

community. Analyses of data from an on-orbit foreign mission would be considered nonresponsive.

The budget for only the first five years of the investigation should be entered into the NSPIRES budget forms.

2.3 Technical Requirements and Constraints

In addition to the requirements given in ROSES, all proposed investigations must also demonstrate:

- their formal relationship with the sponsoring agency's mission (e.g., selected participant, invited participant, or proposed participant (provide this information in the separately uploaded "Expertise and Resources - Not Anonymized" document (see Section 2.4)));
- the status of the mission within the sponsoring agency (i.e., Pre-Phase A, Phase A, Phase B, etc.), including the level of commitment that the sponsoring agency has made to complete development;
- a description of the type and the characteristics of the data from this investigation, as well as any ancillary science data that will be archived as part of this investigation and a clear statement of the data policy for the mission that documents the process and schedule by which the data will be made available to the U.S. Earth science community; and
- a detailed explanation of how the U.S. Earth science community benefits from this participation.

2.4 Preparing Proposals for Dual-Anonymous Peer Review

Proposals submitted to this program will be evaluated using a dual-anonymous peer review process in which, not only are proposers unaware of the identity of the members on the review panel, but the reviewers do not have explicit knowledge of the proposal teams during the scientific evaluation of the proposal. The overarching objective of dual-anonymous peer review is to reduce unconscious bias in the evaluation of the merit of a proposal.

To implement dual-anonymous peer review, reviewers may not see any information that would identify proposers, so proposers must follow the instructions in the "Guidelines for Anonymous Proposals" document under "Other Documents" on the NSPIRES page for this program element that explain how to properly prepare the proposal for dual-anonymous peer review.

The forms filled out on the NSPIRES web pages with Proposal Summary, Budget, Proposal Team and Program Specific and Business Data known as the NSPIRES "cover pages" will not be seen by peer reviewers. This has two implications: 1) The Proposal summary must also be included as the first page of the proposal PDF and 2) proposers must upload a separate "Expertise and Resources - Not Anonymized" document, that contains all of the personally (and organizational) identifying information.

In order to meet the objectives of dual-anonymous peer review, review panels will be instructed to evaluate the anonymized proposals based on their scientific merit, without taking into account the proposing team qualifications. As a final check, and only after the scientific evaluation is finalized for all proposals, the panel will be provided with the

"Expertise and Resources - Not Anonymized" documents. The panel will assess the qualifications of the team in order to allow the reviewers to assess the team capabilities required to execute a given proposed science investigation.

A summary of the key requirements for anonymized proposals, reproduced from the "Guidelines for Anonymous Proposals" document, is listed below:

Item	Requirement
References	References must be in the [1], [2] format.
Proposal summary	Enter as part of the NSPIRES cover page and as the first page of the uploaded proposal PDF file.
Page limits	15 pages. One additional page is allotted for the Proposal Summary, and two additional pages may be allotted for the Data Management Plan.
Biographical Sketches	Do not include in main proposal document. Include in separate "Expertise and Resources - Not Anonymized" document.
Current and Pending Support	Do not include in main proposal document. Include in separate "Expertise and Resources - Not Anonymized" document.
Redacted Budget **and** Narrative	Include **both redacted budget and narrative** in proposal document in an anonymized format. **[Clarified June 25, 2020]**
Summary Table of Work Effort	Include in an anonymized fashion (e.g., PI; Co-I#1; Co-I#2) in the main proposal document and in non-anonymized fashion in the separate "Expertise and Resources – Not Anonymized" document.
Facilities and Equipment	Do not include in main proposal document. Include in separate "Expertise and Resources - Not Anonymized" document.
Data Management Plan	Include in main proposal document in an anonymized format. Two additional pages are allotted for the Data Management Plan.
High End Computing request	Submit PDF HEC form as document type "Appendix" in NSPIRES.
Separate "Expertise and Resources - Not Anonymized" document	Submit as document type "Appendix" in NSPIRES. This document provides a list of all team members, their roles, expertise, and contributions to the work. The document should also discuss any specific resources that are key to completing the proposed work, as well as a summary of work effort. Statements of Current and Pending Support must also be included. Any formal relationship with the sponsoring agency's mission shall be described in this section. Membership in ongoing mission science teams that may overlap with the proposed research shall be described in this section. Letters of support, e.g., from facilities or archives, must be included in this section.

2.5 Proposal Evaluation Factors

Proposers are reminded that the evaluation criteria for this solicitation are given in the *ROSES Summary of Solicitation* Section VI (a) and the *Guidebook for Proposers*. In

addition to the standard factors, the evaluation criterion "intrinsic merit" specifically includes the benefits to the U.S. Earth science community from this investigation, as noted in section 2.3.

3. Summary of Key Information

Expected program budget for first year of new awards	~ $750K
Number of new awards pending adequate proposals of merit	~5-6
Maximum duration of awards	5 years (see section 2.2)
Due date for Notice of Intent	See Tables 2 and 3 of this ROSES NRA
Due date for proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	6 months after proposal due date
Page limit for the central Science/Technical/Management section of proposal	15 pp. One additional page is allotted for the Proposal Summary and two additional pages for the Data Management Plan. See also Table 1 of ROSES.
Relevance to NASA	This program is relevant to the Earth Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See A.1 The Earth Science Research Overview and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-ESUSPI

Point of contact concerning this program	Richard S. Eckman Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: 202-358-2567 Email: Richard.S.Eckman@nasa.gov

A.31 INTERDISCIPLINARY RESEARCH IN EARTH SCIENCE

NOTICE: Interdisciplinary Research in Earth Science will not be competed in ROSES-2020. It was last solicited as A.32 in ROSES-2019. This program is tentatively scheduled to next solicit proposals no earlier than ROSES-2021.

1. Scope of the Program

This solicitation is for new and successor interdisciplinary research investigations within NASA's Interdisciplinary Research in Earth Science (IDS) program. Proposed research investigations will meet the following criteria: a) offer a fundamental advance to our understanding of the Earth system; b) be based on remote sensing data, especially satellite observations, but including suborbital sensors as appropriate; c) go beyond correlation of data sets and seek to understand the underlying causality of change through determination of the specific physical, chemical, and/or biological processes involved; d) be truly interdisciplinary in scope by involving traditionally disparate disciplines of the Earth sciences; and e) address at least one of the specific themes listed this solicitation.

As an example, in ROSES-2019, the themes were:

- Volcanoes in the Earth System;
- Interactions Between Sea Ice and the Atmosphere;
- Polar Ocean/Biology/Biogeochemical Coupling;
- The Life Cycle of Snow;
- Impacts of urbanization on local and regional hydrometeorology;
- Space Archaeology: Using the Past to Inform the Present and Future;
- Exploring the Microbial Biodiversity of the Atmosphere.

It is expected that the themes in any subsequent IDS solicitation will differ significantly from those from ROSES-2019 or other prior solicitations.

The results of these investigations will improve our capability for both prognostic predictions and retrospective simulations of the Earth system. They will also advance our understanding of the vulnerabilities in human and biogeophysical systems, and their relationships to climate extremes, thresholds, and tipping points.

Meeting these goals requires approaches that integrate the traditional disciplines of the Earth sciences, as well as innovative and complementary use of models and data.

2. Context and History

Since its inception more than a decade ago, NASA's IDS program has advanced the goal of understanding the Earth system by promoting interdisciplinary research and exploiting the vast wealth of data from NASA satellite and airborne sensors. The program's focus has generally aligned with the goals of the U.S. Global Change Research Program (http://globalchange.gov/). Substantial contributions have also been made to Earth system model development, training the next generation of interdisciplinary Earth system scientists, and developing the necessary infrastructure to

take full advantage of current and future satellite data from NASA and its interagency and international partners.

The specific topics of the program have varied through time (see prior solicitations and awards at nspires.nasaprs.com), and each solicitation may represent the development of new elements and/or the evolution of others that had been solicited previously.

The specific scientific topics and questions identified by the subelements in a future solicitation will constitute the priorities for that solicitation. Proposals submitted in response to a future IDS element MUST address at least one of the identified subelements, and proposals MUST identify clearly which subelement or subelements are addressed.

Proposed research investigations must also meet all of the following criteria, and each of these should be specifically addressed in the proposal:

- offer a fundamental advance to our understanding of the Earth system;
- be based on remote sensing data, especially satellite observations, but including suborbital sensors as appropriate;
- go beyond correlation of data sets and seek to understand the underlying causality of change through determination of the specific physical, chemical, and/or biological processes involved;
- be truly interdisciplinary in scope by involving traditionally disparate disciplines of the Earth sciences; and
- address at least one of the specific subelements listed in the solicitation.

Proposals developing significant new datasets must include a data management plan.

In future solicitations, NASA expects to have separate peer review panels for each subelement, and proposals will be assigned to one or more panels based on the proposer's identification of the appropriate subelement, as well as NASA's assessment of proposal content. While NASA expects to select proposals in each of the identified subelements, NASA reserves the right to select proposals in none, some, or all of them depending on the nature and distribution of proposals received and the outcome of the peer review process.

3. Point of Contact

General questions about the IDS Program may be directed to:

Jack A. Kaye
Associate Director for Research, Earth Science Division
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546-0001
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Email: Jack.A.Kaye@nasa.gov

A.32 NEW (EARLY CAREER) INVESTIGATOR PROGRAM IN EARTH SCIENCE

NOTICE: Amended September 14, 2020. This Amendment delays the proposal due date for this program element to give more time for proposers displaced by fires in the west. Proposals are now due October 6, 2020.

Clarified April 30, 2020. Section 1.2 Eligibility has been changed to make it clear that individuals such as NASA Postdoctoral fellows are eligible to be PIs on proposals to this program element though they may not be considered "employed". New text is in bold and deleted text is struck through. The due dates remain unchanged.

Amended April 28, 2020. This Amendment releases the final text for this program element. Notices of Intent are requested by August 18, 2020 and proposals are due ~~by September 15, 2020~~.

1. Scope of Program

1.1 Introduction

The New (Early Career) Investigator Program (NIP) in Earth science is designed to support outstanding scientific research and career development of scientists and engineers at the early stage of their professional careers. The program welcomes innovative research initiatives and seeks to cultivate diverse scientific leadership in Earth system science. The Earth Science Division (ESD) places particular emphasis on the investigators' ability to promote and increase the use of space-based remote sensing through the proposed research. Proposals with objectives connected to needs identified in most recent Decadal Survey *Thriving on our Changing Planet: A Decadal Strategy for Earth Observation from Space* are welcomed.

The NIP supports all aspects of scientific and technological research aimed to advance NASA's mission in Earth system science (See the NASA Science Plan at http://science.nasa.gov/about-us/science-strategy/). In research and analysis, the focus areas are:

- Carbon Cycle and Ecosystems,
- Climate Variability and Change,
- Water and Energy Cycle,
- Atmospheric Composition,
- Weather, and
- Earth Surface and Interior.

In applied sciences, the ESD encourages the use of data from NASA's Earth-observing satellites and airborne missions to tackle tough challenges and develop solutions that improve our daily lives. Specific areas of interest include efforts that help institutions and individuals make better decisions about our environment, food, water, health, and safety (see http://appliedsciences.nasa.gov). In technological research, the ESD aims to foster the creation and infusion of new technologies – such as data processing, interoperability, visualization, and analysis as well as autonomy, modeling, and mission architecture design – in order to enable new scientific measurements of the Earth system or reduce the cost of current observations (see http://esto.nasa.gov). The ESD

also promotes innovative development in computing and information science and engineering of direct relevance to ESD. See Appendix A.1 for more detailed descriptions of the focus areas, themes in applied sciences, and related research topics of high priority to the ESD.

The proposed research project must be led by a single, eligible (see further description below for eligibility) investigator serving as the Principal Investigator (PI). Indeed, this individual must be the only essential team member; no Co-Investigators (Co-Is), paid or unpaid, are permitted. The NIP does not accept proposals with Co-PIs, nor two types of PIs, such as a Science PI and an Institutional PI. Students and postdoctoral fellows may participate as paid team members. The proposed research may include collaborations. See the *Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/ for the definitions of Collaborator vs. Co-Investigator and descriptions of China-related restrictions that apply to this program element.

This early career program, NIP in Earth Science, was established in 1996. The frequency of solicitation is currently every three years.

1.2 Eligibility **[Updated April 30, 2020]**

An NIP proposal PI must be a recent Ph.D. recipient, defined as having graduated on or after January 1 of the year that is no more than six years before the issuance date of this Research Opportunities in Space and Earth Science (ROSES) NASA Research Announcement (NRA) (i.e., after January 1, 2014, but see also item four below). **The proposal PI mush have successfully completed their Ph.D. defense prior to the solicitation due date.**

Institutions and organizations are encouraged to submit proposals under the NIP on behalf of their outstanding ~~new faculty members or employees~~ **early career scientists and technologists** in Earth system science and associated applications, as long as the individuals are the proposed PIs.

To be eligible for an NIP award, proposed PIs must meet the following requirements:

1. Be ~~employed at~~ **affiliated in NSPIRES with** an institution in the U.S., its territories or possessions, or the Commonwealth of Puerto Rico, which awards a baccalaureate or advanced degree in a field supporting the objectives of NASA Earth system studies, or be ~~employed at~~ **affiliated in NSPRIES with** any nonprofit research institution or other nonprofit organization that performs work in fields of research supporting the objectives of NASA's Earth Science Program. Such organizations could include museums, observatories, government or nonprofit research laboratories, as well as nonprofit entities in the private sector.
2. Be in tenure- or non-tenure-track position~~s~~ in teaching, research, or both, as long as the ~~employing~~ institution **with which the PI is affiliated in NSPIRES** assumes the responsibility of submitting the proposal with the individual as the proposed PI.
3. Not hold or have held tenure (or equivalent) on or before the submission deadline of this program.
4. Despite being more than six years beyond the receipt of their Ph.D. degrees, individuals who have interrupted their careers for reasons such as military service,

family leave, or serious health problems may also be eligible. These applicants should submit a written email request to the NASA point of contact listed below to obtain prior concurrence from NASA before the due date for Notices of Intent to propose. NASA will provide a written response within three weeks. Such an exception is not intended for individuals who have had successful employment in technical fields in science and engineering, even though the employment is not a direct continuation of their Ph.D. research, nor is it intended for individuals who recently obtained a Ph.D. degree after having already established a successful career in Earth system science or related disciplines.

5. Not be a current or former recipient of the NIP or Presidential Early Career Award for Scientists and Engineers (PECASE) award.

2. Programmatic Information

2.1 Funding

Proposals to the NIP are openly solicited approximately every three years. The anticipated average award is $125K per year for a period of up to three years, subject to satisfactory progress and availability of funds.

2.2 Proposal Preparation

The NIP proposals should be prepared in accordance with the instructions given in the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*. The Science/Technical/Management section of the proposal should contain a detailed statement of the proposed research of no more than 15 pages including figures and tables. This page limit must include a statement of leadership in Earth system science of up to one page (see the special leadership evaluation criterion in section 2.4 below).

2.3 Budget Requirements and Restrictions

The NIP awards are up to three years in duration. The amount for each award is determined according to the scope of the proposed work and the overall competition. Salary for up to three months per year of PI time is allowable. NASA will not reimburse the salary if the PI is a civil servant at an agency other than NASA, except in a limited number of cases as described below.

NASA will only pay portions of civil servant salaries that are not normally fully covered as part of agency budgets. NASA will cover salary (up to three months) for scientists whose compensation must be won through competitive proposals to their employing agency or other agencies. NASA salary support for scientists at other agencies is NOT intended to be provided "in lieu of" salary that would normally be paid by the employing agency. If the salary for other agency civil servants is requested as part of the proposal, the budget page must specifically outline the compensation approach that the agency uses to cover its civil servants and verify that any NASA salary support would not be replacing that normally paid by the employing agency.

Funds may be used for support of students (undergraduate or graduate) and/or postdoctoral researchers who are involved in the proposed research or for research expenses such as costs incurred in field experiments, purchase of equipment and/or supplies, computing, travel, etc. If research collaboration is a component of the

proposal, it is presumed that the collaborator(s) have their own means of research support; that is, an NIP award may not include expenses for personnel or activities at collaborating institutions, nor salary costs for senior personnel, consultants, or subcontractors.

2.4 Proposal Review and Evaluation

As stated in Section VI(a) of the *ROSES Summary of Solicitation*, proposals are ordinarily evaluated with respect to three criteria: intrinsic merit, relevance, and cost.

This program element includes an additional evaluation criterion focused on scientific leadership. Leadership will be evaluated based on the PI's contributions and services to the Earth system science community, as articulated in the leadership statement. Leadership can be demonstrated at an institutional, community, state, regional, national, or international level (with no preference given to a particular level).

Leadership statements should clearly discuss the past and current impact of activities; anticipated future impacts can also be addressed, though proposers should make clear that such impacts have not yet been realized. PIs should explain how leadership activities go beyond what would typically be expected in their current or previous appointment(s). Examples of Earth system science leadership activities could include, but are not limited to, cutting-edge, original, creative, and/or large-scale efforts concerning: education of undergraduate or graduate students, participation in public outreach, involvement in academic or policy-related committees or organizations, invited and/or public lectures, , scientific program committees, conference or workshop organization, professional society activities, special (e.g., international, interagency, intergovernmental, or private-public) partnerships, reviewing or editorship activities, or other actions, awards received, or endeavors that might demonstrate Earth system science leadership.

3. Summary of Key Information

Expected annual program budget for new awards	~ $3.0 M
Number of investigator awards pending adequate proposals of merit	~ 24
Maximum duration of awards	3 years
Due date for Notice of Intent to propose	See Tables 2 and 3 of this ROSES NRA
Due date for proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	6 months after proposal due date
Page limit for the central Science/Technical/Management section of proposal	15 pages, which includes the one-page leadership statement. See also Table 1 of ROSES and the *NASA Guidebook for Proposers*.
Relevance	This program is relevant to the Earth science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.

General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section IV and Table 1 of *the ROSES Summary of Solicitation* and Section 3 of the *NASA Guidebook for Proposers*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of proposal via the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES)	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or 202.479.9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or 800.518.4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-NIP
Point of contact concerning this program	Allison Leidner Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: 202.358.0855 Email: Allison.K.Leidner@nasa.gov

A.33 THE SCIENCE OF TERRA, AQUA, AND SUOMI NPP

NOTICE: Amended April 16, 2020. NASA intends to solicit proposals for this program element in ROSES-2020. The text and due dates will be published in the fall of 2020 and proposals will be due no fewer than 90 days after release. Deleted text is struck through and new text is in bold.

~~NASA will not solicit research proposals under The Science of Terra, Aqua, and Suomi NPP program element in ROSES-2020. The next estimated release of the program element is ROSES-2021~~.

1. Scope of Program

NASA's Earth Science Research Program aims to utilize global measurements to understand the Earth system and interactions among its components as steps toward prediction of Earth system behavior. To achieve this goal, a combination of shorter-term process-oriented measurements is complemented by longer-term satellite measurements of certain environmental properties. A key requirement for the latter is the provision of well-calibrated, multi-year and multi-satellite data and product series.

The Earth Observing System (EOS) was intended to provide global observations needed to advance Earth System Science and to initiate a number of improved long-term global data sets. NASA has completed the development and implementation of the EOS satellites, and successfully operates a comprehensive EOS Data and Information System (EOSDIS) to acquire, process, archive, and distribute these observations and data products (https://earthdata.nasa.gov/about). Among the EOS satellites that were most critical in initiating new, high quality long-term Earth system data records were the Terra and Aqua satellites, launched in 1999 and 2002, respectively.

The Suomi National Polar-orbiting Partnership (Suomi NPP, formerly the NPOESS Preparatory Project) satellite was launched on October 28, 2011, to extend more than 30 high-quality time series data records initiated by earlier NASA satellites (most notably Terra and Aqua, but also Aura, launched in 2004). Its observations should allow scientists to extend a continuous record of satellite data of sufficient quality to detect and quantify global environmental changes. For example, Suomi NPP continues measurements of land surface vegetation, sea surface temperature, and atmospheric ozone that began more than 25 years ago with earlier satellites and which were enhanced with the new instrumentation aboard the EOS satellites. The NASA time series of global observations is continued for certain data records by the on-orbit Suomi NPP program sensors (https://www.jpss.noaa.gov/).

Suomi NPP serves as a bridge between NASA's Earth Observing System (EOS) of satellites and the next-generation Joint Polar Satellite System (JPSS), a National Oceanic and Atmospheric Administration (NOAA) program that collects data for both weather and climate. The first JPSS satellite, now known as NOAA-20, was launched on November 18, 2017 and declared fully operational on May 30, 2018. NASA is bridging the mission capabilities to continue a set of the Earth System Data Records begun with the EOS missions using the Suomi NPP mission data.

This program element of ROSES-2020 will follow on from the prior (ROSES-2017) program element of the same name. This will provide an opportunity for scientists to undertake studies responsive to the NASA Earth Science Research objectives (https://science.nasa.gov/earth-science) and to provide answers to NASA's Earth Science Research questions ((https://science.nasa.gov/earth-science/big-questions) through the use of data and derived products from Terra and Aqua and their measurement sensors, as well as the Suomi NPP satellite and its measurement sensors. It represents a continuation of the research aspects of the EOS and Suomi NPP Instrument Teams for these satellites and emphasizes opportunities for scientists to analyze and exploit EOS and Suomi NPP data. It also provides an opportunity to develop new products by combining multi-sensor and multi-platform data, or by developing innovative approaches to data retrievals. This program element offers investigators an opportunity to conduct integrative research using the data and products resulting from these satellites (Terra, Aqua, Suomi NPP). Additionally, this program element welcomes the opportunity to fuse multiple sensors and data streams, including Terra, Aqua, and Suomi NPP, to conduct interdisciplinary and multi-disciplinary Earth System Science. [This paragraph was added on April 16, 2020]

2. Point of Contact

Barry Lefer
Earth Science Division
Science Mission Directorate
NASA Headquarters
Washington, DC 20546-0001
Telephone: (202) 358-3857
Email: barry.lefer@nasa.gov

A.34 STUDIES WITH ICESAT-2

NOTICE: Amended June 2, 2020. This Amendment releases the final text for this program element. Notices of Intent are requested by September 30, 2020 and proposals are due October 30, 2020.

1. Overview

NASA solicits proposals for Earth science research using observations from the Ice, Cloud, and land Elevation Satellite-2 (ICESat-2), which was launched on September 15, 2018. The Advanced Topographic Laser Altimeter System (ATLAS) instrument on ICESat-2 is a photon-counting lidar with six beams and ICESat-2's near-polar orbit is optimized to enable characterization of elevation changes in Earth's polar ice. The mission also collects data globally, particularly to enable determination of vegetation height, but also to support research and applications in hydrology, oceanography, and atmospheric sciences.

This call for proposals is a successor to the ROSES 2019 "Studies with ICESat-2" opportunity and Principal Investigators (PI) of the proposals selected under this program have additional responsibilities as members of the ICESat-2 Science Team (I2ST). Section 4 lists the topics solicited.

2. Background

ICESat-2's single instrument, ATLAS, is a six-beam, photon-counting lidar operating at 10 kHz. ICESat-2 measures travel time of individual photons that are reflected off the Earth (atmosphere, surface, sub-surface), enabling retrieval of surface heights with a precision of a few centimeters. Each beam has a ground-footprint of ~15 meters in diameter, offset by 0.7 meters along-track. The six beams are organized into three pairs – a strong and a weak beam offset by 90 meters – separated from adjacent pairs by 3.3 kilometers. In addition to providing more observations than a single beam, the multibeam/pair configuration enables direct measurements of instantaneous cross-track surface slope, which is especially important for measuring seasonal and annual height changes of Greenland and Antarctica, as well as height changes of glaciers globally. With an orbital inclination of 92 degrees, ICESat-2 takes measurements up to a latitude of 88 degrees north and south. It has a 91-day repeat orbit for observations over the polar regions to enable seasonal measurements. Nearer the equator, off-pointing by the satellite is used to create a global map with tracks less than 4-km apart for global vegetation height assessments.

More information about ICESat-2 is available at: https://icesat-2.gsfc.nasa.gov/.

3. ICESat-2 Data Products and Cloud-based Resources

3.1 ICESat-2 Data Products

To facilitate research with ICESat-2, algorithms have been developed for routinely produced data products to support a range of users, from those requiring base telemetry through to modelers requiring gridded geophysical data.

More information is available at: https://icesat-2.gsfc.nasa.gov/science/data-products.

ICESat-2 data products are available from the NASA Distributed Active Archive Center (DAAC) at the National Snow and Ice Data Center (NSIDC) at: http://nsidc.org/data/icesat-2/.

3.2 Cloud-based Resources

ICESat-2's photon counting approach is a data-intensive observation technique that generates ~1 Terabyte (Tb) of data per day globally. While the individual data products are smaller, moving, processing and analyzing such volumes of data are challenging. Cloud-based computing may offer critical efficiencies to proposed investigations and should be considered.

NASA's Advanced Data Analytics Platform (ADAPT) (https://www.nccs.nasa.gov/services/adapt) will be made available to investigations selected under this element. ADAPT offers cloud storage and access to high-performance computing resources. To minimize data movement, ADAPT hosts all ICESat-2 data products, as well as related satellite and aircraft altimetry products, including data from the first ICESat (2003-2010) and Operation IceBridge (2009-2020). Proposers who would like to use ADAPT are encouraged to incorporate it in their proposed work plan.

4. Scope of Investigations

The scope for this call is to fund investigations that are complementary to, but not addressing the same specific science questions as, the proposals selected under the ROSES-2019 ICESat-2 opportunity. Under that announcement, 24 proposals were selected, covering the disciplines of cryospheric science, terrestrial ecology, atmospheric science, and ocean bathymetry. For a list of abstracts, see the PDF file of titles and abstracts of selected proposals that may be downloaded under the heading "selections" on the NSPIRES page for the 2019 "Studies with ICESat-2" call for proposals.

ICESat-2 data must be a central and criticial part of the proposed effort and a driver for the investigation; investigations should be studies that could not be carried out without ICESat-2. However, consideration of ICESat-2 data in the context of other satellite, airborne, and/or surface-based measurements is encouraged.

The specific topics solicitated for this opportunity are listed below. Proposals that do not address these research topics will be considered non-responsive. NASA makes no commitment to select proposals in each of these topics.

- Investigations in non-polar physical oceanography, especially topography and waves that utilize the global sea surface height product (https://nsidc.org/data/ATL12).
- Investigations of cloud processes that utilize the global clouds, cloud properties, and lidar backscatter product (https://nsidc.org/data/ATL09).
- Investigations of local-to-regional scale ice sheet and ice shelf processes that utilize the unique capabilities of ICESat-2 to improve our understanding and assessment of the ice sheet mass balance, including ice sheet hydrology and ice shelf-ocean-sea ice interaction.
- Investigations of sea ice and oceanic processes in the Southern Ocean.

- Long-term monitoring of annual changes and variability of sea ice, ice sheets, and Alaskan glaciers using Operation IceBridge as the link between ICESat and ICESat-2.
- Investigations of ice sheet seasonal variability and its drivers in the context of improving projections.

5. Science Team Membership

In addition to their proposed research activities, PIs selected under this program have additional responsibilities as members of the ICESat-2 Science Team (I2ST). The ICESat-2 team will:

- Accelerate ICESat-2 science through the use of Open Science approaches
- Report to NASA Headquarters on the impacts to ICESat-2 science resulting from any issues with mission operations
- Provide guidance to the ICESat-2 Project Office at the NASA Goddard Space Flight Center for mission planning, as requested

All proposers must describe anticipated I2ST contributions and their approach to Open Science (see Section 7). For investigations focused on research outside of polar ice, proposals should describe specific plans to represent the mission to non-polar ice scientific communities and may include these activities in the proposal budget.

6. Meetings

There are two 3-day I2ST meetings each year in changing locations within the United States. One meeting is generally on the East Coast and one on the West Coast, but because of the pandemic could also be held virtually. It is expected at least some portion of these team meetings will be open, and other members of the PI's team will be welcome to attend and participate. Proposers should include support in the proposal budget for the PI and critical team members to attend these meetings.

7. Open Science

This program element requires proposers to implement Open Science (OS) approaches consistent with the recommendations of the report *Open Science by Design: Realizing a Vision for 21st Century Research* from the *National Academies of Science, Engineering and Medicine* (https://www.nap.edu/catalog/25116/open-science-by-design-realizing-a-vision-for-21st-century). Some key recommendations from the report that are particularly relevant to research using ICESat-2 include but are not limited to:

- Developing proposals using Findable-Accessible-Interoperable-Reusable (FAIR) principles
- Conducting research using tools compatible with open sharing
- Preparing data and tools for reproducibility
- Documenting approaches in electronic research notebooks
- Depositing research output in FAIR archives

Progress is accelerated to the maximum extent possible by sharing advances during the conduct of investigations, not just at the publication stage. This sharing:

- Includes scientific results and analytic approaches to ICESat-2 observations;
- Occurs within and across disciplines; and

- Happens openly and frequently via team meetings, contributions to open repositories, and other communications with colleagues.

NASA recognizes that fully-implementing OS approaches will be challenging and entail additional cost. However, NASA sees great benefit to these approaches for accelerating ICESat-2 research, and proposers are required to include Open Science and the costs for implementing it in their work and budget plans, respectively.

7.1 Open Source Software

Awards made under this program element must follow NASA's Earth Science Data Systems (ESDS) Open Source Software Policy (https://earthdata.nasa.gov/earth-science-data-systems-program/policies/esds-open-source-policy).

7.2 Data Policies

Proposals developing significant datasets must include in the data management plan a clear description of the dataset development, including delivery to the NASA DAAC at the National Snow and Ice Data Center (https://nsidc.org/daac), in compliance with NASA data standards (https://earthdata.nasa.gov).

8. Summary of Key Information

Expected program budget for first year of new awards	~$1.5 M
Number of new awards pending adequate proposals of merit	7-10
Maximum duration of awards	3 years
Due date for Notice of Intent to propose	See Tables 2 and 3 of this ROSES NRA
Due date for proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	May 2021
Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of ROSES
Relevance	This program is relevant to the Earth Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*
General requirements for content of proposals	See A.1 Earth Science Research Overview and Section IV and Table 1 of *the ROSES Summary of Solicitation*
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ and Section IV(b) of *the ROSES Summary of Solicitation*
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.

Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-ICESAT2
Point of contact concerning this program	Thorsten Markus Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546 Telephone: (202) 358-3860 Email: thorsten.markus@nasa.gov

A.35 EARTH SCIENCE APPLICATIONS: WATER RESOURCES

NOTICE: NASA does not intend to offer this program element in ROSES this year. The next expected solicitation of this element would be in ROSES-2021

1. Overview

Within the NASA Earth Science Division, the Applied Sciences Program solicits proposals that develop and demonstrate the integration of NASA Earth science data and models into water resource management applications and decision support tools that can be sustained by operational partners or stakeholders. Remote sensing data, in combination with hydrologic models, can provide important information to assist water resource managers working with a wide range of partners and stakeholders. In order to make the best decisions possible and develop strategies that enhance the security and sustainability of water supplies, water resource managers and their stakeholders need timely information on water quality, supply, and demand.

The Water Resources application area primarily focuses on water issues related to drought, streamflow, flood forecasting, water demand and supply, and water quality. The Water Resources applications area includes the Western Water Applications Office (WWAO) that targets Western U.S. water issues. The Water Resources applications area website is available at http://appliedsciences.nasa.gov/programs/water-resources-program.

2. Point of Contact

Bradley D. Doorn
Applied Sciences Program
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A.36 SERVIR APPLIED SCIENCE TEAM

NOTICE: NASA does not intend to offer this program element in ROSES this year. SERVIR Applied Science Team (SERVIR AST) was last solicited in ROSES-2018. This program is tentatively scheduled to next solicit proposals in ROSES-2021.

1. Objectives

The Earth Science Division's (ESD) Applied Sciences Program (ASP) promotes efforts to discover and demonstrate innovative and practical applications of Earth observations. ASP activities partner with organizations from the public and private sectors to apply scientific findings and satellite data in their decision-making activities. The Program has three primary lines of business: Applications, Capacity Building, and Mission Planning. All Program activities support goals to deliver near-term uses of Earth observations, build capabilities to apply Earth science data, and contribute to satellite mission planning.

The Applied Sciences' Capacity Building Program (CBP) builds capacity around the globe in an effort to expand the Earth-observations user base and increase awareness within non-traditional audiences of NASA Earth observations data and products. CBP engages across the ASP Application Areas portfolios of Water Resources, Disasters, Ecological Forecasting, Health & Air Quality, and Agriculture & Food Security, as well as other application areas including Energy, Urban Development, and Transportation & Infrastructure. CBP supports three Elements, including Applied Remote Sensing Training (ARSET), DEVELOP, and SERVIR.

SERVIR, a joint initiative of NASA and the U.S. Agency for International Development (USAID), fosters applications of Earth observations to help developing countries assess environmental conditions to improve their planning and actions. This solicitation requests proposals for the SERVIR Applied Sciences Team (AST), which will improve the abilities of SERVIR regional hubs, national stakeholders, and users to apply Earth observations.

The primary purpose of this team is to provide geographic and thematic applied science expertise to regions supported by the SERVIR global network. Geographic regions include Eastern and Southern Africa, Hindu-Kush Himalaya, Lower Mekong, West Africa, and Amazonia. Thematic topic areas for this solicitation include Agriculture and Food Security, Water Resources and Hydroclimatic Disasters, Land Cover and Land Use Change and Ecosystems, Weather and Climate. Each AST member will co-develop application(s) with, and transfer them to, SERVIR regional hubs to strengthen capacity of hubs and their users to address users' decision-making needs. Team members will also communicate, coordinate, and share expertise with each other and SERVIR hubs across thematic and regional interests.

2. Point of Contact

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A.37 EARTH SCIENCE APPLICATIONS: DISASTER RISK REDUCTION AND RESILIENCE

NOTICE: NASA does not intend to offer this program element in ROSES this year. This program element was last solicited in ROSES-2018. This program is tentatively scheduled to next solicit proposals in ROSES-2021.

1. Overview

The NASA Earth Science Division (ESD), Applied Sciences Program solicits proposals for user-centric applications enabling prevention of new and reducing existing disaster risks, which can both inform decision-making and transform behavior. The projects are expected to pilot and demonstrate the advancement of mature science results through co-development of applications toward infusion into an operational partner's or stakeholder's maintained activity. Selected projects must use an earth system approach and risk assessment framework, where satellite and other Earth observations incorporate cultural, economic and political data and context to provide a unique perspective. Successful projects will inform and focus action within and across sectors and geographies by decision-makers at local, national, regional and global levels, especially for communities and areas at intense risk.

Disaster risk reduction and resilience applications will improve situational awareness related to natural and human-induced perils (including those associated with floods, landslides, tropical cyclones, earthquakes, volcanoes, and oil spills). Outcomes should align with and advance the targets set out in the Sendai Framework for Disaster Risk Reduction 2015-2030. Priority is given to applications for (i) Understanding disaster risk (including exposure and vulnerability); (ii) Strengthening disaster risk governance to manage disaster risk; (iii) Investing in disaster reduction for resilience and; (iv) Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation and reconstruction. Projects are encouraged to promote the access and use of open data, including near-real time data, and the exploitation of geospatial analytics, visualization aids and interpretive tools. The Disaster applications area website is available at https://disasters.nasa.gov and the GIS mapping portal is at https://maps.disasters.nasa.gov.

While NASA does not anticipate soliciting proposals for this element until 2021, the Disasters Program will consider proposals responding to significant Earth system events (Rapid Response and Novel Research in Earth Science – program element A.28). These rapid proposals must be of an urgent nature to take advantage of a target of opportunity due to an unforeseen event in the Earth system or must be exceptionally novel and innovative to advance Earth remote sensing outside the current slate of solicitations. Particular interest is in advancement of mature applications with strong user engagement, evaluating effective risk reduction, and resilience development before, during and/or after real-world events.

2. Point of Contact

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A.38 HEALTH AND AIR QUALITY APPLIED SCIENCES TEAM

NOTICE: Amended April 20, 2020. To allow the proposing community more time for connecting with health end-users and stakeholders overwhelmed with COVID-19 response at this time, this Amendment delays the proposal due date for this program element by a month. Proposals are now due June 30, 2020.

In addition to the 8-page Science/Technical/Management Section, proposals must include a "Societal Impact" of up to two pages, see Section 4.4. Proposers must use the Earth Science standard templates for the table of work effort and current and pending support (see Section 4.4).

1. Overview

The NASA Earth Science Division (ESD) Applied Sciences Program seeks proposals to form a Health and Air Quality Applied Sciences Team (HAQAST). This team will apply Earth observations to improve and develop decision-making activities and enable transition and adoption by public- and/or private-sector organization(s) for sustained use in decision making and services to end users in the areas of public health and air quality.

This team will focus on specific applications and demonstrations required to advance the health and air quality management communities' uses of Earth science observations and models in decision making. An emphasis of the team is on responsiveness to managerial and end user needs, as well as pursuit of multiple applications of varied durations. Awardees will receive baseline funding to be a team member; a separate amount, representing a significant portion of funds overall, will be allocated to team members for "tiger team" projects during the course of the HAQAST. Submissions to this solicitation shall not propose any "tiger team" activities.

2. Scope of Program

2.1 Applied Sciences Program Objectives

The ESD Applied Sciences Program promotes efforts to discover and demonstrate innovative and practical uses of Earth observations. The Program funds applied science research and applications projects to enable near-term uses of Earth observations, formulate new applications, integrate Earth observations and related products in practitioners' decision-making and transition the applications. The projects are carried out in partnership with public- and private-sector organizations to achieve sustained use and sustained benefits from the Earth observations[1]. For more information visit the Applied Sciences Program website at http://AppliedSciences.NASA.gov/.

The Program supports projects that develop and demonstrate improvements to decision-making from the use of an array of Earth observations and related products. The Program considers that Earth observations broadly include a range of products and

[1] Examples include companies, humanitarian organizations, regional associations, international organizations, government agencies, multinational financial institutions, philanthropic institutions, tribal organizations, and not-for-profit organizations.

capabilities, including Earth-observing satellite measurements (NASA in-orbit and planned satellites, as well as foreign, commercial, and other U.S. Government satellites), outputs and predictive capabilities from Earth science models, algorithms, visualizations, knowledge about the Earth system, and other geospatial products. Hereinafter, this set is referred to collectively as "Earth observations".

The Applied Sciences Program has three primary lines of business: Applications, Capacity Building, and Satellite Mission Planning. The Applications themes are currently focused on five of the eight Societal Benefit Areas (SBA) of the international Group on Earth Observations (GEO): Health (including Air Quality), Disasters, Ecological Forecasting, Food Security and Sustainable Agriculture, and Water Resources.[2] The Program includes the influences, risks, and impacts of a changing climate within each of these themes.

2.2 Health and Air Quality Applications Area

The Health and Air Quality application area is managing this program element. This application area supports the use of Earth observations in air quality management and public health, particularly regarding infectious disease and environmental health issues. The area addresses issues of toxic and pathogenic exposure and health-related hazards and their effects for risk characterization and mitigation. The area promotes uses of Earth observing data and models regarding implementation of air quality standards, policy, and regulations for economic and human welfare. The Health and Air Quality Applications area also addresses risks and effects of climate change on public health and air quality to support managers and policy makers in their planning and preparations.

The Health and Air Quality applications area website is available at https://appliedsciences.nasa.gov/programs/health-air-quality-program.

3. Purpose and Scope of Solicitation

The objective of this solicitation is to select a Health and Air Quality Applied Sciences Team (HAQAST). The Health and Air Quality area supports the formation of this team to execute projects on specific applied topics and demonstrations required to advance the health and air quality management communities' sustained use and application of Earth science observations and models in decision making.

This solicitation is a re-compete of the Health and Air Quality Applied Sciences Team (HAQAST) competed in ROSES-2015. HAQAST will continue to address topics at the intersection of the health and air quality communities, but will also address issues unique to each community.

3.1 Team Purpose

The HAQAST will be expected to connect Earth observations and related products with health and air quality management issues, challenges, and decision-making through
1) active partnerships with health and air quality managers with deliverables/outcomes;
2) self-organization of team members to respond quickly to end user needs; and

[2] The eight GEO SBAs are: Agriculture, Ecosystems/Biodiversity, Disasters, Energy/Minerals, Health, Infrastructure/Transportation, Urban Development, and Water Resources.

3) flexibility in how the team allocates resources. Overall, the team will use multiple satellite observations, especially multisensor fusion products, to better connect research knowledge and results with health and air quality activities of Government agencies, businesses, and other organizations.

Objectives of the HAQAST team include:

- Broaden and deepen the awareness, familiarity, and use of Earth observations by the health and air quality communities;
- Deliver applications and test proofs-of-concept for possible applications;
- Deliver prototypes, activities, demonstrations, etc. that support and complete the transition of applications to operational and end-user organizations;
- Provide technical feedback on Earth observations (especially NASA products) from applications-oriented perspectives and end users in health and air quality communities;
- Identify and/or develop new data products with strong applications and applied research potential;
- Integrate expertise on natural sciences, engineering, data systems, social sciences, and human factors to enable applications to organizational decision making;
- Showcase innovative uses of Earth observations to improve decision-making and environmental health outcomes; and
- Articulate specific applied needs and actual or possible societal benefits stemming from research and applications.

3.2 Team Scope and Composition

This team will focus on specific applied topics required to advance the health and air quality management communities' use and application of Earth observations decision making. The HAQAST team will conduct new, focused applied science activities on emerging and urgent needs in the health and air quality communities.

The team-generated applications can use all relevant NASA satellite mission observations and can include data products from non-NASA satellites, including foreign satellites. The team will coordinate with other competitively-selected projects within the Health and Air Quality area's portfolio. The team will likely interact with appropriate mission science teams and with the ESD Research and Analysis Program's science focus areas, such as the Tropospheric Composition science focus area.

The collective composition of the HAQAST team is expected to include Earth science researchers, modelers, and applications specialists as well as representative experts of the environmental health and air quality communities, such as epidemiologists, statisticians, social scientists, public health officers, atmospheric modelers, air quality forecasters, and air quality policy and regulatory managers. The team will be led by a single Team Leader (see Section 4.3).

Members are expected to have a high level of scientific and technical capability in an applicable area and/or have significant expertise on environmental health and/or air quality management and policy topics. Suggested areas and topics include:

- Regional atmospheric chemical and transport modeling capability as applied to environmental health and air quality issues, including air quality forecasting;
- Emissions and emissions inventory evaluation and improvement;
- Technical aspects of national and international environmental health and air quality policy, including long range transport, air quality management approaches in the U.S. and other countries; evolving policy needs arising from interactions among air pollution, health, and climate change; and the national and international organizations that address these issues;
- Assessment of the information content of satellite observations by comparisons with data from other satellite sensors, calibration/validation activities, and well-calibrated existing ground-based sensors;
- Environmental health and air quality trends, regulatory compliance, policy analysis, policy efficacy, and accountability;
- Issues of toxic exposure and health-related hazards and their effects for risk characterization and mitigation;
- Urban heat islands and their impact on air quality and health;
- Epidemiology;
- Other environmental health issues, policies, and impacts (e.g., particulate matter, ozone, wildfires, controlled burns, etc.).

Note: Although the overall Health and Air Quality applications area portfolio includes projects on vector-borne and infectious diseases, as well as on water quality, the HAQAST is not expected to address these topics.

3.3 Team Structure

The structure of the HAQAST will be composed of team members and "tiger teams," which are made up of groups of team members. The tiger teams will conduct ad hoc projects of mixed duration and size to address the priority needs identified through HAQAST engagement with end users. The intent is to provide for agile, rapid, short-term action on emerging needs. These tiger team projects provide flexibility for coordinated efforts to advance systematic, sustained use of Earth observations in the health and air quality communities.

The members of the team will be funded at a baseline level, with additional, supplemental funds available for the tiger team activities (see Section 4.2). Tiger team proposals will be reviewed by members of the health and air quality communities and other subject matter experts. A slate of tiger teams will be periodically recommended by the Team Leader to the Health and Air Quality area Program Manager. The Program Manager will review these inputs and then present his recommendations to the ESD Steering Committee. Team members, especially through the tiger teams, will work in collaboration with end users and managers from the health and/or air quality communities. Please note that submissions to this solicitation shall not propose any "tiger team" activities.

4. Programmatic Information

This Section provides information about the expectations of team members (4.1), budget and eligibility (4.2), team leadership (4.3), content to include in a proposal (4.4), as well as other suggestions (4.5).

4.1 HAQAST Team Members

The HAQAST team is expected to consist of 12 to 15 members whose expertise collectively spans aspects addressed in Section 3.2. The Principal Investigator (PI) of each selected project will serve as sole official member of HAQAST; however, the PI is welcome to include other individuals, e.g., Co-Investigators (Co-Is), collaborators, graduate students, postdoctoral students in the proposal to support the PI's roles, duties, and contributions to the HAQAST. Team membership is for a period of four (4) years.

Team members will be expected to:

- Work with managers in the health and air quality communities to assess priority needs and issues;
- Translate and interpret research knowledge to managers and end users to assist in applications and developing solutions to current and future challenges;
- Maintain knowledge of research progress by the Earth science community related to the team's activities;
- Maintain knowledge on emerging and continuing management and policy issues in health and air quality for possible opportunities for applied research and applications;
- Provide information to NASA on a variety of technical matters associated with health and air quality measurements, instruments, algorithms, data products, etc.; and
- Participate in technical interchange meetings, Health and Air Quality Applied Sciences Team meetings (planned semiannually), relevant science team meetings, and more frequent teleconference calls (proposers should budget for ~four domestic trips per year for meetings);

It is expected that the participation at all HAQAST team meetings and NASA-supported reviews will be by the team member or a named Co-Investigator.

4.2 Budget and Eligibility

Awardees will receive annual baseline funding for their membership on the team; this baseline funding enables the core activities of the team membership. NASA will provide additional, supplemental funds for the "tiger teams." The distribution of tiger team funds is decided postaward. The allocation is based on the nature of the needs, tiger team project focus, required expertise from within the team, and other relevant factors. Individual team members will not necessarily receive equal allocations of the supplemental funds.

The expected annual program baseline budget for awards is approximately $2 million per year. Proposers are strongly encouraged to keep the total cost per investigation to

approximately $100,000 - $125,000 per year, depending on the complexity of the proposed effort.[3]

Cost sharing is allowed and encouraged; however, cost sharing is not part of the evaluation criteria. Cost sharing may become a factor at the time of selection when deciding between proposals of otherwise equal overall merit.

The Team will be self-organizing under the direction of the HAQAST Team Leader (see Section 4.3). The Team will create a prioritized list of additional activities to address needs within the health and air quality community that the Team is qualified to address through the tiger teams. Periodically, an expert review of tiger team proposals will occur, followed by a recommendation of a slate of teams and topics by the Team Leader, and a review of these inputs by the Health and Air Quality area Program Manager. The Program Manager will then present his recommendations for tiger team topics to the ESD Steering Committee.

Additionally, the ESD Steering Committee will review the members of each tiger team and the associated budget per team member. After these actions, the tiger team activities will access additional funding per tiger team per member. It is expected that approximately $1.5 million will be available for these tiger teams in FY 2021; however, these potential funds must not be reflected or addressed in the proposal.

All interested people and organizational sectors are eligible to apply, including academia, private, Government, and nonprofit sectors. Representatives of foreign entities are eligible to propose members on a no exchange of funds basis.

Representatives from commercial organizations are eligible and should refer to terms in Sections III(a) and III(d) of the ROSES *Summary of Solicitation*.

Representatives from interested Federal Government agencies are expected to have labor costs (including indirects) covered by their respective agencies.

4.3 HAQAST Team Leadership

The HAQAST team will be led by a Team Leader, who will be selected by NASA from awarded proposers. The Team Leader will organize the Team, track progress by team members and tiger teams, plan and organize and lead the Team meetings, coordinate development of annual Team work plans (coordinated with the Health and Air Quality area program leadership), and report on achievements of the Team's work, including a public-facing website and other outreach activities. The Team Leader will perform in close association with the NASA Health and Air Quality area program leadership and relevant R&A program scientists.

Proposers may request consideration for selection as the Team Leader, who will receive additional funds for this leadership role. Interested proposers should articulate

[3] This includes salaries, overhead and indirect costs, despite the fact that these costs are to be redacted in the proposal. (For more information on this, see Section I c of the *ROSES Summary of Solicitation* and the SARA website at https://science.nasa.gov/researchers/sara/how-to-guide/nspires-CSlabor/). Thus, all Co-Investigators, including civil servants, must share their total costs, including salaries, overhead and indirects, with the submitting organization.

their qualifications to be Team Leader and their approach to managing the team. Proposals requesting consideration as team lead are allowed one extra page to cover these items. The team leader will receive approximately $225,000 - $250,000 per year (baseline plus leadership funds). Proposals requesting consideration as team lead should budget for $225,000 - $250,000, understanding that if selected as a member of HAQAST, but not team lead, this budget will have to be re-negotiated.

4.4 Mandatory Proposal Information

Because of the novel nature of this Applied Sciences team, care should be taken to document the PI's qualifications for membership and additional expertise of his/her proposed group. Investigators will have two main roles on the Team: 1) to pursue baseline activities facilitated through core funding and, 2) to participate in tiger team activities appropriate to their background and expertise.

The proposer should provide evidence of expertise and knowledge in areas highly relevant to the primary scientific goals and related applications activities of the Team. The types of expertise and knowledge desired were listed in Section 3.2; however, appropriate expertise is not limited to the examples given there. All proposers must explain the knowledge and skills they have to offer and why they are important for HAQAST activities. Proposals should include a section on which aspects of HAQAST the investigator would be able to help develop and why (i.e., what activities the investigator would pursue with baseline funding). Proposers should articulate their experience with and skill in engaging end-users and managers to identify and successfully address needs. Proposers should include information illustrating their experience, skill, and success with working in team settings.

Proposals should contain a list of references to scientific or technical papers the investigator has published and/or positions held and work conducted that establish her/him as a leader in their area(s) of expertise.

Proposals must also include an additional two-page section titled "Societal Impact", which will be used to clearly identify how the proposed work will complement and improve decision-making activities in the health and air quality communities. The societal impact of the proposed work and planned approaches to qualify or quantify the work's impacts on decision-making should be illustrated. This section must directly follow the 8-page Science/Technical/Management section of the proposal.

Proposal budgets must allow for a minimum of two HAQAST meetings per year, travel to approximately two conferences or symposia per year, particularly ones organized by community end users, and any proposed additional travel to meet with end users and managers to address applications and project progress.

Proposers must use the Work Effort and Current and Pending Support templates available on the SARA webpage at https://science.nasa.gov/researchers/templates-for-earth-science-division-appendix-a-roses-proposals.

4.5 Other Suggestions and Considerations

Within the HAQAST and the tiger team projects, NASA will strongly encourage the use of visualizations and visualization techniques to illustrate alternative scenarios and support decision-making activities, so proposers may wish to highlight their ideas and

experience with these items. NASA strongly encourages the use of Earth system science models and coupled models (e.g., physical-biological-ecological models) in team activities. Additionally, NASA will encourage the team to consider and use products from recently launched NASA missions, as well as commercial sources, if they meet project requirements.

The public health and air quality communities have developed networks and websites to share information. Proposers are encouraged to utilize these resources to gather information, make contacts to community representatives, understand key needs and issues, understand existing decision support tools, etc. Examples include:

- CDC Environmental Public Health Tracking Network, http://www.cdc.gov/nceh/tracking/;
- American Public Health Association, http://www.apha.org/;
- American Thoracic Society, http://www.thoracic.org/;
- Air and Waste Management Association, http://www.awma.org/;
- Central States Air Resource Agencies, http://www.censara.org/;
- California Air Resources Board, http://www.arb.ca.gov/homepage.htm;
- Western States Air Resources Council, http://www.westar.org/;
- World Health Organization, http://www.who.int/en/;
- Grand Challenges in Global Health, http://www.grandchallenges.org/;
- Pan American Health Organization, http://www.paho.org/;
- EPA AirNow, http://airnow.gov/.

In addition, the remote sensing and Earth science communities have developed numerous resources to support the application of Earth observations to health and air quality issues. Proposals are encouraged to utilize these resources, as appropriate. Examples include:

- Group on Earth Observations (GEO) Health Community of Practice, http://geohealthcop.org;
- American Meteorological Society (AMS) Board on Environment and Health, http://www2.ametsoc.org/stac/index.cfm/boards/board-on-environment-and-health/;
- Interagency Cross Cutting Group on Climate Change and Human Health (part of the US Global Climate Research Program (USGCRP)), https://www.globalchange.gov/about/iwgs/cchhg;
- NASA Health and Air Quality Applied Sciences Team, http://haqast.org;
- CDC WONDER, http://wonder.cdc.gov/.

5. Proposal Format and Evaluation

All proposals submitted to ROSES must strictly conform to the formatting rules in Section IV of the ROSES *Summary of Solicitation* and the *NASA Guidebook for Proposers*. Proposals that violate those rules may be rejected without review.

Proposals will be evaluated by a peer-review panel for relevance, intrinsic merit, and cost, as defined in Appendix D of the *NASA Guidebook for Proposers* and consistent with Section VI(a) of the ROSES *Summary of Solicitation*, with the following additions.

The evaluation of relevance of a proposal will be not to NASA or Earth Science generally, but specifically to this program element, e.g., as described in Sections 2 and 3. Moreover, the evaluation of Relevance includes the following factors:

- Demonstration of the applicability of Earth observations (and related products) to address a topic of importance to the Applied Sciences program;
- Utility of Earth observations for potentially substantive improvements to health and air quality challenges and decision-making activities;
- Suitability of proposed work to a team setting;
- Extent to which proposed project involves work with and support of air quality and environmental health policy and regulatory managers and end users to deliver solutions enabled by Earth observations; and,
- Potential societal (as opposed to technical) impact of the project.

In addition to the factors given in the NASA *Guidebook for Proposers*, the evaluation criterion "Intrinsic Merit" includes:

- Ability to develop, test, demonstrate, and achieve results in a team setting;
- Ability to apply Earth observations and related products;
- Ability to characterize decision-making activities and needs for improvement;
- Ability of teaming across appropriate sectors and areas of expertise with appropriate end user organization(s); and,
- Feasibility of the proposed approach to manage the project and achieve stated objectives

In addition to the factors given in the *NASA Guidebook for Proposers*, the evaluation of Cost includes:

- Appropriateness of the level of effort to manage the project and achieve stated objectives; and,
- Cost effectiveness of the proposed approach to meet identified needs.

6. Award Reporting Requirements

Each awarded project will be responsible for periodic maintenance of team activities, status updates, highlights, and milestone achievements. NASA will coordinate with each principal investigator at award to provide the necessary information for the online reporting system.

The following reports in Sections 6.1 and 6.2 will be required of awardees. In cases where teams of organizations or subcontractors exist, consolidated project reports, including financial records, must be submitted by and are the responsibility of the Principal Investigator. The proposed budget should provide for these reporting requirements.

6.1 Tiger Team Reports

A one-page tiger team "quad chart" (format provided after award) with Purpose and Objectives, Approach, a Figure, and Key Milestones will be required at the beginning and end of each tiger team. Additional charts may be requested to summarize progress. Progress is also verbally reported at Health and Air Quality Applied Sciences Team meetings.

6.2 Annual and Final Reports

Annual reports should thoroughly discuss milestones and achievements met in the past year and look forward to project plans and milestones for the coming year, including "tiger team" activities. Annuals should also address any risks to schedule and intended milestones and include information on financial status.

A Final Project Report is required prior to the conclusion of the project. The Final Report should describe how the grant activities met the solicitation requirements and demonstrated an impact on decision-making activities using Earth observations. The report should describe all the tiger team and core activities undertaken by the Principal Investigator over the course of the grant. The report should also include lessons learned and recommendations. The Program may request a presentation of the project report, results, and findings.

NASA, ESD, and the Applied Sciences Program may periodically request information to support outreach efforts, website content, etc. PIs are expected to publish results from their work in peer-reviewed/refereed, trade, and popular literature.

7. Summary of Key Information

Expected program budget for first year of new awards	~ $2M; ~$100-$125K per award per annum ($225-$250K for team lead award per annum)
Number of new awards pending adequate proposals of merit	~12-15
Award duration	4 years
Notices of Intent are requested by	See Tables 2 and 3 of this ROSES NRA.
Due date for Proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	October 1, 2020
Page limit for the central Science-Technical-Management section of proposal	8 pages and an additional 2 pages for "Societal Impact" Statement (see Section 4.4). One additional page allowed for proposals requesting consideration as team lead.
Relevance	This program is relevant to the Earth science strategic questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section IV and Table 1 of *the ROSES Summary of Solicitation* and Section 3 of the *NASA Guidebook for Proposers*.

Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-HAQAST
Point of contact concerning this program	John Haynes Applied Sciences Program Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-4665 Email: jhaynes@nasa.gov

A.39 EARTH SCIENCE APPLICATIONS: ECOLOGICAL FORECASTING

NOTICE: This program element has a number of requirements and /or restrictions that are not standard for ROSES, including: a required cost share (see subsection 3.3) with schedule, a mandatory use of templates for the Table of Work Effort and reporting Current and Pending Support (see subsection 4.2.9), and the page limit for the Science/Technical Section is limited to 11 pages (see subsection 4.2). See Section 6 for a checklist of requirements.

1. Scope of Program

1.1 Overview

Ecological Forecasting is an applications area in the NASA Earth Science Division's Applied Sciences Program. This program element seeks proposals for Applications Projects that develop and demonstrate applications of Earth observations for the conservation of nature. In particular, this program element focuses on two approaches to nature conservation: 1) measuring and monitoring protected area outcomes and 2) promoting sustainable rewilding for ecosystem restoration. Details are below on the types of proposals sought to address these two approaches.

The goal of Applications Projects in the Applied Sciences Program is to transition applications developed by the funded projects to public or private partner organizations (i.e., end users) for their sustained use in decision-making and the provision of services.

Please Note: This solicitation has numerous required components detailed in the text below that must be addressed for full consideration. Please ensure you have reviewed and addressed all requirements before submitting (checklist provided for your convenience in Section 6).

1.2 NASA Applied Sciences Program

The Applied Sciences Program promotes the discovery and implementation of innovative and practical uses of Earth observations (defined in subsection 3.1 below) for decision-making. This Program funds projects to: enable near-term use of Earth observations, formulate new applications from Earth observations, integrate Earth observations and related products into practitioners' decision-making, and—in all cases—transition Earth observation-based applications for sustained use by end-user partner organizations. Applications Projects are carried out in partnership with public and private organizations (e.g., government agencies, private companies, regional associations, international organizations, multinational financial institutions, tribal organizations, and not-for-profit organizations). The goal is for these partner end users to achieve sustained use of and benefits from the Earth observations. For more information, visit the Applied Sciences Program website at http://appliedsciences.nasa.gov.

The Applied Sciences Program has three primary lines of business: Applications, Capacity Building, and Satellite Mission Planning. Applications focuses on developing projects in four of the eight societal benefit areas (SBAs) of the international Group on Earth Observations (GEO): Disasters, Ecological Forecasting, Health and Air Quality,

and Water Resources.[1] The Capacity Building line of business focuses on foreign and domestic activities to build skills for the use of Earth observations, including in international and economic development. Satellite Mission Planning promotes the identification and development of applications early in the life cycle of future satellite missions. In addition, the Applied Sciences Program oversees three consortia bringing together NASA and partners to address: the availability of water in the western U.S., global food security, and the valuation of societal benefits from Earth observations.

1.3 Scope of Ecological Forecasting Applications Area

The Ecological Forecasting Applications Area is the source of this program element. It aligns closely with the Biodiversity and Ecosystem Sustainability GEO SBA. The Ecological Forecasting Applications Area promotes the synergistic use of Earth observations, *in situ* observations, and models to analyze and forecast changes that affect ecosystems and to develop effective management strategies. Primary end-user communities are natural resource managers (both land and marine) and, in particular, those involved in conservation and ecosystem management. The Applications Area operates through the development, improvement, and application of predictive tools—with associated uncertainties—for assessing alternative approaches and designing effective decision support strategies. It applies current scientific understanding and modeling capabilities to determine how ecosystems and their components (e.g., species and genes) are changing and likely to change over time. More information on this Applications Area, as well as the related but separate Biological Diversity Program (a stand-alone research activity in the NASA Earth Science Division), is at https://cce.nasa.gov/biodiversity/index.html.

2. Scope of Program Element

This program element seeks two types of proposals. The first type asks proposers to combine three components: Earth observations (see subsection 3.1 for a description), *in situ* biological observations (see subsection 3.2 for examples), and ecological models to develop decision-support tools for measuring and monitoring protected area outcomes (subsection 2.1).

The second type of proposal should also combine the same three components: Earth observations (see subsection 3.1 for a description), *in-situ* biological observations (see subsection 3.2 for examples), and ecological models to develop decision-support tools to measure and monitor the impacts of rewilding for ecosystem restoration by measuring the ecological progress and the socioeconomic costs and benefits of rewilding efforts (subsection 2.2).

2.1 Protected Area Outcomes

Protected areas (e.g., national parks, wilderness areas, community conserved areas, nature reserves, etc.) have long been a (perhaps the) primary tool for conservation of terrestrial, freshwater, and marine ecosystems. Given their demonstrated value to

[1] The eight GEO SBAs are: Biodiversity and Ecosystem Sustainability, Disaster Risk Reduction, Energy and Mineral Resource Management, Food Security and Sustainable Agriculture, Public Health Surveillance, Sustainable Urban Development, Infrastructure and Transportation Management, and Water Resources Management.

conservation of natural systems, recent international initiatives have set numerical targets for certain percentages of the Earth's land and water areas to be managed as protected areas. The Convention on Biological Diversity's Aichi Target 11 calls for the conservation by 2020 of at least 17 percent of terrestrial and inland water areas and 10 percent of coastal and marine areas through protected areas and other effective area-based conservation measures. Likewise, Target 14.5 of the United Nations Sustainable Development Goals (SDGs) seeks to conserve at least 10 percent of coastal and marine areas by 2020, based on the best available scientific information. SDG Indicator 15.1.2 mandates that the proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas should itself be a key metric for countries to use in assessing success in meeting the SDG 15 goal for conservation of land and freshwater ecosystems. Furthermore, the United Nations cites as progress in meeting its goals the substantial increases since the year 2000 in the areas of terrestrial, freshwater, and marine ecosystems under protection. Recent conservation initiatives seek to protect 30 percent of the Earth's land and water areas by 2030, rising to 50 percent by 2050. By most accounts, there continues to be a need for additional protected areas to conserve nature and the ecosystem services it provides.

With recent increases in protected area number and extent, managers, political leaders, and the broader public want to understand the conservation outcomes resulting from these protected areas. More specifically, they seek to understand: 1) how well the global network of protected areas represents the full range of the planet's biodiversity in terms of its genes, species, and ecosystems (i.e., coverage); 2) how effective the world's protected areas are at conserving the wild nature they are supposed to protect (i.e., effectiveness); and 3) what are the connections between and among protected areas as an aid to movement by organisms in response to both changing climate and evolving patterns of human use of nature (i.e., connectivity).

This topic seeks proposals that will develop and enhance Earth observations-based tools to allow natural resource managers, decision makers, and/or the general public to measure and monitor protected area outcomes. The overarching focus for this topic is conserving existing wild nature. Proposals must specifically address one or more of the three outcomes-oriented questions below.

1) How representative are protected areas in terms of the biodiversity (genes, species, and ecosystems) they are meant to protect, i.e., how well are protected areas covering the life on Earth—at multiple levels of organization—that they need to protect?
2) How effective are protected areas at conserving the natural systems (again, across genes, species, and ecosystems) they are set up to conserve, i.e., are protected areas working in terms of conserving nature?
3) How connected are protected areas across the surface of the Earth, e.g., will they allow for the movement of organisms, believed necessary for survival on a changing planet?

2.2 <u>Impacts of Rewilding for Ecosystem Restoration</u>

On March 1, 2019, the United Nations General Assembly declared the years 2021 to 2030 to be the UN Decade on Ecosystem Restoration. Its stated aim is "to massively

scale up the restoration of degraded and destroyed ecosystems as a proven measure to fight the climate crisis and enhance food security, water supply and biodiversity." For almost thirty years, ecologists, conservation biologists, and paleontologists have been developing the concept of rewilding, an approach largely based on protection of core wild areas, connection of these core areas through habitat corridors, and reintroduction of lost species. Rewilding is becoming a major approach for restoring the ecological integrity of landscapes and seascapes impaired or destroyed by human action. A primary goal of rewilding is to bring back natural ecological processes (e.g., reestablishing trophic webs, promoting preexisting patterns of elemental and water cycling, allowing natural disturbance regimes, and reviving the dispersal of organisms) to lands and waters in which they are no longer operating. Rewilding is complex in that it involves not only ecological factors but also sociological ones. For example, it is not sustainable without ensuring societal acceptability, typically through the return of certain benefits to society.

This topic seeks proposals that will design and implement Earth observations-based methods to enable managers, decision makers, and/or the general public to promote sustainable rewilding for ecosystem restoration by measuring the progress and impacts of rewilding efforts. The overarching focus for this topic is restoring the ecological integrity of features of wild nature resulting in healthier ecosystems with more fully functioning processes appropriate to the system in question. Proposals must specifically address one or both of the themes below.

1) Developing methods allowing managers, decision makers, and/or the general public to understand, measure, and monitor the ecological progress of rewilding projects by tracking: a) changes in trophic complexity, b) patterns of disturbance, and/or c) the dispersal of organisms resulting from these projects (this theme focuses on the ecological impacts of particular rewilding activities)
2) Developing methods allowing managers, decision makers, and/or the general public to determine, attribute, and monitor the costs and benefits to society arising from rewilding projects (this theme focuses on the social and economic costs and benefits to defined groups of people arising from particular rewilding activities)

3. <u>General Conditions for All Proposals</u>

Proposals, regardless of topic, must include the following elements.

- Earth observations, as defined in subsection 3.1
- *In situ* biological observations, examples in subsection 3.2
- Ecological models to provide ecological forecasts of use to the end-user organization(s)—with associated uncertainties noted and explained

Proposals must clearly identify:

- the decision-making activity(-ies) addressed,
- the need for the remote sensing-based application (tool, product, etc.) to be developed,
- the end users for the application (tool, product, etc.) developed, and
- detailed plans for the transition of the developed application (tool, product, etc.) to the end-user community within the term of the award.

A proposal must only address a topic described in either subsection 2.1 or subsection 2.2, i.e., a single proposal should not attempt to address topics from both of these subsections. However, an investigator may submit more than one proposal.

Proposals may focus on protected areas or rewilding in terrestrial, freshwater, marine, or airborne ecosystems or some combination of terrestrial, freshwater, marine, and airborne ecosystems.

This program element seeks proposals for projects of up to four years in duration.

While this program element allows projects at any level: multinational, national, regional, tribal, U.S. state, and substate (e.g., county, local), proposals operating at U.S. state and substate levels must include elements to enable and deliver impact beyond that specific, limited geography so that project results accrue more broadly.

Proposal teams wishing to work internationally must involve an established public or private organization with an international mandate (e.g., a U.S. Government organization with a foreign relations mandate and appropriation, a nongovernmental organization, international financial institution, or philanthropic foundation). Proposals involving international participants should also follow the guidance in Appendix A of the NASA *Guidebook for Proposers* on "Proposals Involving Non-U.S. Organizations."

The Applied Sciences Program allows and strongly encourages private sector companies (and teams of companies) to submit proposals and/or be involved in project teams.

Proposers are also invited to explore avenues for supporting activities of the Group on Earth Observations Biodiversity Observation Network or GEO BON (http://geobon.org) and its components.

This program element welcomes proposals from tribes or other organizations of Indigenous Peoples.

In addition, this program element welcomes the use of crowdsourcing activities whether the crowd consists of citizen scientists or a group(s) of professionals involved in the activity of concern to management (e.g., crowdsourcing of fishery observations by fishers).

Proposals must meet the funding and time limits of this program element. Proposals with budgets or schedules that exceed the guidance below (see Section 7 Summary of Key Information) may be deemed non-responsive and may not be submitted by NASA for peer review.

3.1 Earth Observations

For the purposes of this solicitation, "Earth observations" means: measurements (i.e., data and information products) from NASA on-orbit satellites (including the International Space Station); simulated measurements from planned NASA satellites; measurements from commercial, foreign, and other U.S. Government satellites; outputs and predictive capabilities from models associated with NASA products; NASA algorithms; NASA visualizations; and other NASA geospatial products, including airborne products. The use of non-NASA satellite products is welcome - although, as this is a NASA solicitation, proposals must include specific NASA satellite remote sensing products in the overall

mix of data products proposed. Satellite remote sensing data should be explicitly named within the proposal. The proposal will be evaluated as to how essential these data are to achieving the proposal's goals.

Observations from suborbital airborne sensors may be included in proposals responding to this solicitation. That said, the use of suborbital airborne sensors should be clearly justified, complementary to, and, ideally, generate products coincident with the data from the satellite and *in situ* observations forming the focus of this solicitation. Proposed suborbital airborne activities, for which NASA funding is sought, must fit within the funding limits of this solicitation and must also include a complete "includes-all-costs" cost estimate for these suborbital activities, including a full flight cost estimate (aircraft and instrument), data integration and analysis costs, etc. For proposed flights of NASA suborbital airborne platforms, a flight request should be submitted to the NASA Airborne Science Program at https://airbornescience.nasa.gov. NASA flight requests should result in that part of the "includes-all-costs" cost estimate focused on the use of the NASA suborbital airborne platform itself.

NASA has arrangements with certain commercial providers of satellite imagery allowing access to their commercial imagery by NASA-funded investigators. To learn more about this imagery and determine the possibility of tasking certain commercial satellites, please visit https://earthdata.nasa.gov/esds/small-satellite-data-buy-program.

3.2 *In situ* Biological Observations

Examples of *in situ* biological observations include—but are not limited to—survey and census results, tracks of animal movement or other behavioral data from Global Positioning System tags or other biologging and biotelemetry devices, camera trap imagery, information from acoustic sensors, various types of citizen science collections, and outputs from environmental DNA (eDNA). These observations may come from terrestrial, freshwater, marine, or airborne sources. The proposal will also be evaluated as to how essential these observations are to achieving the proposal's goals.

3.3 End-User Involvement in Projects

Commitment from end users is critical to the success of all Applications Projects. Specifically, this commitment is necessary for the transition and adoption of products for sustained use by end users.

An individual from the end-user organization implementing the application (tool, product, etc.) must be included as a team member in all proposals.

Proposal teams should consider having the Principal Investigator (PI) be someone who is very familiar with the needs of the end-user (i.e., decision-making) organization.

Funded proposals must involve end users and associated practitioners in the proposal planning stage and to the fullest extent possible, especially to describe the management challenge(s) and decision-making improvements necessary. Project teams must show a clear path for further developing the partnerships and opportunities for transfer throughout the course of the funded project (i.e., a transition plan). The end-user organizations that will ultimately adopt the application in their decision-making activities should demonstrate a strong interest and commitment in the proposal and they must be involved through the entirety of all funded projects. As the application matures and the

likelihood of success increases, the commitment of the end-user organization is expected to grow, including resource commitments, to incorporate and maintain the use of Earth observations in their decision-making activities. As such, NASA is establishing a tiered cost sharing requirement to accomplish this transition.

Proposers are required to include end-user/partner cost share in the budget, at the levels listed in Table 1 below. Proposers may propose to meet the cost share at a higher rate than listed in this chart. If the proposal is funded, the awardee must meet the cost share percentage that was proposed in the funded proposal. Proposal budgets that fail to include the required end-user cost share at these minimum percentages will not be peer reviewed.

Table 1: Cost Sharing Requirements

Project	Activity	NASA Share	End-User Share
Year 1	Prove out application potential and begin development	100%	0%
Year 2	Develop application	80%	20%
Year 3	Continue development	60%	40%
Year 4	Complete application and transition	40%	60%

Failure to meet the required end-user cost share during any budget year of the project:

- will require the awardee to return funds based on the approved cost share rate in proportion with the total (cost share and Federal funds) of that year's funding,
- will be part of the yearly review to determine if NASA will continue funding for the following year, and
- may result in enforcement actions, including termination, for failure to comply with the terms and conditions of the award.

Cost-sharing and end-user resource commitments for funded projects are required in years two through four of the project. While the solicitation accepts in-kind contributions during the course of the project as cost sharing, financial contributions are preferred. Relevant past work, prior results, or previous support and accomplishments can be described, but the Applied Sciences Program does not consider these as cost sharing or in-kind contributions for proposals to this program element.

Projects may be less than four years in duration. Whatever the proposed duration of the award, offerors must adhere to the cost sharing presented in Table 1, above, i.e., 0% in year 1, 20% in year 2, etc. Regardless of planned duration, proposals must demonstrate that the proposed goals put forward for projects are likely to be achieved in the proposed time frame.

2 CFR 200.306(b)(5) does not allow applying organizations to use funds, goods, or services provided through a Federal award to meet the cost share requirements for another Federal award. 2 CFR 200.38 defines a Federal award as the Federal financial

assistance or a cost-reimbursement contract that a non-Federal entity receives directly from a Federal agency or a pass-through entity.

However, if the applying organization enters into a partnership agreement with an end user that is a Federal agency and this agreement does not involve the transfer of any funds, goods, or services to the applying entity, then that agreement is not considered a Federal award. Therefore, the applying entity may use the Federal agency's in-kind support to meet the cost share requirements for this funding opportunity. 2 CFR 200.306 explains how to determine the monetary value of the support provided by the partner agency. Proposers should use the budget narrative section to explain that this support is provided under a partnership relationship and not through a Federal award.

Proposals must include Tables 2 and 3 below to document end-user/partner cost share. Failure to include these two tables will result in NASA's not submitting a proposal for peer review. These tables should appear in the Budget Justification section of the proposal.

Table 2: Required Cost Share Table – Financial Contribution

Please fill in the financial contribution of NASA and the End User to each year's funding. If a given line has no support from either the End User or NASA in a given year, please leave the cells blank. Proposers may propose to meet the cost share at a higher rate than listed in this chart. If the proposal is funded, the awardee must meet the cost share percentage that was proposed in the funded proposal. Proposal budgets that fail to include the required cost share at the minimum percentages in Table 1 will not be peer reviewed. Templates for these required cost share tables maybe downloaded from the "SARA" web page at https://science.nasa.gov/researchers/templates-for-earth-science-division-appendix-a-roses-proposals.

	Year 1		*Year 2*		*Year 3*		*Year 4*	
	NASA	End User	NASA	End User	NASA	End User	NASA	End User
Total	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Labor	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Facilities	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Equipment	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Travel	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Traineeship Support	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Materials and Supplies	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Publication Costs	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Consultant Services	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
ADP/Computer Services	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Subawards/Consortium/Contractual Costs	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Equipment or Facility Rental/User Fees	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Alterations and Renovations	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Table 3: Required Cost Share Table – Proportional Contribution

Please fill in the proportional contribution of NASA and the End User to each year's funding. If a given line has no support from either the End User or NASA in a given year, please leave the cells blank. Proposers may propose to meet the cost share at a higher rate than listed in this chart. If the proposal is funded, the awardee must meet the cost share percentage that was proposed in the funded proposal. Proposal budgets that fail to include the required cost share at the minimum percentages in Table 1 will not be peer reviewed. Templates for these required cost share tables maybe downloaded from the "SARA" web page at https://science.nasa.gov/researchers/templates-for-earth-science-division-appendix-a-roses-proposals.

	Year 1		*Year 2*		*Year 3*		*Year 4*	
	NASA	End User	NASA	End User	NASA	End User	NASA	End User
Total	**XX%**	**XX%**	**XX%**	**XX%**	**XX%**	**XX%**	**XX%**	**XX%**
Labor	XX%	XX%	XX%	XX%	XX%	XX%	XX%	XX%
Facilities	XX%	XX%	XX%	XX%	XX%	XX%	XX%	XX%
Equipment	XX%	XX%	XX%	XX%	XX%	XX%	XX%	XX%
Travel	XX%	XX%	XX%	XX%	XX%	XX%	XX%	XX%
Traineeship Support	XX%	XX%	XX%	XX%	XX%	XX%	XX%	XX%
Materials and Supplies	XX%	XX%	XX%	XX%	XX%	XX%	XX%	XX%
Publication Costs	XX%	XX%	XX%	XX%	XX%	XX%	XX%	XX%
Consultant Services	XX%	XX%	XX%	XX%	XX%	XX%	XX%	XX%
ADP/Computer Services	XX%	XX%	XX%	XX%	XX%	XX%	XX%	XX%
Subawards/Consortium/Contractual Costs	XX%	XX%	XX%	XX%	XX%	XX%	XX%	XX%
Equipment or Facility Rental/User Fees	XX%	XX%	XX%	XX%	XX%	XX%	XX%	XX%
Alterations and Renovations	XX%	XX%	XX%	XX%	XX%	XX%	XX%	XX%

The monetary value of in-kind contributions must be provided and certified as part of the annual and final reports. As part of the annual and final reports, awardees will verify that the cost share requirements have been met.

The final project year must include transition activities and an end-of-project event to announce results (outlined within transition plan).

At the conclusion of a funded project, the end-user organization(s) is responsible for the operational costs to run its decision support system using the Earth observations.[2] If additional activities are needed to assist in the sustained use of the Earth observations, NASA will support additional efforts with in-kind support, as possible. NASA will continue to provide appropriate Earth observations through the NASA data centers for use by the partner organization(s), as possible.

3.4 NASA Biological Diversity and Ecological Forecasting Team Meeting

Funded PIs are expected to attend the annual NASA Biological Diversity and Ecological Forecasting Team Meeting (generally held each spring in the Washington, DC area)

[2] The ongoing costs to incorporate and maintain the application of the Earth observations in the decision-making activities will likely be much less than the costs to develop, test, and transition the application.

during each year of their award. Thus, proposals should budget for all costs needed for transportation, lodging, and per diem to attend these meetings.

3.5 Other Considerations

All proposals must identify a specific management challenge requiring better ecological forecasting tools or products and also include direct and significant participation by an end-user organization(s) involved in the management and/or decision-making activity identified in the proposal. This organization(s) should be the end-user for any tools or products developed and deployed by projects funded through this program element.

The goal is for the end-user organization to host the Ecological Forecasting products or outputs developed through the life of the project. Proposals must also include a transition plan to deploy and test the tools or products developed.

Ecological Forecasting requires the integration of observations and modeling. This integration can improve predictive tools used in decision-making activities for assessing scenarios, analyzing options, and designing effective management strategies, among other things.

Any proposal that aims to conduct only fundamental Earth science research will be considered noncompliant. For fundamental research pursuits, the reader is referred to other Earth Science appendices in the ROSES solicitation.

This program element strongly encourages multiorganizational, multidisciplinary, and multisectoral teams. Proposals are strongly encouraged to have team members familiar with the topics identified, relevant management or policymaking activities, and also the needs of end-users in these areas. The program element encourages early interaction with personnel knowledgeable of NASA Earth science, models, and sensors (e.g., NASA science team and instrument scientists) to understand capabilities and limitations of NASA tools.

4. Alterations and Modifications to the ROSES *Summary of Solicitation*

The following information provides, for this program element, modifications and augmentations to some of the defaults in the *Summary of Solicitation* of this NASA Research Announcement (NRA). The information below supersedes direction provided in the respective sections of the *Summary of Solicitation* and NASA *Guidebook for Proposers*.

4.1 Award Type

This program element will award funds through four vehicles: (1) grants, (2) cooperative agreements, (3) interagency transfers, and (4) awards to NASA Centers. NASA does not anticipate any contract resulting from this program element because it would not be appropriate given the nature of the work being solicited.

4.2 Proposal Format and Contents

All proposals should provide sufficient detail to allow reviewers to assess viability and potential for success. Proposals must adhere to the following page guidelines and order. Content descriptions, specified below, modify those in the *NASA Guidebook for Proposers*.

Proposal Cover Page..... As found on NSPIRES site
..... (includes budget summary)
Proposal Summary.....4000 characters (on NSPIRES)
Table of Contents..... 1 page
Decision-Making Activity ..... 1 page
Earth Observations Used..... 1 page
Science and Technical (including figures/tables) .....11 pages
- Figures and Tables (as appropriate; integrated into text if possible)
Anticipated Results/Improvements.....1 page
Project Management…….....….....1 page
Letters from End-User Organizations (optional).....up to 4 one-page letters
Budget Justification: Narrative and Details..... as needed
Facilities and Equipment (if applicable).....1 page
Resume/Curriculum Vitae: PI(s)…….....2 pages
Resume/CV: Each Co-Investigator.....1 page
Table of Work Effort and Current and Pending Support.....as needed
References and citations .....as needed

4.2.1 *Proposal Summary*

Entered into a 4000-character text box on the NSPIRES "cover pages," this section should briefly describe the concept for the proposed activity. This section should state why the activity should be done and how it relates to the topics identified in subsections 2.1 or 2.2 of this opportunity. It must be clear how the information provided from this project will inform end-user activity/action and how this activity/action will differ dependent upon the results.

4.2.2 *Decision-Making Activity*

This section explicitly identifies and describes the decision-making activity/action to be addressed, created, and/or enhanced by the proposed activity. The description should describe the management, business, policy topic, or other issue that it serves, including any quantitative information regarding its use. This section must identify and describe the end-user organization(s) and their responsibility and/or mandate to address the topic/issue. This section must provide statement(s) from the end user(s)/practitioner(s) describing the management challenge and the need and opportunity to improve decision-making. As such, this section must state the metrics used by the end-user organization to assess their decision-making and state the baseline performance standard by which project improvements will be compared.

4.2.3 *Earth Observations Used*

This section identifies and describes the Earth observations, derived products and/or models (see subsection 3.1) that the proposal seeks to apply to improve decision making. This section should include any NASA and non-NASA data sets that are expected to play an important role in the application.

4.2.4 *Science and Technical*

As the main body of the proposal, this section should cover the following material:

- How the proposed activity responds and relates to the topics identified in subsection 2.1 or 2.2;
- Application of the Earth observations to the decision-making activity, including rationale (per subsection 3.1);
- Application of *in situ* biological observations to the decision-making activity, including rationale (per subsection 3.2);
- Application of ecological models for forecasting to the decision-making activity, including rationale;
- Methodology to be employed in the application, including discussion of the innovative aspects;
- Approach to assess the feasibility of the application, including scientific and technical aspects, should state and describe the measures (both quantitative and qualitative) the team will use to assess and judge the feasibility of the application;
- Estimate of the Applications Readiness Level (per Section 5) of the application, including any expected improvements from beginning to end of the project;
- Challenges and risks affecting project success (technical, policy, operations, management, etc.) and the approaches to address these challenges and risks; and
- Relevant tables/figures that demonstrate key points of the proposal.

4.2.5 *Anticipated Results/Improvements*

This section describes the expected results and improvements to the decision-making activity from the application.

4.2.6 *Project Management*

This section should articulate the management approach and structure; plan of work; partnership arrangements; and the expected contribution, roles, and responsibilities of the team members. Project schedule and milestones must be included. Note: Meetings (number of, frequency of, etc.) do not qualify as project management milestones.

4.2.7 *Letters of Support from End-User Organizations (optional)*

This optional section may include up to four, one-page letters from the end-user organizations that will benefit from the proposed activity. The letters may include input from the community and beneficiaries served by the end-user organizations. All letters must be included within the submitted proposal. Letters sent via a mechanism outside of the proposal submission text will not be considered in review.

4.2.8 *Budget Justification: Narrative and Details*

Include the cost sharing tables, in subsection 3.3, and related information in this section of the proposal.

4.2.9 *Table of Work Effort and Current and Pending Support*

Proposers must use the Table of Work Effort and the form for Current and Pending Support located at https://science.nasa.gov/researchers/templates-for-earth-science-division-appendix-a-roses-proposals.

4.3 Evaluation Criteria

In addition to objectives given in Section 2, the evaluation criterion “relevance” specifically includes:

- Plan to demonstrate the applicability of Earth observations to address a topic of importance; and
- Ability to determine the utility of Earth observations for potentially substantive improvements to a conservation challenge(s) and decision-making activities.

In addition to or as a clarification of the factors given in the *ROSES Summary of Solicitation* and the NASA *Guidebook for Proposers*, the evaluation criterion "intrinsic merit" specifically includes:

- Likelihood for potential, demonstrable impact to the state of practice and community capabilities;
- Quality and adequacy of the approach and methodology and ability to apply Earth observations and related products;
- Ability to characterize the decision-making activities and needs for improvement;
- Quality of teaming across appropriate sectors and areas of expertise; and
- Involvement of the end-user organization(s) in the project.

In addition to or as a clarification of the factors given in the *ROSES Summary of Solicitation* and the NASA *Guidebook for Proposers*, the evaluation criterion "cost" specifically includes:

- Overall approach to manage the project and to achieve stated objectives;
- Appropriate level of effort to meet the objectives cost-effectively; and
- Extent to which the proposed project includes funds or in-kind contributions from non-Federal sources and Federal agencies, consistent with subsection 3.3 of this program element.

4.4 Award Reporting Requirements

Each funded project will be responsible for timely maintenance (via an on-line system) of project information, status updates, highlights, and milestone achievements. NASA will coordinate with each PI at award to provide the necessary information for the on-line system.

The following reports will be required of funded projects. In cases where teams of organizations or subcontracts exist, consolidated project reports, including financial records, must be submitted and are the responsibility of the lead organization. The proposed budget should provide for these reporting requirements.

Funded projects will have a Project Plan due within three months of award and the first annual report due no later than twelve months after the project start date with annual reports due thereafter on the project anniversary date. At the project mid-term, the annual report will take the form of an initial assessment report.

4.4.1 *Annual Report*

Annual reports, other than the initial assessment report, involve three items. One item is a brief (one page), written summary of the progress in the project to date; it should

identify key milestones (met or upcoming) and highlight changes from the proposal or recent reporting. The second item is a one-page project "quad-chart" (format provided at award) with Purpose and Objectives, Approach, a Figure, and Key Milestones and ARL; quad charts are updated as needed. The third item is the verification of cost-share requirements.

4.4.2 *Assessment Report*

NASA program management will provide guidelines for the initial assessment report and the final assessment report (aka the final report).

NASA, the Earth Science Division, and the Applied Sciences Program may periodically request information to support outreach efforts, website content, etc.

A Final Assessment Report is required prior to the conclusion of the project. The Final Assessment Report should describe how the grant activities met the solicitation requirements and demonstrated an impact on decision-making activities using Earth observations. This report should also include lessons learned and recommendations. The Applied Sciences Program may request presentations of the awardee's report, results, and findings.

5. Application Readiness Levels

Proposals must contain an assessment of the Applications Readiness Level (ARL) at the time of the proposal submission and expected advances over the course of the project for any method, tool, or product to be developed through the proposed project.

The Applied Sciences Program developed a nine-step ARL index to track the development of applications and integration of Earth observations into end-user organizations' decision-making activities. The ARL index is an adaptation of the Technology Readiness Level (TRL) scale used in NASA to assess technical maturity in sensors and hardware development. The ARL index provides a scale for the expected advancement along a continuum, starting with a concept and progressing through levels of development and transition to operational use. Compared to the technology-based TRL, the operational decision-making activity of the practitioner organization is the applications analog to operation on orbit.

The ARL reflects three main tiers in applications development. In general, ARLs 1-3 encompass application discovery and feasibility; ARLs 4-6 address application development, test, and validation; and ARLs 7-9 focus on application demonstration in partners' systems and transition.

The following are the nine levels of the ARL:

1. Basic Research - Basic principles and concepts observed and reported. Scientific research produces results that could begin to be translated into applied research and development.
2. Application Concept - Application invention and formulation begins. Once basic principles are observed and products produced and validated, practical applications can be invented. Initial understanding and characterization of the decision making activity.

3. Proof of Application Concept - Feasibility studies to assess the potential viability of the application. More complete characterization of the decision making process, including baseline performance and mechanisms. Analytical and experimental studies to set the Earth science products into the decision-support context.
4. Initial Integration and Verification (in experimental environment) - Basic components of Earth science products and decision making activity (decision support system, tool, etc.) are integrated together to establish that they will work together.
5. Validation in Relevant Environment - Basic components are integrated with reasonably realistic supporting elements so application can be tested in a simulated decision making environment.
6. Demonstration in Relevant Environment - Major increase in the application's demonstrated readiness. Prototype system demonstration in a relevant environment or simulated operational decision making environment.
7. Application Prototype in Partners' Decision Making - Prototype near or at planned operational system. A major advance from ARL 6, requiring prototype system demonstration of an actual system prototype in an operational environment, such as partners' decision-making activity.
8. Application Completed and Qualified - Actual system completed and 'qualified' through test and demonstration for partners' decision-making activity. Application has been proven to work in its final form and under expected conditions.
9. Approved, Operational Deployment and Use in Decision Making - Actual operational, successful use of application by users in decision making activities.

6. <u>Checklist of Solicitation-Specific Requirements</u>

The NASA Applied Sciences Program strives to push the frontier of science-based decision making but recognizes the challenges inherent in doing so. To ensure the greatest likelihood of success for awarded activities, there are multiple elements that must be included within submissions, which have been outlined in the text above. Proposers should check to determine whether their proposal meets these requirements for this solicitation, which have succinctly been listed below for convenience. Proposals that do not meet these requirements may be returned without review.

- Does this proposal address only one of the program subelements (2.1 or 2.2)? Is one (or more) of the outcomes-oriented questions or themes to be addressed under this subelement specified?
- Does the proposed work include use of NASA Earth observations (subsection 3.1), *in situ* biological observations (subsection 3.2), and ecological models to provide ecological forecasts of use to the end-user organization(s)—with associated uncertainties noted and explained? Are the observations explicitly named? Are they integral to addressing the decision making need?
- Does the proposal clearly identify an end user, a decision-making activity to be addressed, their responsibility and/or mandate to address the topic/issue, end-user metrics used to assess decision making, a need for the remote sensing-based application to be developed, and a detailed project schedule (with milestones) and transition plan for transfer of the developed application to the end-user community within the term of the award (including an end-of-project event to announce results)? Is an end user included as a member of the proposal

team? Does the proposal include a statement(s) from the end user(s)/practitioner(s) describing the management challenge and the need and opportunity to improve decision making? Is it clear how the information provided from this project will inform the end-user's activity/action and how this activity/action will differ dependent on the results?

- Does the proposal contain an assessment of the Applications Readiness Level (ARL) at the time of the proposal submission and expected advances over the course of the project for any method, tool, or product to be developed through the proposed project?
- Does the proposal meet the funding and time limits of this program element? Does the proposal include plans to deploy and test the tools or products developed? Does the proposal adhere to the cost sharing requirements outlined in Table 1 (subsection 3.3) and include a detailed outline of the specific financial and proportional contributions (Tables 2 and 3 in subsection 3.3)?
- Does the proposal follow the formatting and contents guidance outlined in subsection 4.2?
- If this project is operating at a U.S. state or substate level, does it include elements to broadly enable and deliver impact beyond that specific geography? If this project is international, does the team involve an established public or private organization with an international mandate?

7. Summary of Key Information

Annual Total Amount of NASA Funding	$3,000,000 per year
Anticipated Number of Awards	10 to 20
Maximum Duration of Awards	4 Years
Contributions from End-User Organizations	Transition plan and resource commitments from end-user organizations are required
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 of this ROSES NRA
Due date for proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	November 30, 2020
Page limit for the central Science and Technical section of proposal	11 pp.; see subsection 4.2 of this Program Element
Relevance	This program is relevant to the Earth Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.

Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-ECOF
Point of contact concerning this program	Woody Turner Applied Sciences Program Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1662 Email: woody.turner@nasa.gov

A.40 ADVANCING COLLABORATIVE CONNECTIONS FOR EARTH SYSTEM SCIENCE

NOTICE: The Advancing Collaborative Connections for Earth System Science (ACCESS) program will not be competed in ROSES-2020. NASA anticipates soliciting this program element in ROSES-2022.

1. Scope of the Program

The primary objective of the Advancing Collaborative Connections for Earth System Science (ACCESS) program is to enhance, extend, and improve existing components of NASA's distributed and heterogeneous data and information systems infrastructure. NASA's Earth science data systems, comprised of both core and community elements, directly support agency science and applied science goals and objectives. ACCESS projects increase the interconnectedness and reuse of key information technology software and techniques underpinning the advancement of Earth science research.

The ACCESS program supports the deployment of data and information capabilities that enable the freer movement of data and information within our distributed environment of providers and users. This often requires the use of tools to measurably improve Earth science data access and data usability. Awarded projects are expected to augment NASA's heterogeneous data system components by leveraging mature information technologies in innovative ways along with existing infrastructure to rapidly deploy capabilities that address specific gaps or weaknesses.

The ACCESS program seeks to deploy and reuse existing technological solutions in the support of Earth science data and information needs. The use of mature technologies and practices helps to lower the overall project risk of system deployment, while making these new capabilities readily available to research and applied science communities. The reuse of existing Earth data and information systems infrastructure and interfaces reduces cost, promotes a better environment for technology infusion, and improves NASA's system of systems infrastructure for users. The program encourages targeted and reusable solutions to current data access and data usability issues by supplying new tools to our Earth science research community.

2. Point of Contact for Further Information

Kevin Murphy
Earth Science Division
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546-0001
Telephone: (202) 358-3042
Email: HQ-EOSDIS-MMOGrants@lists.hq.nasa.gov

A.41 CITIZEN SCIENCE FOR EARTH SYSTEMS PROGRAM

NOTICE: Amended June 12 2020. This Amendment releases the final text for this program element. Mandatory Notices of Intent are due August 4, 2020 and proposals are due September 11 2020.

1. Scope of the Program

1.1 Overview

The primary goal of the Citizen Science for Earth Systems Program (CSESP) is to develop and implement capabilities to augment and enhance NASA scientific data and capacity through voluntary observations, interpretations, or other direct participation by members of the general public to advance understanding of the Earth as a system. The program complements NASA's capability of observing Earth globally from space, air, land, and water by engaging the public in NASA's strategic goals in Earth Science (see https://science.nasa.gov/about-us/science-strategy).

The program aims to advance the use of citizen science in scientific research about Earth by directly supporting citizen science activities, as well as by deploying technology to further citizen science research. This program element is a follow on to the 2016 CSESP ROSES Program element for which the funded projects are described on the Citizen Science for Earth Systems Program page. While much of the focus of the original program element has remained, the new program element also includes an option to propose to analyze and interpret legacy NASA-supported citizen science data. For the purposes of this program element, NASA citizen science data means data that were collected by citizen scientists and that were derived from a NASA-funded citizen science project, or citizen science data hosted directly on a NASA data system, or citizen science data that are directly used to calibrate or validate NASA Earth observation data.

For the purpose of this program element, citizen science is defined as efforts or projects that use voluntary public participation in the scientific endeavor, including – but not limited to – formulating research questions, conducting experiments, collecting and analyzing data collected by citizen and/or professional scientists, interpreting results, making new discoveries, and/or developing or deploying technologies and applications. Crowdsourcing, another frequently used term describing voluntary contributions, is included under citizen science in this program element.

All proposals must demonstrate clear linkages between citizen science and NASA observation systems to advance NASA's Earth science (see https://science.nasa.gov/earth-science/big-questions). Projects that demonstrate value in adding or enhancing crowdsourcing in scientific workflows are encouraged. Calibration and validation, augmentation, or enhancement to significantly increase the quality, resolution, scope, or extent of remotely sensed data are all possible focal areas. Combination of remotely sensed data with other data sources in concert with a citizen science effort to dramatically advance an area of Earth science is also welcome.

This program element directly supports NASA's response to Section 402 of the *American Innovation and Competitiveness Act* of 2017, which encourages and grants

authority for citizen science activities and enumerates the benefits including: "accelerating scientific research, increasing cost effectiveness to maximize the return on taxpayer dollars, addressing societal needs, providing hands-on learning in STEM, and connecting members of the public directly to Federal science agency missions and to each other".

1.2 Scientific Focus

The Citizen Science for Earth Systems Program is using this program element to promote the use of citizen science, crowdsourcing, and the data they generate in concert with NASA Earth observation data and applications to dramatically advance Earth science. Citizen scientist projects can have a high impact by significantly extending the scope and quality of satellite-based observations to answer important scientific questions that cannot otherwise be addressed. For example, massive field-based training data sets gathered by citizen scientists can increase the level of effective resolution in model-based predictions produced by certain remote sensing applications such that the resulting dataset can be used to answer new and important questions that could not previously be resolved. See further details on NASA's Earth Science data at https://earthdata.nasa.gov/ and NASA's Earth observing satellites at https://eospso.nasa.gov/content/all-missions/.

1.3 Award Type, Duration and Budget

NASA anticipates making awards for two types of projects (Types 1 and 2, as described in Section 2). NASA anticipates that awards to non-governmental organizations will be grants. Approximately $3M total is available to fund a total of approximately eight to twelve projects of both types for 18 months. Pending the outcome of an independent review of the Type 1 projects as they approach their 18-month maturation, two to five may have their funding augmented to continue with full implementation for an additional three years. Approximately $2M per year is available across all of those continuing projects for the additional three years. Projects based on existing NASA-enabled citizen science data (Type 2) are expected to be complete in 18 months and will not be part of the down-selection for an implementation phase.

2. Types of Proposals

This program element aims to use citizen science and crowdsourcing platforms or techniques to advance our scientific knowledge of the Earth system and to complement the research currently conducted using NASA's Earth-observing satellites. To address this aim, this program element requests two types of proposals as defined below.

2.1 Type 1 Proposals: Citizen Science Research Gathering New Data

NASA will support development of new research projects or significant enhancement or refocusing of existing projects that use citizen science to advance scientific understanding of the Earth system. Projects must use citizen science or crowdsourcing platforms or techniques to advance our scientific knowledge of the Earth system and to complement the research currently conducted using NASA's Earth-observing systems.

These proposals are for collection of new data and may aim to address real-world problems at the local, regional, continental, or global scales; to complement NASA

observation systems by increasing temporal or spatial sampling; to contribute to the validation of NASA data products derived from satellite observations; to dramatically enhance the quality and quantity of data collected by individual NASA-focused citizen scientists; to achieve a combination of the above; or to implement other innovative methods to enhance the utility of NASA's observation systems from space, air, land, and water. These proposals will be for projects with an 18-month pilot phase to be followed by a three-year implementation phase for those projects that successfully pass a continuation review. The descriptions of the work and budget required for the two phases should be clearly separated in the proposal because there will be a down-selection near the end of the pilot phase to determine the subset of projects that receive funding to move on to the implementation phase. During the first year of funding for Type 1 projects, NASA will provide explicit instructions for a report to be filed by a deadline shortly after the first year of funding. Selection for the implementation phase will be primarily based on an evaluation of this report by an external review panel. Failure to submit the report by the due date will result in automatic elimination from consideration for the implementation phase.

Areas of investigation can include any of the Earth Science focus areas: Atmospheric Composition, Weather and Atmospheric Dynamics, Climate Variability and Change, Water and Energy Cycle, Carbon Cycle and Ecosystems, or Earth Surface and Interior.

These projects could include crowdsourced observations using instrumentation with established specifications, analysis of citizen science data or joint analysis by incorporating NASA satellite-based data products, or development of user interface applications, algorithms, and websites to increase the efficiency and accuracy of crowdsourced data. However, in contrast to Type 2 proposals, new data provided by actively participating citizen scientists must be the primary data source highlighted in the project.

Proposals must address all aspects of recruitment and retention of citizen scientists, as well as commit to open sharing of the data collected through NASA-approved data and information systems throughout the project. Data from projects selected for continuation to full implementation will be archived at a NASA-approved data center, following best practices for assurance of data quality (see the recommendations and standards outlined in the *NASA ESDS Citizen Science Data Working Group White Paper*).

2.2 Type 2 Proposals: Proposals for Reuse, Enhancement, or Characterization of Existing NASA Citizen Science Data

Proposals for reuse, enhancement, or characterization of existing NASA citizen science data can be in any Earth science subject area but may not include collection of new data. For the purposes of this program element, NASA citizen science data means data that were collected by citizen scientists as a primary funded deliverable in a NASA-funded citizen science project, citizen science data hosted directly on a NASA data system, or citizen science data that are currently used to calibrate or validate NASA Earth observation data. All data used in these projects should come from sources where participants were aware of and agreed to submit their data as part of a citizen science project (for example, data from The Global Learning and Observations to Benefit the Environment [GLOBE] Program [www.globe.gov] and previously funded CSESP

projects). Non-participatory citizen science (e.g., using movement data from mobile phones or mining Flickr images without individual informed participation) or simply using a dataset that was not created using citizen science is out of scope for this program element. Proposers must demonstrate that citizen scientists were aware of potential uses of the data they contributed, and explain how the intended research conforms with community norms for using citizen science data. These proposals will be for projects with an entire length of 18 months and should include well-defined final deliverables at the end of that period. There is no pilot phase and these projects are not eligible for continued funding from this program element beyond their full 18 month implementation.

3. Proposal Preparation and Submission

A Notice of Intent (NOI) is required for all submissions.

The general information provided in Section IV of the *ROSES-2020 Summary of Solicitation* about proposal preparation and submission applies to this program element. Accompanying the cover page will be a "Program-specific Questionnaire," where the proposer must specify the type of proposal being submitted, the scientific focus, and the relevant current or future NASA Earth-observing satellite(s).

All proposals must be responsive to the Science Mission Directorate Policy on Citizen Science, which specifies a data management plan and a sunset plan. Proposals should describe a strategy for monitoring data quality and consistency throughout the lifetime of the project. Proposals must commit to the use of open-source formats and metadata standards to increase interoperability with other Earth observation data. See: *NASA ESDS Citizen Science Data Working Group White Paper* by the NASA Citizen Science Data Working group (CSDWG) as well as NASA recommended standards (https://earthdata.nasa.gov/user-resources/standards-and-references).

Data, results, and other information created for this proposal are subject to NASA's Earth Science Data and Information Policy (http://science.nasa.gov/earth-science/earth-science-data/data-information-policy/). All data will be released, along with the source code for algorithm software, coefficients, and ancillary data used to generate products. Data and results will be archived at a NASA-approved repository.

All resulting software, along with source code, will be released as open-source software. If deemed appropriate by NASA, release will be facilitated through https://github.com/nasa and is subject to the NASA Earth Science Alternate Data Rights language to be included in cooperative agreements for projects selected (http://science.nasa.gov/earth-science/earth-science-data/data-information-policy/data-rights-related-issues/).

All proposals should include funding for participation by a team member in The Citizen Science for Earth Science Data Working Group including time for regular teleconferences and other participation. This resource estimate should include travel and time for at least one face-to-face meeting per year.

4. Proposal Evaluation Criteria

Proposals will be evaluated vs. the three standard criteria: intrinsic merit, relevance, and cost as defined in the *NASA Guidebook for Proposers*. The general information

provided in Section VI of *ROSES-2020 Summary of Solicitation* about the proposal review and selection process applies to this program element. Additionally, the direct connection between NASA Earth observation systems and citizen science, as well as responsiveness to the proposal requirements (e.g., described in Section 2 of this program element) will be used in the assessment of relevance.

5. Summary of Key Information

Expected total program budget for new awards	~ $3M for all proposals selected for the initial 18 months; then ~$2M per year total for the Type 1 proposals selected for continuation.
Number of new awards pending adequate proposals of merit	~8-13 proposals for the initial 18 months, the proportion of each type determined by the proportion and quality of proposals submitted. After the initial 18-month period, ~2-5 Type 1 proposals will be selected for the three-year continuation period.
Maximum duration of awards	18 months for the initial selection of both Type-1 and Type-2 projects, with the potential for an additional three years for Type 1 projects selected for continuation (See Section 2)
Due date for mandatory Notice of Intent to propose (NOI)	See Tables 2 and 3 of this ROSES NRA
Due date for Proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	6 months after proposal due date
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Table 1 in the *ROSES Summary of Solicitation*.
Relevance	This program is relevant to the Earth Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*
General requirements for content of proposals	See A.1 Earth Science Research Overview and Section IV and Table 1 of *the ROSES Summary of Solicitation*
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ and Section IV(b) of *the ROSES Summary of Solicitation*
Submission medium	Electronic proposal submission is required; no hardcopy is required.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ help desk available at nspires-help@nasaprs.com or (202) 479-9376

Web site for submission of proposals via Grants.gov	http://grants.gov/ help desk available at support@grants.gov or (800) 518-4726
Funding opportunity number for downloading an application	NNH20ZDA001N-CSESP
Points of contact concerning this program, both of whom share this postal address: Earth Science Division Science Mission Directorate, NASA Headquarters Washington, DC 20546	Kevin Murphy Program Executive for Earth Science Data Systems Telephone: (202) 358-3042 Email: kevin.j.murphy@nasa.gov Gerald "Stinger" Guala Telephone: (202) 255-3366 Email: gerald.f.guala@nasa.gov

A.42 COMMERCIAL SMALLSAT DATA ANALYSIS

NOTICE: Clarified June 5, 2020. In response to questions, Section 2.1 has been expanded to provide guidance regarding when proposals that build on previous work is permissible. New Text is in bold. The due dates remain unchanged.

Amended June 1, 2020. This amendment releases final text for A.42 Commercial Smallsat Data Analysis, which was previously listed as TBD under the name "Commercial SmallSat Data Evaluation Team". Mandatory Notices of Intent are due July 1, 2020 and 5-page proposals are due September 1, 2020.

Proposals that build on previous work are strongly discouraged, see Section 2.1.

The commercial data that is the focus of this call are subject to vendor specific End User License Agreements (EULA), see Sections 2.1 and 2.2.3 for details.

Proposers must use the Earth standard template for detailing the level of work effort see: https://science.nasa.gov/researchers/templates-for-earth-science-division-appendix-a-roses-proposals.

1. Scope of Program

This NASA Commercial Smallsat Data Analysis (CSDA) opportunity is to further the analysis of commercially produced satellite data obtained by NASA as part of the Commercial Smallsat Data Acquisition Program (CSDAP) and/or through other agreements that allow access to data obtained by commercial sources. CSDAP's primary goal is to identify, evaluate, and acquire data from commercial sources and to make this data available to the Earth science research and application communities. NASA's Earth Science Division (ESD) recognizes that commercial data may augment or complement existing additional NASA remote sensing data to advance Earth system science and applications development for societal benefit. This solicitation provides short-term resources for analyses of commercial satellite data from Planet, Spire Global, Maxar (formerly DigitalGlobe, Inc.), and the Teledyne Brown Inc., DLR Earth Sensing Imaging Spectrometer (DESIS).

The scientific community may use commercial datasets that are obtained by NASA for scientific purposes in adherence to vendor-specific terms and conditions. Here "for scientific purposes" is defined as use by NASA, or a NASA awardee, pursuant to a NASA-selected investigation established through a NASA Research Announcement or similar public notice of opportunity and performed for the purpose of conducting experiments, evaluation, research, and/or development, including basic and applied research sponsored by NASA's Earth Science Division. "Scientific purposes" do not include the development of commercial products or services, activities funded or sponsored by non-governmental organizations, or activities conducted outside of NASA.

Data that were previously acquired during the evaluations of Planet, Maxar, and Spire Global (see the Commercial Smallsat Data Acqusition Program Pilot Evaluation Report)

will be available at no cost to proposers selected for NASA funding. Through NASA ESD's collaboration with the International Space Station (ISS) Project, data from the DESIS, hyperspectral instrument launched to the ISS in 2018 will also be available at no cost to all U.S. government-funded researchers.

Information about these vendors and available data can be found in the CSDAP Data Products Information document. However, for the purposes of this Research Opportunities in Space and Earth Science (ROSES) element, the only commercial data that may be considered for analysis are the data from the vendors identified above. Once awarded, the selected proposers will have access to these data.

2. Research Solicited

NASA requests proposals for investigations that will utilize data available from the commercial small satellite datasets available to NASA through purchases (Planet, Maxar, Spire Global) and/or agreement (DESIS) for furthering our understanding of the Earth system and/or enhancing applications as described in NASA's 2018 Strategic Science Plan. As additional commercial small-satellite datasets are evaluated and acquired by NASA, those datasets will also be made available. Investigators are allowed to propose to use the data products for analyses, as well as develop derivative products from data products provided by NASA. Please see the CSDAP Data Products Information document for the specific vendor data rights associated with the data and any derivative products.

2.1 Research Topics **[Clarified June 5, 2020]**

Commercial data may be used for any NASA Earth science research or applications activities except for activities that duplicate the work carried out as part of the initial data evaluation process. Moreover, projects that primarily build on previous work, as documented in the Commercial Smallsat Data Acqusition Program Pilot Evaluation Report, are strongly discouraged. **Projects that would primarily build on previous work are welcome if:**

1. **The proposal involves different subject and/or different locations and/or different data sets and if**
2. **The proposal would rely entirely or primarily on the results previously obtained, those results are fully available to the outside community**

Analyses may be synergistic with any program in the Earth Science Division. All research activities must comply with applicable EULAs as referenced in the CSDAP Data Products Information document.

2.2 Additional Proposal Requirements

2.2.1 *Duration of Award*

The proposed scientific tasks must be of no more than eighteen months duration. If the proposed research can be conducted in less than eighteen months, a shorter period of performance is encouraged.

2.2.2 *Requirements for Data Acquisition and Use*

The research proposed in this solicitation must make primary use of data from the

CSDAP, although combining CSDAP data with other data sources is encouraged. Once awarded, the Principal Investigators will have free access to (i.e., the capability to download) the commercial data.

2.2.3 *Data Availability*

Commercial data acquired during the evaluations of Planet, Maxar (formerly DigitalGlobe, Inc.), and Spire Global will be available; data from DESIS will be provided through a separate collaboration with the International Space Station (ISS) project. All data products acquired through CSDAP will be available at no cost to the proposers selected under this solicitation and will be subject to scientific use licenses as defined herein.

The commercial data currently distributed by NASA are available under different scientific use licenses and various access portals. Vendor-specific EULAs are available via the access portals. Please see the CSDAP Data Products Information document for the EULAs.

2.2.4 *Work Effort and Current and Pending Support*

Proposers must use the Earth Science Division standard templates for detailing the level of work effort and current and pending support (see https://science.nasa.gov/researchers/templates-for-earth-science-division-appendix-a-roses-proposals).

3. Programmatic Information

3.1 Funding Allocations

$2M of Fiscal Year 2020 funding is available to support new research under this program element.

3.2 Evaluation Criteria

Proposals will be evaluated according to the criteria defined in Appendix D of the the *2018 NASA Guidebook for Proposers*, consistent with Section VI(a) of *the ROSES 2020 Summary of Solicitation*. In addition to the factors given in the *Guidebook for Proposers*, the evaluation of merit will include, as part of the assessment of impact, the extent to which the proposal would primarily build on previous work, as documented in the *Commercial Smallsat Data Acqusition Program Pilot Evaluation Report* (see Section 2.1 above). Proposals that primarily build on previous work are strongly discouraged and will be ranked lower than those featuring new concepts.

4. Summary of Key Information

Expected program budget for first year of new awards	$2.0M
Number of new awards pending adequate proposals of merit	~10-15
Maximum duration of awards	18 months
Due date for mandatory Notice of Intent (NOI) to propose	See Tables 2 and 3 of ROSES-2020

Due date for proposals	See Tables 2 and 3 of ROSES-2020
Planning date for start of investigation	March 2021
Page limit for the central Science/Technical/Management section of proposal	5 pages; see also Table 1 of the *ROSES Summary of Solicitation* and *the 2018 NASA Guidebook for Proposers*.
Relevance	This program is relevant to the Earth Science questions and goals in the NASA Science Plan. Proposals relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See A.1 Earth Science Research Overview and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES)	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or 202-479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or 800-518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-CSDA
Points of contact concerning this program, both of whom share the following postal address: Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001	Kathy A. Hibbard Science Mission Directorate Telephone: (202) 358-0682 Email: Kathleen.A.Hibbard@nasa.gov Alfreda Hall Commercial Smallsat Data Acquisition Program Telephone: (301) 614-5241 Email: alfreda.a.hall@nasa.gov

A.43 INSTRUMENT INCUBATOR PROGRAM

NOTICE: This program element will not be competed in ROSES-2020. IIP was competed in ROSES-2019. It is anticipated that it will next be solicited in ROSES-2021.

1. Objectives

The Instrument Incubator Program (IIP) funds innovative technologies that lead directly to new Earth observing instruments, sensors, and systems in support of SMD's Earth Science Division (ESD). The technologies and measurement concepts developed under the IIP may extend up through field demonstrations, with a longer-term aim for infusion into future ESD research and flight programs. The objectives of the IIP are to research, develop, and demonstrate new measurement technologies that:

- Enable new or greatly enhance Earth observation measurements and
- Reduce the risk, cost, size, mass, and development time of Earth observing instruments.

2. Point of Contact

Parminder Ghuman
Earth Science Technology Office
Telephone: (301) 286-8001
Email: p.ghuman@nasa.gov

A.44 ADVANCED COMPONENT TECHNOLOGY

NOTICE: Amended April 21, 2020. This Amendment releases the final text for this program element. A preproposal bidder's conference will be held Monday, May 18 at 1:00 PM Eastern Time, Phone: 1-844-467-6272, Passcode: 831772. Notices of Intent are requested by May 22 and proposals are due by July 21, 2020. Proposers to this program element should not submit a data management plan.

1. Scope of Program

1.1 Introduction

The Advanced Component Technology (ACT) program seeks proposals for technology development leading to new component- as well as subsystem-level spaceborne and/or airborne measurement techniques to be developed in support of the Science Mission Directorate's Earth Science Division. The ACT program is managed by NASA's Earth Science Technology Office (ESTO). ESTO supports the development of a range of advanced observation and information systems technologies to meet the demand of future Earth science measurements and activities addressing the full scientific measurement process. This includes, but is not limited to, instruments needed to make specific observations, data systems, and information products that render observations useful to the scientific community in a timely manner.

Emerging technologies, novel instrument architectures, and innovative platforms show great promise for measuring natural Earth phenomena and physical processes that have not been previously or adequately characterized by conventional satellite instruments alone. In particular, phenomena that are transient, transitional, and/or dynamic in nature have been difficult to study using traditional low Earth orbit (LEO) orbiting instruments due to insufficient temporal and/or spatial sampling of such events. Inexpensive, high quality intelligent sensors and platforms at higher orbits, or in a constellation and/or in a coordinated fashion, coupled with new pointing, real-time data processing, and command capabilities, can now give scientists the ability to selectively conduct observations focused on dynamic events of interest. Emerging new instrument technologies coupled with new platform capabilities and rapidly evolving information technologies could become the foundational infrastructure of new observing systems that can dynamically react to rapidly changing environmental conditions.

This ACT call seeks disruptive technology, i.e., that involves higher risk but also has the potential for greater impact. These disruptive technologies can come from inside or outside the traditional field of Earth Science remote sensing. For any technology advanced, proposers must define an instrument architecture along with the science measurement(s) enabled, and then describe the proposed critical component or subsystem and how the proposed technology will fit into the instrument architecture. A description of how the proposed technology is responsive to both goals of the ACT program as described in Section 1.2 is required. Although this program element does not request software development, proposers are asked to show, where appropriate, how innovations in artificial intelligence, machine learning, onboard processing, etc. could augment the proposed instrument architecture and/or could be used in the initial stages of the component or subsystem design.

1.2 Goals of the Advanced Component Technology Program

The goals of the ACT program are to research, develop, and demonstrate component- and subsystem-level technology development that:

- Enable or dramatically enhance Earth observation remote sensing measurements in new, innovative ways.
- Reduce the size, weight, power requirements, risks, cost, and development time of Earth science remote sensing observation systems.

For the purpose of this program element, components are defined as the critical parts that comprise an instrument subsystem. Consequently, subsystems are defined as a series of interconnected components that comprise a part of an observational instrument or system.

Proposers may find information about currently and previously funded technologies at the Earth Science Technology Office (ESTO) Website.

No funding is available under the current announcement for:

- Research and development of new instrument component technology for Designated Observables recommended by the 2017 Earth Science Decadal Survey (https://www.nap.edu/catalog/24938) unless these are substantially different from, and provide significant improvement, over existing techniques
- Technology components or subsystems that make airborne *in situ* or ground-based observations, unless they are critical components that enable innovative spaceborne observing system architectures
- Incremental improvements to existing components or subsystems.

1.3 Proposal Research Topics

This ACT program element solicits new component and subsystem-level technologies to support future instrument developments addressing any of the science focus areas in NASA's Earth Science program (see ROSES-2020, Program element A.1 for further description of the focus areas). The solicited new technologies could enable new types of observations as well as measurement techniques that improve NASA's Earth Science program. Technologies can target any Earth science measurement or issue in order to advance strategic goals, questions, and, most importantly, future missions or observational architectures as outlined in Objective 1.1 of the *NASA 2018 Strategic Plan,* which can be accessed at http://science.nasa.gov/about-us/science-strategy.

Proposers are required to describe how the ACT component or subsystem fits into a future NASA Earth Science measurement system architecture and to provide potential alternatives to perceived challenges and/or risks in the technology development. The ACT program element seeks advances in any of the component technologies that enable new measurement capabilities or allow current systems to increase their scientific utility by providing new or enhanced capabilities for remote sensing applications beyond the current state of the art. The component technologies should demonstrate their ability to advance remote sensing measurement performance in addition to their viability to space implementation.

Proposers are asked to consider applications of rapidly emerging technologies, such as photonic integrated circuits, system-on-a-chip solutions, metamaterials/metasurfaces, quantum remote sensing, deployable antennas, room temperature detectors, as well as other compact electronic and optical architectures. This program element also seeks next generation components for sensors developed for use aboard long-duration aircraft, such as high-altitude pseudo-satellites or balloons. In an effort to continually reduce size, weight, and power (SWaP) for future spaceflight missions, this program element also seeks integration of key instrument components or subsystems that either enable or significantly improve new Earth remote sensing systems. Miniaturization is particularly important where size reductions can be most meaningful in replacing current high SWaP subsystems and components.

ESTO encourages proposers to investigate leveraging emerging technologies under Internal Research and Development activities, Small Business Innovative Research (SBIR) awards (http://sbir.gsfc.nasa.gov), as well as other research programs.

The proposed ACT activity is expected to have an entry Technology Readiness Level (TRL) between 1 and 2 with an exit TRL between 3 and 4. It is the responsibility of the proposer to justify the entry and exit TRLs of the proposed technology. TRL definitions can be found at: https://www.nasa.gov/pdf/458490main_TRL_Definitions.pdf

The ACT Program will fund tasks at an appropriate level commensurate with the TRL proposed. Activities appropriate for the ACT program can include, but are not limited to: proof of concept, laboratory demonstrations, and advanced component or subsystem hardware development.

2. Programmatic Information

This document provides requirements and details tailored to this specific program element that supplement or may supplant the general guidelines of the *ROSES Summary of Solicitation* or the *NASA Guidebook for Proposers*. See Section I (g) of the *ROSES Summary of Solicitation* regarding the order of precedence.

2.1 Proposal Content and Submission

2.1.1 *Notice of Intent to Propose*

Notices of Intent (NOI), as described in Section IV(b)vi of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*, are strongly encouraged, but not required.

2.1.2 *Questions and Answers*

Prospective proposers are requested to submit any questions in writing to amber.emory@nasa.gov no later than 30 days before the proposal due date. Questions and answers will be posted in a Frequently Asked Question (FAQ) on the NSPIRES page for this program element under "other documents." It is the proposer's responsibility to check the NSPIRES page for this program element for possible updates to any FAQ document or clarifications to the program element. Proposers who subscribe to the SMD email distribution list in NSPIRES will receive an email if this program element is amended.

3. Proposal Content

3.1 Proposal Summary (Abstract)

The NSPIRES web page requires proposers to fill in a text box with a proposal summary of no more than 4000 characters. The proposal summary includes: (a) objectives and benefits; (b) an outline of the proposed work and methodology; (c) the period of performance; and (d) entry and planned exit Technology Readiness Level (TRL).

3.2 Scientific/Technical/Management Section

This section of the proposal must include the following content information in subsections that use the same titles. Failure to provide any of this material may be cause for the proposal to be judged as noncompliant and returned without further review. The Scientific/Technical/Management (S/T/M) Section is limited to 15 non-reduced, single-spaced typewritten pages. Standard proposal style formats shall be in accordance with the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*. Proposals that exceed the 15-page limit may be returned without review. The S/T/M Section includes items 1-6:

1. Applicability to Earth Science Measurements - Describe the benefits to future Earth science (satellite, SmallSat, CubeSat, High Altitude Balloon/Pseudo-Satellite, or Airborne) missions that could utilize the proposed technology. Describe how the component or subsystem will improve the science measurement (e.g., spectral, spatial, accuracy, precision, etc.) and describe its importance. Include a one-page relevancy scenario showing how the proposed technology contributes to one or more Earth science measurements.
2. Description of Proposed Technology - Provide a description of the proposed new technology for an instrument system or subsystem. Define an overall instrument architecture along with the science measurement(s) enabled or enhanced and then describe how the proposed critical component or subsystem will fit into the instrument architecture. Explain and justify how the proposed choice of measurement platform enables science. Discuss any possible benefits to other NASA Earth or Space Science activities or societal/commercial benefits.
3. Comparative Technology Assessment - Describe anticipated advantages of this technology compared to those currently in use, e.g., reduction in size, mass, power, volume, cost, improved performance, or enabling of a new capability not previously possible. Reference the current state of the art and relate it to the proposed work.
4. TRL Assessment - Proposers must define and substantiate the starting TRL for the component and subsystem technology and the anticipated exit TRL or success criteria for the proposed activity. The TRL must advance by at least one level during the period of performance of the activity. If the proposed activity duration is for multiple years, advancement of one TRL per year is desirable. TRL definitions can be found here: https://www.nasa.gov/pdf/458490main_TRL_Definitions.pdf
5. Research Management Plan - Proposer must provide a statement of work that concisely describes each task and milestone to be accomplished in the course of the research and development. Define the success criteria associated with each

task or milestone. Also, include a chart of the schedule of the critical milestones. At least two milestones per twelve-month period must be defined.

6. Subcontracting portions of the research project is acceptable, but overall management and reporting are the responsibility of the proposing organization. Personnel - Provide a list of key personnel and identify experience related to the proposed activity. Proposers must include technology and instrument development skills of the team. The key personnel list is included in the overall page count and must include, as a minimum, the Principal Investigator (PI). Optionally, one-page resumes for Key Personnel may be supplied; these resumes are not included in the 15-page limit for the S/T/M section.

In addition, the following components are also required, but are not part of the 15-page S/T/M Section:

7. Facilities and Equipment - Describe significant facilities and equipment required to complete the work. Before requesting funding to purchase a major item of capital equipment, the proposer should determine if sharing or loan of equipment already available within the proposing organization is a feasible alternative. This Section is not page limited and is not included in 15-page limit for the S/T/M section.
8. Special Matters - Proposers must include a brief description of the organization, its facilities, and previous work experience in the field of the proposal. This is also where any other relevant special concern of which NASA should be aware should be identified. This Section is not page limited and is not included in 15-page limit for the S/T/M section.
9. Quad Chart – Provide a summary chart (quad chart) that contains the following information:
   - Upper Left Quadrant: "Objectives"
   - Lower Left Quadrant: "Approach" and "Co-Is/Partners"
   - Upper Right Quadrant: A visual, graphic, or other pertinent information
   - Lower Right Quadrant: "Key Milestones" and "Entry TRL"

   A template and example of the quad chart can be downloaded from http://esto.nasa.gov/files/EntryQuad_instructions_template.ppt. Note: This quad chart is not included in the 15-page limit for the S/T/M section.

4. Evaluation Criteria

The three basic evaluation criteria are given in Section VI(a) of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers* and they are Relevance, Intrinsic Merit, and Cost Reasonableness. Clarifications and additions specific to this program element are listed below.

The first criterion, Relevance, includes the applicability of the proposed investigation to Earth Science Focus Area(s) and other science measurement and technology needs. Specifically, it includes:

- The proposal's relevance and potential contribution to this ACT program element, including the potential to contribute to future Earth science instruments and the degree to which the proposed investigation specifically supports the objective of at least one

of the Earth Science Focus Areas (see A.1 The Earth Science Research Overview for a description of Earth Science Focus Areas);

- The potential for the component or subsystem level technology development to significantly reduce the risk, cost, size, and/or development time of Earth science instruments or to enable new Earth science measurements. Potential cost reductions should be clearly stated and substantiated to the extent possible with supporting analysis that indicates scalability;
- The potential of the component or subsystem level technology to be integrated, once matured, into an Earth science instrument system; and
- The potential for the component or subsystem technology development to have cross-cutting or commercial benefits.

The second evaluation criterion, Intrinsic Merit, includes:

- Impact, significance, and feasibility of the proposed technical approach to achieve the technology development objectives;
- Degree of innovation of the proposed technology development concepts and approach that fulfill the goals of the ACT program;
- Qualifications of key personnel and adequacy of facilities, staff, and equipment to support the proposed activity as demonstrated by past performance and related experience in the proposed area of technology development, to ensure that the team has strong technology development and instrument development skills;
- Substantiated justification and appropriateness of the entry and anticipated exit technology readiness levels (TRL); and
- Feasibility of making the newly enabled measurement with the proposed component or subsystem; and, feasibility of making a demonstrable TRL increase. The TRL must advance by at least one (1) level during the performance period of the project.

The third criterion, Cost Reasonableness, includes:

- Adequacy and likelihood of meeting the proposed milestones and associated success criteria;
- Reasonableness of accomplishing the work given the labor hours identified;
- Adherence to sound and consistent management practices appropriate to the TRL of the proposed task; and,
- Commitment of the organization's management to the proposed technology development (evidenced by prior teaming arrangements, etc.). Proposers should identify previous relevant investments by the organization/program and provide supporting documentation.

Cost sharing is not required and is not part of the cost criteria, but NASA will accept cost sharing if it is offered voluntarily and it may be considered at the time of selection when deciding between proposals of otherwise equal merit.

5. Award Information

The Government's obligation to make award(s) is contingent upon both the availability of appropriated funds from which payment can be made and the receipt of proposals that NASA determines are acceptable for award under this program element. No additional funds beyond the negotiated award value will be available. NASA does not allow for payment of profit or fee to commercial firms under grant awards, and few fees

are permitted (See http://science.nasa.gov/researchers/sara/faqs#16 for more information).

5.1 Funding

The total funding available for this sub-element will limit the number and magnitude of the proposals awarded. It is anticipated that a total of 12 proposals will be selected and the value of each will be approximately $400K per year per proposal for a 3-year proposal and approximately $600K per year for a 2-year proposal.

5.2 Period of Performance

The expected period of performance is a minimum of 12 months to a maximum of 36 months. Proposals must define clear, measurable milestones to be achieved for each year of performance in order to warrant continuation in the second and third years.

5.3 Type of Award

All selected proposals will result in the award of grants, cooperative agreements, or intra-Government transfers, as appropriate. Grants and cooperative agreements will be subject to the provisions of the *Grants and Cooperative Agreement Manual (GCAM)* and the *NASA Guidebook for Proposers*. In the case of any conflict, the *GCAM* takes precedence. If a commercial organization wants to receive a grant or cooperative agreement, cost sharing is required, unless the commercial organization can demonstrate that it does not expect to receive substantial compensating benefits for performance of the work. If this demonstration is made, cost sharing is not required, but may be offered voluntarily (see references in Section III (d) of the *ROSES Summary of Solicitation*).

6. Technical Reporting Requirements

In addition to the agency reports for grants, a number of ESTO-specific reporting requirements are detailed on the ESTO reporting requirements website. These requirements, including semi-annual, annual, and final review presentations and the ESTO Quad Chart, must be included in the proposal and included in proposal work plans.

6.1 Earth Science Technology Forum

The awardee is encouraged to participate in the Earth Science Technology Forum (ESTF), if held. The ESTF is an opportunity for NASA planners, managers, technologists, and scientists to review research funded by ESTO. It is also an opportunity for researchers from NASA, academia, and industry to meet with their peers to better understand NASA Earth science requirements. Awardees are encouraged to include one trip per year in their travel budget for one person to attend the ESTF. The ESTF typically alternates its location from East coast to West coast (e.g., Greenbelt, MD, and Pasadena, CA).

7. Summary of Key Information

Expected program budget for first year of new awards	Up to $4.8 M

Number of new awards pending adequate proposals of merit	~ 12
Duration of awards	Minimum 1 year/Maximum 3 years
Due date for Notice of Intent to Propose (NOI)	See Tables 2 and 3 of this ROSES NRA.
Due date for delivery of proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	4-6 months after submission of proposal
Page length for the central Science-Technical-Management section of proposal	15 pp; See Section 3.2 of this program element; See also the *NASA Guidebook for Proposers*.
Relevance	This program is relevant to the Earth Science questions and goals in the NASA Science Plan. Proposals that are relevant to the ACT Program are, by definition, relevant to NASA. (See Section 4 of this program element.)
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	Please see the *ROSES Summary of Solicitation* Section l(h) Order of Precedence and the *NASA Guidebook for Proposers*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Website for submission of proposal via NSPIRES	http://nspires.nasaprs.com (Help Desk available at nspires-help@nasaprs.com or 202-479-9376
Website for submission of proposals via Grants.gov	http://grants.gov (Help Desk available at support@grants.gov or 800-528-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-ACT
Point of contact regarding this program	Amber E. Emory Science Mission Directorate Earth Science Technology Office National Aeronautics and Space Administration Washington, DC 20546 Telephone: 301-614-6274 Email: amber.emory@nasa.gov

A.45 IN-SPACE VALIDATION OF EARTH SCIENCE TECHNOLOGIES

NOTICE: NASA intends to solicit research proposals via this program element in ROSES-2020. The final text will be released as an amendment to ROSES-2020 with a submission deadline no fewer than 90 days after the release of the amendment.

1. Introduction

There has been and continues to be a need for some new technologies to be validated in space prior to use in a science mission. This is necessary because the space environment imposes stringent conditions on components and systems, some of which cannot be fully tested on the ground or in airborne systems. The In-space Validation of Earth Science Technologies (InVEST) program element is intended to fill that gap. Validation of Earth science technologies in space will help reduce the risk of new technologies in future Earth science missions. This program seeks to advance the readiness of existing Earth Science-related technology and reduce risks to future missions through space flight validation.

2. Point of Contact

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A.46 SUSTAINABLE LAND IMAGING-TECHNOLOGY

NOTICE: This Program element will not be competed in ROSES-2020. SLIT was last competed in ROSES-2019. It is anticipated that it will next be solicited in ROSES-2022.

1. Scope of Program

The Sustainable Land Imaging – Technology (SLI-T) program seeks proposals to develop and demonstrate new measurement technologies and architectures that improve upon the Nation's current land imaging capabilities while also reducing the overall program cost for future SLI measurements in support of the Science Mission Directorate's Earth Science Division. The SLI- T program seeks to:

- Reduce the risk, cost, size, volume, mass, and development time for the next generation SLI instruments, while still meeting or exceeding the current land imaging program capabilities.
- Enable new types of observations that improve the temporal, spatial, and spectral resolution of SLI measurements.
- Enable new SLI measurements and architectures, which can improve the program's operational efficiency and reduce the overall costs of the Nation's land imaging capabilities.

The SLI-T program is envisioned to be flexible enough to accept new instruments, sensors, systems, components, architectures, data systems, and measurement concepts that offer flexibility in implementing and enhancing future SLI measurements.

The Sustainable Land Imaging – Technology (SLI-T) program funds innovative technology development activities leading to new Sustainable Land Imaging (SLI) instruments, sensors, systems, components, data systems, measurement concepts, and architectures in support of the nation's future SLI activities. The technologies, measurement concepts, and architectures developed under the SLI-T may extend up through field demonstrations with a longer-term aim for infusion into future SLI flight programs

2. Point of Contact

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A.47 DECADAL SURVEY INCUBATION STUDY TEAMS

NOTICE: The Decadal Survey Incubation (DSI) program will not be competed in ROSES-2020. NASA expects to initiate a call in ROSES-2021 for activities relevant to the Incubation targeted observables for Planetary Boundary Layer (PBL) and Surface Topography and Vegetation (STV).

1. Scope of Program

The 2017 decadal survey recommended the implementation of an incubation program intended to accelerate the readiness of high-priority observables not yet feasible for cost-effective flight implementation. Utilizing results from the Decadal Survey Incubation Study Team activities solicited in ROSES-2019 with completion expected by the fall of CY2020, a new solicitation called Decadal Survey Incubation is expected to be released in ROSES-2021. The DSI program will seek proposals for technology development and related activities that support future development of the PBL and STV targeted observables for the Science Mission Directorate's Earth Science Division.

2. Point of Contact

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A.48 ADVANCED INFORMATION SYSTEMS TECHNOLOGY

NOTICE: The Advanced Information Systems Technology (AIST) program will not be competed in ROSES-2020. It is anticipated that the Advanced Information Systems Technology program will be competed again in ROSES-2021.

1. Objectives

The objectives of the Advanced Information Systems Technology (AIST) program are to identify, develop, and (where appropriate) demonstrate advanced information system technologies which:

- Reduce the risk, cost, size, and development time of Earth Science Division (ESD) space-based and ground-based information systems;
- Increase the accessibility and utility of science data; and
- Enable new observation measurements and information products.

2. Program Description

NASA's Advanced Information Systems Technology (AIST) Program identifies, develops, and supports the adoption of novel information systems that respond to future Earth Science's needs in a 5-10-year timeframe. ESTO's AIST program employs an end-to-end approach to evolve technologies – from the design of future observation systems and strategies to the space segment, where the information pipeline begins, and finally to the end user, where knowledge and data intelligence is advanced. Information provided to a nationwide community of users will result in significant leaps of knowledge of Earth science dynamics that benefit the global community.

At the start of the pipeline, the AIST New Observing Strategies (NOS) thrust optimizes measurement acquisition using many diverse observing capabilities, collaborating across multiple dimensions and creating a unified architecture. This includes utilizing Distributed Spacecraft Missions (DSM) and diverse observations from multiple vantage points, as well as inter-spacecraft communications and onboard analysis and decision making. On the user side of the pipeline, AIST Analytic Center Frameworks (ACF) enhance and enable focused science investigations by facilitating access, integration and understanding of disparate datasets using groundbreaking visualization and analytics tools as well as relevant computing environments. This will allow flexibility for science investigators to choose among a variety of datasets and tools, while reducing repetitive work in data access and pre-processing.

3. Programmatic Information

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A.49 SOLAR IRRADIANCE SCIENCE TEAM

NOTICE: Amended June 8, 2020. This Amendment adds this program element to ROSES-2020. Notices of Intent are requested by August 7, 2020 and proposals are due September 11, 2020.

1. Scope of Program

1.1 Overview

Solar irradiance represents the primary external forcing operating on the Earth and contributes to variability and change in the Earth's climate and atmospheric composition. Solar irradiance can only be measured above the atmosphere given the significant absorption that takes place within the atmosphere. The Earth system is sensitive to variations in the Total Solar Irradiance (TSI) and to the spectral dependence of any variation, given that different wavelengths experience the most absorption at different altitudes in the atmosphere. Variations in TSI are quite small—the typical variation over the 11-year solar cycle is on the order of 0.1%. Variations in the solar irradiance as a function of wavelength—or Spectral Solar Irradiance (SSI)—increase with decreasing wavelength, by a few percent at the short-wavelength ultraviolet radiation responsible for photodissociation of oxygen and a factor of order unity at wavelengths near Lyman Alpha (121.6 nm).

1.2 Science Team Activities

The Solar Irradiance Science Team (SIST) was first competed in the ROSES-2014 solicitation, and subsequently recompeted in 2017. The primary purpose of the SIST is to support the development of consistent multi-instrument/multi-platform space-based data sets of both total and spectrally resolved solar irradiance. The data sets should be useful as input to global models (e.g., general circulation models, atmospheric chemistry/transport models) and data assimilation systems, so that the effects of variations in solar output can be properly represented and their impacts on the Earth system investigated. The efforts carried out in this area will be expected to involve components such as the following:

- Rigorously accounting for drifts in instrument operation over the respective instrument lifetimes
- Determining calibration offsets that can be applied to one or more data sets to create a consistent data record
- Reprocessing data sets from previously operating satellites using newly obtained calibration information
- Analyzing and/or interpreting laboratory or other (balloon, rocket, etc.) calibration data that can be used to recalibrate existing data records
- Intercomparing total solar irradiance and spectrally resolved solar irradiance observations to describe changes in the relationships between them that may provide a mechanism for establishing relative consistency or inconsistency of different approaches for connecting disparate data sets
- Comparing solar irradiance data sets with those of solar irradiance proxies to help define the range of relationships between them and support the inference of longer-term solar irradiance records that can be used to force models as described above

- Exploring methods for bridging with minimal impact any previous or future gaps in solar irradiance records that can occur with the unexpected loss of an instrument or failure to launch subsequent instruments in a timely manner

The SIST is not intended to support fundamental research in solar physics, or irradiance observations at wavelengths less than 100nm. At those wavelengths the primary impact of solar irradiance is to drive changes in atmospheric composition at altitudes above those commonly represented in the climate and atmospheric composition models used by NASA's Earth Science Division research community. The SIST is also not intended to carry out research on the impacts of solar irradiance on Earth's climate and/or atmospheric composition. Research in those areas is periodically solicited by other NASA research programs from the Heliophysics Division and the Earth Science Division. Proposals submitted to this SIST program element that are focused in these areas will be deemed non-responsive and returned to the proposer without review.

2. Programmatic Information

2.1 Data Sets

Proposers are free to include any mix of solar irradiance data sets, including those from currently operating missions, e.g., Total and Spectral Solar Irradiance Sensor-1 (TSIS-1), Compact Spectral Irradiance Monitor (CSIM); missions no longer taking data, e.g., Solar Radiation and Climate Experiment (SORCE), Total Solar Irradiance Calibration Transfer Experiment (TCTE), Active Cavity Radiometer Irradiance Monitor Satellite (ACRIMSAT), and Upper Atmosphere Research Satellite (UARS); and missions launched in the future. Examples of such future missions include the Total Solar and Spectral Solar Irradiance Sensor – 2 (TSIS-2), scheduled to be launched by NASA in 2023, or the Compact Total Irradiance Monitor (CTIM). Data from NASA and non-NASA sources are fully appropriate for inclusion, subject to the restriction that all data being used in the proposal must be publicly available to the entire proposing community. Proposals involving the use of data sets that are not publicly available may be returned as non-responsive to the proposer, or only be funded for proposal components using publicly available data sets. Data sets from free-flying satellites as well as human-occupied platforms (including the International Space Station) may also be included.

2.2 Solar Irradiance Science Team Leader

In addition to proposals for SIST membership, proposers may apply for the position of SIST Leader. The SIST Leader will be responsible for providing scientific leadership and direction to the SIST and supplying scientific inputs regarding solar irradiance issues to NASA management. In consultation with the NASA Headquarters program scientist(s) for the relevant missions, he/she will be responsible for calling and organizing science team meetings and related activities.

SIST Leader proposals should include a separate section of up to three additional pages in the Scientific/Technical/Management section that describes only the activities to be undertaken as SIST Leader and that addresses the following aspects of team leadership:

- The solar irradiance research qualifications and leadership skills of the proposing SIST Leader

- A clear articulation of the proposed SIST Leader's vision for the NASA SIST and its contribution to NASA's Earth Science research goals
- A management plan that describes the approach to science team leadership, how interactions with the SIST and NASA management will be conducted, and how science team business and meetings will be organized and conducted

In addition, SIST Leader proposals must include a detailed budget and a narrative and justification for the SIST Leader work only - separate from any SIST member activities - in the Budget Justification: Narrative and Details section. NASA expects a budget commensurate with the proposed scope of the SIST Leader activity, not to exceed $30,000 per year. Proposers who wish to be considered for SIST Leader also should indicate their candidacy by answering the relevant cover sheet question.

NASA reserves the option to select a SIST Leader from among the SIST members should proposals of adequate merit and suitability not be received for the SIST Leader role.

2.3 Science Team Meeting

All proposers will be expected to attend one three-day annual meeting, ideally to be held virtually due to the small size of the science team.

3. Summary of Key Information

Expected program budget for first year of new awards	~ $1.0 M
Number of new awards pending adequate proposals of merit	~6-8
Maximum duration of awards	3 years
Due date for Notice of Intent to propose	See Tables 2 and 3 of this ROSES NRA
Due date for proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	6 months after due date for proposals
Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 in the the *ROSES Summary of Solicitation*. Also, three additional pages for Team Leaders, see Section 2.2.
Relevance	This program is relevant to the Earth Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*
General requirements for content of proposals	See A.1 Earth Science Research Overview and Section IV and Table 1 of *the ROSES Summary of Solicitation*
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ and Section IV(b) of *the ROSES Summary of Solicitation*

Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ help desk available at nspires-help@nasaprs.com or (202) 479-9376
Web site for submission of proposal via Grants.gov	http://grants.gov/ help desk available at support@grants.gov or (800) 518-4726
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-SIST
Point of contact concerning this program	David B. Considine Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: 202-358-2277 Email: david.b.considine@nasa.gov

A.50 SAGE III/ISS SCIENCE TEAM

NOTICE: Amended June 16, 2020. This Amendment adds this program element to ROSES-2020. Notices of intent are requested by September 18, 2020, and proposals are due November 6, 2020.

1. Introduction

Atmospheric composition changes affect air quality, weather, climate, and critical constituents, such as ozone. Atmospheric exchange links terrestrial and oceanic pools within the carbon cycle and other biogeochemical cycles. Solar radiation affects atmospheric chemistry, and is thus a critical factor in atmospheric composition. Atmospheric composition is central to Earth system dynamics, since the atmosphere integrates surface emissions globally on time scales from weeks to years and couples several environmental issues.

NASA's research for furthering our understanding of atmospheric composition is geared toward providing an improved prognostic capability for key processes and issues, including the recovery of stratospheric ozone and its impacts on surface ultraviolet radiation, evolution of greenhouse gases and their impacts on climate, and evolution of tropospheric ozone and aerosols and their impacts on climate and air quality. Research within the Atmospheric Composition Focus Area addresses the following science questions:

- How is atmospheric composition changing?
- What trends in atmospheric composition and solar radiation are driving global climate?
- How does atmospheric composition respond to and affect global environmental change?
- What are the effects of global atmospheric composition and climate changes on regional air quality?
- How will future changes in atmospheric composition affect ozone, climate, and global air quality?

Objectives of NASA's Atmospheric Composition Focus Area include monitoring and assessing the coupled effects of changes in ozone-depleting substance emissions and climate variations on ozone recovery and future atmospheric composition; enabling more accurate climate forecasts based on improved understanding of the forcings of global environmental change; and developing and refining better air quality forecasts that take into account feedback between regional air quality and global climate variations. Achievements in these areas via advances in observations, data assimilation, and modeling enable improved descriptions and predictions of how changes in atmospheric composition affect ozone, climate, and air quality.

An integrated observational strategy involving global observations from space, augmented by suborbital and ground-based measurements, is key to NASA’s scientific approach to analyzing and predicting atmospheric composition. This integrated observational strategy is furthered via studies of atmospheric processes using unique suborbital platform-sensor combinations to investigate, for example: (1) the processes responsible for the emission, uptake, transport, and chemical transformation of ozone

and precursor molecules associated with its production in the troposphere and its destruction in the stratosphere, and (2) the formation, properties, and transport of aerosols in the Earth's troposphere and stratosphere, as well as aerosol interaction with clouds. NASA's research strategy for atmospheric composition encompasses an end-to-end approach for instrument design, data collection, analysis, interpretation, and prognostic studies.

2. Programmatic Information

The Stratospheric Aerosol and Gas Experiment III (SAGE III) was launched to the International Space Station (ISS) on February 19, 2017. The SAGE III instrument's primary objective is to monitor the vertical distribution of aerosols, ozone, and other trace gases in Earth's stratosphere and troposphere to enhance our understanding of ozone recovery and climate change processes in the stratosphere and upper troposphere (https://sage.nasa.gov/missions/about-sage-iii-on-iss/). SAGE III/ISS is providing data that may be used for:

- Assessing long-term, vertically resolved changes in upper atmospheric composition (e.g., ozone, aerosol, water vapor, temperature);
- Identifying and modeling geophysical variability influencing the distributions of ozone and other atmospheric constituents, such as the quasi-biennial oscillation, El Niño–Southern Oscillation, solar variability, and volcanic eruptions;
- Developing accurate, multi-source products that draw on the respective strengths of different techniques for measuring aerosols in the upper troposphere and stratosphere by integrating SAGE III aerosol observations with those of other space-based and/or surface or airborne sensors; and
- Generating spatial/temporal fields of key chemical species observed by SAGE III/ISS and using such fields for quantitative scientific study.

SAGE III is the third generation of solar occultation instruments operated by NASA. SAGE I was flown from 1979 through 1981 as a follow-up to the Stratospheric Aerosol Measurement (SAM) instrument on the July 1975 Apollo-Soyuz mission. SAGE II, launched aboard the Earth Radiation Budget Satellite (ERBS), operated from 1984 through 2005. The first SAGE III instrument was launched in 2001 on a Russian satellite, Meteor-3M, and provided data through 2005 (https://eosweb.larc.nasa.gov/project/sage3/sage3_table). For the current SAGE III mission, the ISS inclined orbit of 51.6° is ideal, because the orbit permits solar occultation measurement coverage everywhere between approximately 70° N and 70° S latitudes. In addition to solar occultation measurements, SAGE III/ISS, in common with SAGE III/Meteor-3M, is making measurements using lunar occultation and limb scattering measurement techniques.

Well-calibrated and -characterized geophysical data from SAGE III/ISS are available at the NASA Atmospheric Science Data Center (https://eosweb.larc.nasa.gov/project/sageiii-iss/sageiii-iss_table). Solar and lunar occulation data releases follow a monthly release schedule with minimal lag.

The SAGE III/ISS instrument and processing are similar to those of SAGE III/Meteor-3M. With the exception of the experimental cloud presence profile product generated for SAGE III/Meteor-3M but not produced for SAGE III/ISS, the major SAGE III/ISS data

products are the same as those for SAGE III/Meteor-3M and have quantitatively similar characteristics and accuracies, as did products from the earlier Meteor-3M mission. For the purposes of proposals to this solicitation, Table 1 in the SAGE III/ISS Data Product User's Guide (https://eosweb.larc.nasa.gov/project/sageiii-iss/guide/DPUG-G3B-2-0.pdf) can be used as a guide to the products produced by SAGE III/ISS.

3. Research Themes

This program element seeks proposals for members of the SAGE III Science Team. Proposals are sought in six topical areas. The first five areas are presented in no particular priority order, while the sixth topic, Independent Validation (Section 3.6), is deemed of somewhat lower priority. While NASA is soliciting proposals in all of the areas, it is not committing to funding proposals in each of these areas.

3.1 Assessing Long-term Changes in Atmospheric Composition

Proposals are sought that identify and quantify trends in constituents and atmospheric variables where SAGE III/ISS observations can play a significant role; specifically, ozone, aerosol extinction, water vapor, and nitrogen dioxide. For decadal-scale trend detection, it is necessary to link the SAGE III/ISS measurements with earlier missions in a rigorous manner and to provide quantitative uncertainty estimates. Applicable missions include, but are not limited to, other solar occultation experiments (including the earlier SAGE missions), as well as limb-sounding profile, emission-based profile, and column-based measurements.

3.2 Aerosol and Cloud Studies

The 2014 NASA Atmospheric Composition Focus Area workshop on "Outstanding Questions in Atmospheric Composition, Chemistry, Dynamics and Radiation for the Coming Decade" (https://espo.nasa.gov/home/sites/default/files/documents/SMDWorkshop_report_final.docx) identified key findings and research recommendations with respect to stratospheric aerosol and cloud morphology and trends. Proposals are sought that address one or more of these research questions, focusing on aerosols, clouds, and/or their interactions, using SAGE III/ISS observations.

3.3 Data Analysis and Modeling Efforts Using SAGE Datasets

This topic area solicits proposals that utilize SAGE III/ISS, and possibly other satellite-derived profile measurements, to advance Earth system modeling/prediction capability, create products to facilitate the analysis of noncoincident satellite occultation measurements, or that use SAGE III/ISS observations in chemical data assimilation studies.

3.4 Multi-sensor Data Product Development

This topic area is soliciting proposals that integrate data from SAGE III/ISS and other contemporary spaceborne platforms, as well as surface and airborne observations (as appropriate), to develop and utilize self-consistent global products to investigate phenomena for which SAGE III/ISS observations alone are not sufficient (e.g., ozone diurnal variability, mesospheric ozone structure, aerosol speciation, single scattering albedo). The Committee on Earth Observation Satellites (CEOS) Earth Observation

Handbook online database (http://database.eohandbook.com/measurements/overview.aspx) provides information about currently-operating, space-based measurement capabilities that could be used in these studies. Proposers must explicitly identify the non-SAGE III/ISS data products they plan to use and must present a realistic plan for obtaining any non-SAGE III/ISS data not available from the NASA EOSDIS.

3.5 Limb Scatter Retrieval Algorithm Development or Adaptation

Proposals are sought that adapt proven algorithms or develop new algorithms for retrieving profiles of atmospheric constituents/parameters utilizing SAGE III/ISS limb scatter observations (e.g., ozone and wavelength-dependent aerosol scattering). Proposals should include a methodology for evaluating the validity of each retrieval product.

The proposed activities are expected to produce algorithms that will run on the SAGE III/ISS Science Computing Facility at the NASA Langley Atmospheric Science Data Center. The SAGE III/ISS project is responsible for the implementation of the algorithm, performing routine production processing, and maintaining product distribution. The proposer is responsible for algorithm development, verifying and documenting its implementation and performance in an Algorithm Theoretical Basis Document, and validating the retrieval products. The SAGE III/ISS project will maintain any codes developed. More information will be made available at https://sage.nasa.gov/ by early July.

3.6 Independent Validation

Continuous validation is important for assessing the stability of the datasets. The project relies on Network for the Detection of Atmospheric Composition Change (NDACC) sites for routine correlative measurements of ozone and aerosol vertical profiles using lidars (http://www.ndacc.org). Frost-point sonde measurements are used in water vapor validation, while National Institute of Water and Atmospheric Research (http://www.ndaccdemo.org/stations/lauder-new-zealand) measurements are used for nitrogen dioxide validation.

Proposals are sought for activities that complement those conducted by the project and contribute to validation of the accuracy and precision of the SAGE III/ISS standard science products (see Table 1 in the SAGE III/ISS Data Product User's Guide), particularly through acquisition of correlative measurements. The scientific justification for such activities must be compelling and must quantitatively state how the work proposed will reduce uncertainty and/or deal with recognized limitations of current algorithms. Proposed validation activities may involve a single or multiple data products.

New field validation campaigns are not solicited. Proposers may make use of existing field-based observations.

4. Science Team Leader

In addition to proposals for SAGE III/ISS Science Team membership, there is also the opportunity to propose for the position as Team Leader for the SAGE III/ISS Science Team. The SAGE III/ISS Science Team Leader is responsible for providing scientific

leadership and direction to the Team and scientific input regarding relevant issues to NASA management. In consultation with the Headquarters program scientist, he/she is responsible for calling and organizing science team meetings and related activities.

Team Leader proposals should include a separate section of up to three additional pages in the Scientific/Technical/Management section that describes only the activities to be undertaken as the SAGE III/ISS Science Team Leader and addresses the following aspects of team leadership:

- The scientific qualifications and leadership skills of the proposing Team Leader;
- A clear articulation of the proposed Team Leader's vision for the NASA SAGE III/ISS Science Team and its contribution to NASA's Earth Science research goals; and
- A management plan that describes the approach to science team leadership, how interactions with the SAGE III/ISS Science Team and NASA management will be conducted, and how science team business and meetings will be organized and conducted.

In addition, for those proposing to be the Team Leader, the *Budget Justification: Narrative and Details* section of the proposal must include a (redacted) detailed budget and a narrative and justification for the Team Leader work only, separate from that of the leader's proposed SAGE III/ISS Science Team member activities. On the NSPIRES cover page budgets, please put the total of the costs associated with the Team lead activities in Section F line 8 or 9. Team lead activities are unlikely to require more than $75k/year, however NASA expects a budget commensurate with the proposed scope of the Team Leader activity. Proposers who wish to be considered for SAGE III/ISS Science Team Leader should also indicate their candidacy by answering the relevant cover sheet question.

NASA reserves the option to select a Team Leader from among the Science Team members should proposals of adequate merit and suitability not be received for the Team Leader role.

5. Science Team Meeting

All proposers should budget to attend one two-day annual science team meeting to be held on the East Coast of the United States each year (for costing purposes, assume the meeting will take place in the Hampton, VA area).

6. Summary of Key Information

Expected program budget for first year of new awards	~$1.5M
Number of new awards pending adequate proposals of merit	~8-10
Maximum duration of awards	3 years
Due date for Notice of Intent	See Tables 2 and 3 of this ROSES NRA
Due date for Proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	6 months after proposal due date

Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of ROSES. Also, three additional pages for Team Leaders, see Section 4.
Relevance	This program is relevant to the Earth Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*
General requirements for content of proposals	See A.1 Earth Science Research Overview and Section IV and Table 1 of *the ROSES Summary of Solicitation*
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ and Section IV(b) of *the ROSES Summary of Solicitation*
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-SAGEIII
Point of contact concerning this program	Richard S. Eckman Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: 202-358-2567 Email: Richard.S.Eckman@nasa.gov

A.51 SCIENCE TEAM FOR THE OCO MISSIONS

NOTICE: Amended June 29, 2020. This Amendment adds this program element to ROSES-2020. Notices of Intent are requested by November 13, 2020 and proposals are due January 13, 2021.

1. Scope of Program

Proposals are solicited for participation in the Science Team for the Orbiting Carbon Observatory-2 (OCO-2) and Orbiting Carbon Observatory-3 (OCO-3) missions.

NASA launched the OCO-2 mission in July 2014. OCO-2 has been operating on orbit, producing precise column average CO_2 concentration data globally with validated precision and accuracy of better than 0.25% , since September 2014. The OCO-3 mission, with a near-replica instrument to OCO-2, has been operating on the International Space Station (ISS) since June of 2019 and is now returning data with similar precisions as OCO-2. The primary differences in the data sets are the spatial and temporal sampling as a result of the different orbits of the observations (especially inclination) and the available observational modes of the instruments.

These missions follow in the footsteps of the successful Japanese Aerospace Exploration Agency (JAXA) Greenhouse gasses Observing SATellite (GOSAT) mission, which launched in 2009, and GOSAT-2, which launched in 2018. The OCO-2 project and its current science team have been working closely with the GOSAT teams to best assure accuracy and consistency in the data products from the four missions (GOSAT, GOSAT-2, OCO-2, OCO-3).

The primary goal of the OCO missions is to make near-global observations of column abundances of atmospheric CO_2 to better understand the processes that control this important greenhouse gas. These processes include exchange between the atmosphere and oceans and terrestrial biosphere, and emissions from anthropogenic sources. Global observations from a satellite are desired because they provide a significantly denser set of data over a much wider range of conditions than can be provided by surface observations alone. Observations of column averaged abundances of CO_2 require precisions and accuracies of better than 0.3% (or 1 ppm), which are significantly lower than variations seen globally and regionally, and with sensitivity to the boundary layer of the atmosphere.

These observations are obtained through retrievals from high precision, high resolution, near infrared spectra of two CO_2 channels and one channel of the O_2 A-band in nadir viewing solar reflection geometries. The latter is to ensure knowledge of the dry air column of the same air mass as observed by the co-aligned CO_2 channels. Dividing the CO_2 column by the dry air mass column provides average column dry air mixing ratios (XCO_2). These observations produce narrow swath (10.3 km), narrow footprint (3 km^2) observations around the globe. The small footprint was chosen to reduce the influences of cloud and aerosol contamination in the observed spectra to better ensure reduced systematic uncertainties in the retrieved abundances.

Data from the OCO-2 and OCO-3 instruments also provide retrievals of Solar Induced Fluorescence (SIF) that serve as an indicator of photosynthetic activity of the terrestrial biosphere. SIF has been used by researchers to infer the uptake of CO_2 by plants,

which relates to roughly half of what is required to understand exchange between the atmosphere and biosphere.

OCO-2 operates in a sun synchronous orbit and coordinated with several other Earth observing satellites as part of the A-Train constellation. Information on the A-Train, and the other observations being made, can be found at http://atrain.nasa.gov/. This orbit allows for near-global coverage, with the observations at any latitude occurring at roughly the same solar time each orbit. OCO-3 on the ISS (orbital inclination of 51.5 degrees) has a precessing orbit. This orbit does not allow for observations over high latitude regions and the solar times of the observations at any latitude will change with each orbit. This has both limitations and opportunities when using the data for understanding CO_2 exchange processes. Plus, OCO-3 has a more agile (faster) scene selection mechanism, allowing for more focused mapping of regions of interest when scientifically appropriate. These observations are currently focused on areas around with globe with unique potential CO_2 emission and uptake patterns that are of scientific interest.

Additional information about the OCO-2 and OCO-3 missions is available at the OCO websites: http://oco.jpl.nasa.gov and https://ocov3.jpl.nasa.gov/.

2. Science Team for the OCO-2 and OCO-3 Missions

The OCO-2 mission has been operating for more than 5 years and is currently in extended operations. OCO-3 had been in operations for roughly one year. A number of versions of the OCO-2 data products have been made available to the research community through the NASA Goddard Earth Science Data and Information Services Center (GES DISC), and a new version (v10), consistent with the algorithm used to produce OCO-3 XCO_2, and is also becoming available. The v10 data significantly reduce the systematic differences/biases between observations over land and those from the glint observations over the ocean. Hence, desired contributions to the OCO team are mainly for science analysis that effectively advances the OCO-2 and OCO-3 science goals. Several focused activities are being solicited, with the goal of enabling production of future improved OCO-2 and OCO-3 data products. These tasks include:

- Flux inversion analysis using OCO-2/3 data (GOSAT data may also be included as appropriate), including assessment of retrieval errors on flux inversions that significantly advance understanding of carbon cycle processes.
- New research and innovative analyses using OCO-2 and OCO-3 data combined with other sensors (e.g., GOSAT, other A-Train sensors, SMAP, GEDI, ECOSTRESS) to advance OCO-2 and OCO-3 science goals and significantly advance our understanding of carbon cycle processes (oceanic and terrestrial) and/or anthropogenic emissions.
- Studies that take full advantage of the OCO-2/OCO-3 Solar Induced Fluorescence data product in combination with the Level 2 CO_2 product and other satellite-based observations to significantly advance our understanding of carbon cycle processes.
- Significant improvement to OCO-2/OCO-3 relevant spectroscopy that provides demonstratable and significant improvement in XCO_2 retrievals, particularly of H_2O transitions within the 2-micron CO_2 band.

- Assess retrieval biases, errors, and covariances in the OCO-3 (primarily) and OCO-2 (secondarily) Level 2 products relative to key variables, such as observational geometries, clouds, spectral polarization, aerosols, and surface reflections, to ensure better scientific interpretation of the Level 2 data product.
- Validation strategies for Level 2 products (including XCO_2, cloud detection, solar induced fluorescence) beyond the current OCO-2 and OCO-3 validation plan (plan available at: https://co2.jpl.nasa.gov//static/docs/OCO-2_SciValPlan_111005_ver1_0_revA_final_signed.pdf). Validation activities should include possible new sources of validation data traceable to World Meteorological Organization standards and useful to OCO-2 and OCO-3, with primary interest in under-sampled regions of the globe (South America, Africa, etc.).
- Analysis of the OCO-2 and OCO-3 data sets for understanding anthropogenic discrete and distributed sources of CO_2 emissions, particularly taking advantage of OCO-3 capabilities.

3. Programmatic Information and Proposal Requirements

Proposals for Science Team membership must include, within the 15-page description of the research, the proposer's interest and expertise that contribute to the Science Team.

3.1 Participation from Non-US organizations

Non-United States (US) organizations are welcome to submit proposals on a no-exchange-of-funds basis and within the constraints described in the *NASA Guidebook for Proposers* (http://www.hq.nasa.gov/office/procurement/nraguidebook/). Proposers affiliated with organizations not in NSPIRES may make use of the NASA Foreign PI Support Organization. Proposers from non-US institutions should read the Foreign PI Affiliation instructions document, which is downloadable as a PDF file from the NSPIRES web page for this program element. Non-US proposals will be reviewed to the same standards as proposals from US institutions and selected solely by NASA. All such proposals (and proposals from US organizations that have Co-Is from non-US organizations) must contain a certification that a sponsoring foreign government agency or foreign institution commits to bearing the cost of the research proposed to be performed by the non-US organization should the proposal be selected by NASA.

3.2 Evaluation Criteria

Proposals will be evaluated vs. the three standard criteria: intrinsic merit, relevance, and cost, as defined in the *NASA Guidebook for Proposers*. The general information provided in Section VI of *ROSES-2020 Summary of Solicitation* about the proposal review and selection process applies to this program element.

In addition, as part of the scientific merit, proposals will also be evaluated on the basis of the principal investigator's proven capabilities, past performance and results on related activities (if applicable), as well as the novel approaches and activities proposed to address topics that will ensure maximizing the science return for OCO-2 and OCO-3.

4. Summary of Key Information

Expected program budget for first year of new awards	~$3.5M/year
Number of new awards pending adequate proposals of merit	~15-20
Maximum duration of awards	3 years
Due date for Notice of Intent to propose	See Tables 2 and 3 of this ROSES NRA
Due date for proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	6 months after due date for proposals
Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 in the *ROSES Summary of Solicitation*.
Relevance	This program is relevant to the Earth Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*
General requirements for content of proposals	See A.1 Earth Science Research Overview and Section IV and Table 1 of *the ROSES Summary of Solicitation*
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ and Section IV(b) of *the ROSES Summary of Solicitation*
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ help desk available at nspires-help@nasaprs.com or 202-479-9376.
Web site for submission of proposal via Grants.gov	http://grants.gov/ help desk available at support@grants.gov or 800-518-4726.
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-OCOST
Point of contact concerning this program	Kenneth W. Jucks Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: 202-358-0476 Email: kenneth.w.jucks@nasa.gov

APPENDIX B. HELIOPHYSICS RESEARCH PROGRAM

NOTICE: April 6, 2020. Section 1.5 has been corrected in a number of ways. New text is in bold and deleted text is struck through.

Please note the major changes in the Heliophysics program in 2020 listed in Section 1.1.1.

B.1 HELIOPHYSICS RESEARCH PROGRAM OVERVIEW

1. Overview

NASA's Heliophysics' overarching goal is to understand the Sun and its interactions with the Earth and the Solar System, including space weather. In this framework, the Heliophysics Research Program is guided by the *NASA 2014 Science Plan* (available at https://science.nasa.gov/about-us/science-strategy) and by the *2013 National Research Council Decadal Strategy for Solar and Space Physics report, Solar and Space Physics: A Science for a Technological Society* (www.nap.edu/catalog.php?record_id=13060). Heliophysics research addresses these recommendations by implementing a program to achieve all of the goals and objects in the science plan and DS report, summarized by these combined objectives:

- Explore and characterize the physical processes in the space environment from the Sun to the heliopause and throughout the universe
- Advance our understanding of the Sun's activity, and the connections between solar variability and Earth and planetary space environments, the outer reaches of our solar system, and the interstellar medium
- Develop the knowledge and capability to detect and predict extreme conditions in space to protect life and society and to safeguard human and robotic explorers beyond Earth.

The Heliophysics Research Program supports investigations in all research regimes of Heliophysics. The program supports investigations of the Sun, including processes taking place throughout the solar interior and its atmosphere, as well as the evolution and cyclic activity of the Sun. It supports investigations of the origin and behavior of the solar wind, transient structures, energetic particles, and magnetic fields in the heliosphere and their interaction with the Earth and other planets, as well as with the interstellar medium. The program supports investigations of the physics of magnetospheres, including fundamental interactions of plasma wave-particle interactions and particles with guide fields, as well as coupling to the solar wind and ionospheres. It supports investigations of the physics of the terrestrial mesosphere, thermosphere, and ionosphere, neutral and ionized, and coupling of these phenomena to the lower atmosphere and magnetosphere. It supports investigations focused on processes that create space weather events, and investigations to enable a capability for predicting future space weather events.

The Heliophysics Research Program also supports investigations that span the regimes and address a systems approach – emphasizing the understanding of fundamental processes and interconnections across the traditional science disciplines, on a broad range of spatial and temporal scales. In concert with the other NASA science divisions (Planetary Science, Astrophysics, and Earth Science), the program shares responsibility

for learning about the Earth, our Solar System, the Universe, and their interrelationships.

1.1 Solicited Programs

ROSES-2020 program elements are listed below. It is the overall purpose of each of these program elements to contribute as effectively and directly as possible to the achievement of the NASA Heliophysics' overarching goal and three science objectives. Priority for selection is given to those proposals that most clearly demonstrate the potential for such contributions.

The program elements are as follows:

- B.2 Heliophysics Supporting Research (HSR)
- B.3 Heliophysics Theory, Modeling, and Simulations (HTMS) – not solicited this year
- B.4 Heliophysics Guest Investigators Open (HGIO)
- B.5 Living With a Star Science (LWS)
- B.6 Living With a Star Strategic Capabilities (LWS-SC)
- B.7 Space Weather Science Applications Operations 2 Research (SWO2R)
- B.8 Heliophysics Technology and Instrument Development for Science (H-TIDeS)
- B.9 Heliophysics Low Cost Access to Space (H-LCAS)
- B.10 Heliophysics Flight Opportunities Studies (H-FOS)
- B.11 Heliophysics Flight Opportunities for Research & Technology (H-FORT)
- B.12 Heliophysics Data Environment Enhancements (HDEE)
- B.13 Heliophysics U.S. Participating Investigators (H-USPI)
- B.14 Heliophysics Early Career Investigators Program (ECIP)
- B.15 GOLD/ICON Guest Investigator (GIGI)
- B.16 Parker Solar Probe Guest Investigator (PSPGI)

Each element above contains element-specific requirements, e.g., scope, content, length. General Heliophysics-specific requirements are included in this document in Section 1. Common requirements for all ROSES elements are fund in the *ROSES Summary of Solicitation* and the *Proposer's Guidebook* (https://www.hq.nasa.gov/office/procurement/nraguidebook).

The order of precedence is the following: ROSES Element B.2 through B.16 followed by the Heliophysics Overview, ROSES Element B.1 (this document), followed by the ROSES *Summary of Solicitation*, followed by the *Proposer's Guidebook*. Proposers should be familiar with all of these resources and should especially read each element (above) carefully.

1.1.1 *What's New in Appendix B This Year*

Please note the three major changes in the Heliophysics program in 2020: First, the Heliophysics Flight Opportunities for Research and Technology program is now split into three program elements – Low Cost Access to Space (HLCAS, Section 2.9), Flight Opportunities Studies (HFOS, Section 2.10), and Flight Opportunities: SmallSats and Ridershare (HFORT, Section 2.11). Second, proposals submitted to the Guest Investigator Open program will be evaluated using dual-anonymous peer review in

which, not only are proposers unaware of the identity of the reviewers, but the reviewers are not given the identity of the proposers. This is described in Sections IV(b)i and VI(b) of the *ROSES-2020 Summary of Solicitation* and Section 1.8, below. Third, the sufficiency of the data management plan (DMP) will be evaluated as part of Merit and thus may have a bearing on whether or not the proposal is selected (see Section 1.5).

Other changes in or additions to the Heliophysics program in 2020 include:

Two targeted guest investigator programs – GOLD/ICON (Section 2.15) and PSP (Section 2.16) in addition to the guest investigator open program (Section 2.4); for the open program, GOLD, ICON, and PSP are excluded.

Early Career Investigators Program (ECIP) is solicited in 2020 (Section 2.14).

Citizen Science projects are accepted into any ROSES Element (Section 1.9).

High-risk/high impact proposals are accepted into any ROSES Element (Section 1.10).

1.2 General Proposal Content

Proposals require three core aspects: (1) a clear statement of the specific objective(s), (2) a justification of why the objective(s) is important, and (3) a description of how the objective(s) will be achieved. Successful proposals clearly lay out each aspect for reviewers. They often lead with clear, achievable objectives and then just enough background to justify why the objectives are important, followed by an extensive detailed description of how the objectives will be achieved.

Proposals should be focused enough to be achievable within the lifetime of the award. Proposals should include adequate personnel commitments to ensure achievable results.

1.3 Two-Step Process

Proposal submission to elements in Heliophysics will use a two-step proposal submission process unless otherwise specified in a specific program call. Use of the two-step process increases the notice provided to potential reviewers. The overall description of a two-step process can be found in Section IV(b)vii of the *ROSES Summary of Solicitation*.

In the two-step process a Step-1 proposal is required. Potential reviewers are solicited based on the Step-1 proposal. The proposal team members may not be changed between the Step-1 and Step-2 proposals, unless prior approval is obtained from the Program Officer of the element. The title and broad science goals of the proposal may not be changed such that they would significantly affect the scientific or technical expertise required to properly evaluate a proposal. Changes in a proposal that impact the review will result in a proposal being declared non-compliant.

All Step-1 and Step-2 proposals for the Heliophysics elements must be submitted electronically by the due date (see Table 2 and Table 3 of ROSES). Both Step-1 and Step-2 proposals must be submitted by the organization's Authorized Organizational Representative (AOR). No budget or other elements are required for a Step-1 proposal. Only proposers who submit a Step-1 proposal are eligible to submit a Step-2 proposal.

All Heliophysics programs with Step-1 proposals will review the Step-1 proposals for compliance and will require a description that is limited to the 4000-character text box on the NSPIRES cover page that includes (1) the science goals and objectives, and (2) the proposed methodology. All compliant proposals submitted to these calls will be "invited" to submit a Step-2 proposal.

1.4 Multiple Submissions and Duplication

Proposers are limited to one submission per Principal Investigator (PI or Science PI) per program element, i.e., they can submit one and only one proposal as PI to each, unless otherwise specified in the program call.

Proposers may not submit Step-2 (or full) proposals for the same or essentially the same work to more than one program element concurrently. Each proposal should be submitted only once until it is accepted, declined, or withdrawn. This covers all program elements in Appendix B and also all cross-divisional ROSES program elements (Appendix E) supported by the Heliophysics Division. This prohibition includes switching the PI and a Co-I while submitting the same or essentially the same work.

This prohibition is active for a particular submitted proposal until the PI is notified that the proposal was accepted or declined, or until the proposal is withdrawn. The prohibition on duplicate proposals applies across ROSES years as well (e.g., a duplicate of a pending ROSES-2019 proposal may not be submitted in response to ROSES-2020). If a second proposal is submitted while a duplicate proposal is still pending in another program element, only the first proposal will be evaluated; the duplicate proposal may not be evaluated or considered and may be returned without review.

1.5 Data Management Plans and Archiving

New in ROSES-2020: The data management plan (DMP) will be evaluated as part of the Intrinsic Merit of the proposal and must be included in a special section (see below).

To broaden access to the results of NASA-funded research, proposals submitted to program elements in Appendix B must include a data management plan (DMP). The philosophy behind this requirement is that all relevant taxpayer-supported data should be made publicly available (i.e., without fee or restriction of use) at the time of publication, or at the earliest practical time thereafter, through a stable and long-term supported public data repository. If the proposed work would not produce data suitable for deposition in a public archive, then that should be explicitly justified in the proposal. Individual program elements may provide instructions that amplify the following requirements, but those stated below are the minimum.

For some program elements, the nature of the work is inexorably linked to the handling of data so DMP is part of the page-limited Scientific/Technical/Management (S/T/M) section of the proposal, e.g., B.7 Space Weather Science Applications and B.12 Heliophysics Data Environment Emphasis. With the exception of elements like those listed above where it explicitly says otherwise, all proposals to any of the ROSES elements that require DMPs must place it in a special section of the proposal, not to exceed two pages in length, entitled "Data Management Plan" immediately following the references and citations for the S/T/M portion of the proposal. Formatting requirements

for DMPs are the same as for the S/T/M section. When appropriate or required by the program element, letters of support from the Heliophysics Data Archives: the Solar Data Analysis Center (SDAC), and the Space Physics Data Facility (SPDF) ~~must~~ **may** be included in a Statements of Commitment and Letters of Support, Feasibility and Endorsement section of the proposal (see ROSES *Summary of Solicitation*, Table 1).

Proposers requiring a DMP are strongly encouraged to use the HPD DMP template, that may be downloaded as a Word document, from the SARA web page at: https://science.nasa.gov/researchers/templates-heliophysic-division-appendix-b-roses-proposals.

The DMP must cover any data needed to validate the scientific conclusions of peer-reviewed publications, particularly data underlying figures, maps, and tables. It also needs to cover any other data and software that would enable future research or the replication/reproduction of published results.

For proposals that use non-mission data (e.g., laboratory results, Earth-based observations) that are not publicly available (in any publicly accessible archive, in the literature, etc.), the project is expected to make the data available following the Data Management Plan guidelines.

"Data" does not include preliminary and other unpublished data, data in prepublication documents, private communications, or certain other types of information that have been specifically exempted from the DMP requirement.

In the case of a project that would produce no data, as defined above, or only data specifically exempted, the DMP must state that no data preservation or data sharing is needed and must also explain why. In a case where no appropriate archive exists for a particular data set, the DMP should discuss alternative methods for making the data publicly available.

DMPs will be reviewed as part of the proposal review process. Proposals that do not address each of these items in their DMP, even if determined to be selected or selectable for funding, may not be funded until an adequate DMP is submitted. Funded researchers, research institutions, and NASA centers are responsible for ensuring and demonstrating compliance with the DMPs approved as part of their awards. Awardees who do not fulfill the intent of their DMPs may have continuing funds withheld and this may be considered in the evaluation of future proposals.

Software, whether a stand-alone program, an enhancement to existing code, or a module that interfaces with existing codes, created as part of a ROSES award, should be made publicly available when it is practical and feasible to do so, and when there is scientific utility in doing so. Stand-alone code that is not straightforward to implement, or whose utility is significantly outweighed by the costs to share it, is not expected to be made available. SMD expects that the source code, with associated documentation sufficient to enable use of the code, will be made publicly available in ~~the Heliophysics section the NASA GitHub (https://github.com/nasa),~~ either of the two Heliophysics Archives (for mission-specific code, when appropriate), or an appropriate community-recognized depository ~~(for instance, the homepage of the code base for which a module was developed)~~. Archiving software in a public repository does not require the proposer

to maintain the code. Awards that derive from proposals that include plans to post code ~~in GitHub~~ will contain a ~~Rights in Data clause~~ **permissive open source license** reflecting this expectation. This expectation extends to three types of software, defined as follows:

Short Name	Name	Description	Examples
Libraries	Libraries and toolkits	Generic tools implementing well-known algorithms, providing statistical analysis or visualization, and so on, that are incorporated in other software categories.	Numerical Recipes, NumPy, general FFTs, LAPACK, scikit-learn, AstroPy, GDAL
Analysis software	Analysis, post-processing, or visualization software	Generalized software (not low-level libraries) used to manipulate measurements or model results to visualize or gain understanding.	Stand-alone image processing, topology analysis, vector-field analysis, satellite analysis tools, and so on
Frameworks	Modeling frameworks	Multicomponent software systems that incorporate a variety of models and couple them together in a complex way.	Community Earth System Model (CESM) is a collection of coupled models including atmospheric, oceanographic, sea ice, land surface, and other models

1.6 Data Eligibility

All spacecraft mission data must be available in the SDAC, SPDF, or an equivalent, publicly accessible archive, at least 30 days prior to the full proposal submission deadline, unless otherwise specified in the program call. If proposers are utilizing a publicly accessible archive other than SPDF or SDAC, then a link to that archive must be included.

1.7 Organizing Science Reviews

Heliophysics has established two questions that must be answered for all proposals submitted to Elements in Appendix B on the NSPIRES cover page. The answers define the Research Regime and Science Topic for the proposal and help to organize the evaluation and peer review. Unless otherwise specified in the program call, the values will default to what is listed here. The default values for Research Regime are Sun, Heliosphere, Magnetosphere, Ionosphere-Thermosphere-Mesosphere (ITM) and System-Interdisciplinary. The default values for Science Topic are listed below.

1. Solar Interior
2. Photosphere
3. Solar Transient Events
4. Solar Atmosphere - Corona

5. Particle Acceleration, Transport, Modulation
6. Turbulence, Waves, Composition
7. Interplanetary CMEs / Magnetic Clouds
8. Outer Heliosphere - Interstellar Boundary
9. Dayside Magnetosphere
10. Inner Magnetosphere
11. Magnetotail
12. Ionosphere – Atmosphere Coupling
13. Neutral Atmosphere
14. Solar-Heliosphere Coupling
15. Solar Wind – Magnetosphere Coupling
16. Magnetosphere – Ionosphere Coupling
17. Solar–Ionosphere/Atmosphere Coupling
18. Multi-disciplinary

Note: Do not choose Heliosphere meaning Heliophysics; they are not synonymous. This wastes time and resources to redirect; such misdirected proposals may be returned without review.

1.8 Dual-anonymous Reviews

SMD is strongly committed to ensuring that the review of proposals is performed in an equitable and fair manner that reduces the impacts of any unconscious biases. To this end and motivated by a successful pilot program conducted for the Hubble Space Telescope, Heliophysics Guest Investigator Open proposals (see Section 2.4) will be evaluated using dual-anonymous peer review. Under this system, not only are proposers unaware of the identity of the members on the review panel, but the peer reviewers are not told the proposing teams or organizations until after they have evaluated the scientific merit of all of the anonymized proposals. Proposers to HGIO must adhere to the instructions in the call on how to prepare proposals so as to allow dual-anonymous peer review, and detailed instructions for the preparation of proposals will be posted on the NSPIRES page for this ROSES element and at https://science.nasa.gov/researchers/dual-anonymous-peer-review. Note that GIGI (Section 2.15) and PSP-GI (Section 2.16) are not using dual-anonymous reviews.

1.9 Citizen Science Projects

Citizen science is a form of open collaboration in which individuals or organizations participate voluntarily in the scientific process. Proposers to any ROSES program element are invited to incorporate citizen science and crowdsourcing methodologies into their submissions, where such methodologies will advance the objectives of the proposed investigation. The current SMD Policy on citizen science, describes standards for evaluating proposed and funded SMD citizen science projects. For more information see Section 3 H.R.6414 - Crowdsourcing and Citizen Science Act of 2016, which authorizes federal agencies to utilize crowdsourcing and citizen science and the https://science.nasa.gov/citizenscience webpage, that provides information about existing SMD-funded projects, including how to sign up for the NASA-SOLVE email

listserve. Proposers who are including a Citizen Science element must select the NSPIRES checkbox indicating Citizen Science, to ensure an appropriate review of the citizen science methodology.

1.10 High-Risk/High Impact

Proposers to any ROSES program element are invited to submit proposals that are high risk – high impact, or include high risk – high impact components, as appropriate for the scope or conduct of the investigation. For more information see Section VI(b) of the *ROSES Summary of Solicitation*.

1.11 Award Types

NASA Heliophysics primarily awards grants, Inter-Agency Transfers (IATs), and awards to NASA centers, as these are the most appropriate to the nature of the work. These are the default for program elements in Appendix B, unless stated otherwise in a specific program element.

2. Program Elements

2.1 Introduction

A brief description of each program element offered in the Heliophysics Research Program is given below. The intent of the following summaries is to give the prospective proposer some insight into the element's purpose within the context of the overall program structure. Detailed descriptions of each element are to be found in Program Elements B.2 through B.16. Please note that the numbering and names of the program elements may have changed from ROSES-19.

2.2 Heliophysics Supporting Research (HSR)

The HSR program solicits research investigations of significant magnitude that employ a variety of techniques to address Heliophysics goals and objectives. The investigations that will be of highest priority to the HSR program will be those that use data from current or historical NASA spacecraft, or from non-NASA data, together with theory, modeling and/or numerical simulation to address one of the four Heliophysics Decadal Survey goals. Theory, modeling, and simulation must be substantiated with, and guided by, data. Innovative ideas and techniques are welcome. The Heliophysics Supporting Research program is described in Program Element B.2.

2.3 Heliophysics Theory, Modeling, and Simulations (HTMS)

The Heliophysics Theory, Modeling, and Simulations Program uses numerical simulations and modeling synergistically with data analyses and rigorous theory development to solve the fundamental problems of Heliophysics. The HTMS program is described in Program Element B.3.

The HTMS Program is not being solicited in ROSES-2020. It is only solicited every third year. It is anticipated that it will be next solicited in 2022.

2.4 Heliophysics Guest Investigators (H-GIO)

The Heliophysics Guest Investigator Open (H-GIO) program is intended to maximize the scientific return from operating missions of the Heliophysics System Observatory (HSO)

by providing support for research that is beyond the scope of work of the mission science teams. All H-GIO investigations must be intensive data analysis efforts that provide specific justification how any additional resources (e.g. simulations, secondary data sets, or machine learning tools) help analyze HSO observations. H-GIO will be implemented in 2020 using Dual-Anonymous Reviews (see Section 1.8). The Heliophysics Guest Investigators open program (H-GIO) is described in Program Element B.4.

Note that proposals that use eligible GOLD, ICON or PSP data (see Section 1.1.1 above) are not allowed to be submitted to this ROSES-2020 H-GIO.

2.5 LWS Science (LWS)

The Living With a Star (LWS) Program emphasizes the science necessary to understand those aspects of the Sun and Earth's space environment that affect life and society. The ultimate goal of the LWS Program is to provide a scientific understanding of the system that leads to predictive capability of the space environment conditions at Earth, other planetary systems, and in the interplanetary medium. To ensure this, the LWS Science program solicits proposals for Focus Teams to conduct coordinated large-scale investigations that cross discipline and technique boundaries and have a direct impact on life and society. The details of the Living With a Star (LWS) Science program are described in Program Element B.5.

2.6 Living With a Star Strategic Capabilities (LWS-SC)

A primary goal of NASA's LWS Program is the development of first-principles-based models for the coupled Sun-Earth and Sun-Solar System, similar in spirit to the first-principles models for the lower terrestrial atmosphere. Such models can act as tools for science investigations, as prototypes and test beds for prediction and specification capabilities, as frameworks for linking disparate data sets at vantage points throughout the Sun-Solar System, and as strategic planning aids to enable exploration of outer space and testing new mission concepts. The development of these models is generally conducted in terms of Strategic Capabilities and is described in Program Element B.6.

2.7 Space Weather Science Applications

In response to the National Space Weather Action Plan (SWAP), NASA established the Space Weather Science Applications Program (SnAP). The component of SnAP that addresses the aspect of transitioning knowledge between research and operations is reflected in the SnAP Operations-to-Research (O2R) program. For the purpose of this opportunity, NASA, NOAA, and NSF working under the tri-agency Space Weather MOU, have determined that the focus of this year's call is open. Please note that the proposal, in order to demonstrate relevance to O2R, must address how the research will directly advance the information needed by users of space weather information in the proposed focus area. The Space Weather Science Applications O2R Program Element is described in B.7.

2.8 Heliophysics Technology and Instrument Development for Science (HTIDeS)

The HTIDeS program seeks to advance the development of technologies and their application to enable investigation of key heliophysics science questions. This is done through incubating innovative concepts and development of prototype technologies. It is

intended that technologies developed through HTIDeS then be proposed to H-LCAS, H-FOS, or H-FORT to mature by demonstration in a relevant environment. HTIDeS utilizes the following sub-elements:

- Laboratory Nuclear, Atomic, and Plasma Physics (LNAPP) Program: The LNAPP program supports studies that probe fundamental nuclear, atomic, and plasma physical processes and produce chemical and spectroscopic measurements that support spacecraft observations and atmospheric models.
- Instrument Technology Development (ITD) Program: This includes innovative technology development and instruments that may be proposed as candidate experiments for future space flight opportunities.

The HTIDeS program is not soliciting Step-1 proposals or NOIs in 2020. Only a full proposal is solicited. HTIDeS with sub-elements ITD and LNAPP is described in Program Element B.8.

2.9 Heliophysics Low Cost Access to Space (H-LCAS)

H-LCAS was previously part of Flight Opportunities for Research and Technology (H-FORT) but now has been split out on its own. Like H-FORT, H-LCAS seeks to advance the development of technologies and their application to enable investigation of key heliophysics science questions. H-LCAS includes technology and associated science investigations that can be carried out with instruments flown on suborbital rockets, stratospheric balloons, or NASA airborne platforms, collectively referred to as Low Cost Access to Space.

The H-LCAS program is not soliciting Step-1 proposals or NOIs in 2020. Only a full proposal is solicited. H-LCAS is described in Program Element B.9.

2.10 Heliophysics Flight Opportunities Studies (H-FOS)

H-FOS was previously part of Flight Opportunities for Research & Technology (H-FORT) but now has been split out on its own. Like H-FORT, H-FOS seeks to advance the development of technologies and their application to enable investigation of key heliophysics science questions. H-FOS includes technology and associated science investigations that can be carried out with instruments flown on Smallsats (including CubeSats), or as payloads on the International Space Station (ISS), Department of Defense (DoD), or other rideshare opportunities. H-FOS awardees will receive a 10-month grant to conduct a concept study. After completion, H-FOS awardees can propose for a flight opportunity to, e.g., H-FORT (Section 2.11).

The H-FOS program is not soliciting Step-1 proposals or NOIs in 2020. Only a full proposal is solicited. H-FOS is described in Program Element B.10.

2.11 Heliophysics Flight Opportunities for Science & Technology (H-FORT)

H-FORT is the flight opportunity for SmallSats and Rideshare that is now on its own. H-FORT is limited to proposers who had a successful H-FOS proposal and received a formulation phase 10-month grant. Such proposers may submit to this program element a proposal that includes a Concept Study Report (CSR) and if successful, proceed with the implementation phase.

H-FORT seeks to advance the development of technologies and their application to enable investigation of key heliophysics science questions. This is done through demonstration of innovative technologies and associated science investigations in a relevant environment. H-FORT includes technology and associated science investigations that can be carried out with instruments flown on Smallsats (including CubeSats), or as payloads on the International Space Station (ISS), Department of Defense (DoD), or other rideshare opportunities.

The H-FORT program is not soliciting Step-1 proposals or NOIs in 2020. Only a full proposal is solicited. H-FORT is described in Program Element B.11.

2.12 Heliophysics Data Environment Enhancements (H-DEE):

The goal of the H-DEE program is to enable breakthrough research in Heliophysics by providing both a state of the art data environment and necessary supporting infrastructure to maximize the scientific return of the NASA missions. It is essential that observations be properly recorded, analyzed, released to the general public, documented, and rapidly turned into scientific results. This year, continuing from last year, the call solicits proposals (Value Added Enhancements) to advance the goal of a robust, vital, and cohesive Python environment for Heliophysics.

The Heliophysics Data Environment Enhancement program is described in Program Element B.12.

2.13 Heliophysics U.S. Participating Investigator (H-USPI):

The purpose of the Heliophysics U.S. Participating Investigator (H-USPI) program element is to solicit potential Heliophysics investigations in which investigators participate as a Co-Investigator (Co-I) for an instrument, experiment, or technology demonstration that is being built and flown by a sponsor agency other than NASA. The Heliophysics U.S. Participating Investigator program is described in Program Element B.13.

2.14 Early Career Investigators Program (ECIP):

The Early Career Investigator Program (ECIP) in Heliophysics is designed to support outstanding scientific research and career development of scientists and engineers at the early stage of their professional careers. The program aims to encourage innovative research initiatives and cultivate diverse scientific leadership in Heliophysics. This program is designed to foster the empowerment, inspiration, and education of the next generation of space researchers. The ECIP Program is described in Program Element B.14.

2.15 GOLD/ICON Guest Investigator (GIGI)

The Global Observations of Limb and Disk (GOLD) and Ionospheric Connection Explorer (ICON) Guest Investigator program solicits proposals that focus on analysis of data from the GOLD and ICON missions separately or together. This program is intended to maximize the scientific return from these missions by providing support for

research beyond presently funded investigations. The GIGI Program is described in Program Element B.15.

2.16 Parker Solar Probe Guest Investigator (PSPGI)

The Parker Solar Probe (PSP) Guest Investigators (PSP-GI) program solicits proposals that focus on analysis of data from the PSP mission in the inner heliosphere. This program is intended to maximize the scientific return from the mission by providing support for research beyond presently funded investigations. Funded investigators (PIs and Co-Is) of this solicitation will be considered Guest Investigators of PSP for the duration of the award and will be invited to attend and present progress at PSP team meetings. The PSPGI program is described in Program Element B.16.

B.2 HELIOPHYSICS SUPPORTING RESEARCH

NOTICE: Please note that each PI is limited to submit one and only one proposal to this program. There is no longer an exception for multiple submissions per PI that involve Science PIs.

1. Scope of Program

Heliophysics Supporting Research (SR) awards are research investigations of significant magnitude that employ a combination of scientific techniques. These must include an element of (a) theory, numerical simulation, or modeling, and an element of (b) data analysis and interpretation of NASA-spacecraft observations.

HSR is a component of the Heliophysics Research Program and proposers interested in this program element are encouraged to see B.1, The Heliophysics Research Program Overview for Heliophysics-specific requirements. Common requirements for all ROSES elements and proposals are found in the ROSES *Summary of Solicitation* and the *Proposer's Guidebook* and the order of precedence for proposers is the following: ROSES Element B.2 (this document) takes precedence followed by B.1, The Heliophysics Research Program Overview, followed by the ROSES *Summary of Solicitation* and, finally, the *Proposer's Guidebook*. Proposers should be familiar with all of these resources.

1.1 Solicited Investigations

Science investigations are solicited with this Heliophysics SR program. These must include an element of a) theory, numerical simulation, or modeling, and an element of b) data analysis and interpretation of current or historical NASA-spacecraft observations, and c) should address the Heliophysics overarching goal or a specific objective as described in B.1. Theory/modeling/simulation proposals must be substantiated with and guided by data. It is expected that proposing teams will be composed of investigators that cover the necessary expertise that the combination of techniques requires. Innovative ideas and techniques are welcome.

Proposals with a major focus on analyzing non-NASA data, must still include a NASA data analysis and/or interpretation aspect, and must demonstrate that the proposed work is necessary to make a significant contribution to Heliophysics.

1.2 Data Usage and Availability

All data, whether of NASA or non-NASA origin, must be available from NASA's Solar Data Analysis Center (SDAC), Space Physics Data Facility (SPDF), or at no cost from an equivalent, publicly accessible archive (with a link to archive included in the proposal) 30 days prior to the Step-2 (full-proposal) deadline. Proposals for projects that aim to produce (e.g., combined non-NASA and NASA-) data products should explain how those products would be made publicly available through a data management plan.

1.3 Limitations in Scope

Proposals outside the scope of Heliophysics Supporting Research include the following:

- Proposals for the same or essentially the same work submitted concurrently to other program elements in Appendix B or E, as specified in B.1 Section 1;

- Work for which the proposing organization (or investigators) are already funded by NASA. Proposals involving currently funded investigators must include a description in a separate subsection of the scientific/technical/management section that specifies how the new proposed effort is different and not duplicative with currently supported efforts;
- Model or tool development and/or new data analysis techniques, where this effort constitutes more than 50% of a three-year effort;

2. Submission and Evaluation Guidelines

2.1 General Considerations

Each Principal Investigator (PI) is allowed to submit one and only one Step-1 proposal to this program element. In that proposal, the Principal Investigator (or Science PI) must invest a substantial portion of their time, 30%, to the investigation in order to adequately ensure the conduct of the investigation. Within the proposing team, the PI and Co-Investigators (Co-Is) must each have specific and defined tasks in the project, and the tasks must be essential to the completion of the project. Collaborators must show outside support for any defined tasks which must be essential to completion of the project. Proposals may be declared noncompliant based on either the Step-1 or Step-2 proposal if they are outside the scope of the H-SR program (see Section 1 above) or if they fail to meet submission guidelines specified below (Section 2.2-2.4).

2.2 Two-Step Submission Process

To provide adequate notice to potential reviewers, this program uses a two-step proposal submission process. The overall description of a two-step process can be found in Section IV(b)vii of the ROSES *Summary of Solicitation*.

In the two-step process a Step-1 proposal is required. Potential reviewers are solicited based on the Step-1 proposal. The proposal team members may not be changed between the Step-1 and Step-2 proposals, unless prior approval is obtained from the Program Officer of the element. The title and broad science goals of the proposal may not be changed such that they would significantly affect the scientific or technical expertise required to properly evaluate a proposal. Changes in a proposal that impact the review will result in a proposal being declared non-compliant.

2.3 Step-1 Proposals

A Step-1 proposal is required and must be submitted electronically by the Step-1 due date (see Table 2 and Table 3 of ROSES). The Step-1 proposal must be submitted by the organization's Authorized Organizational Representative (AOR). No budget or other elements are required. Only proposers who submit a Step-1 proposal are eligible to submit a full proposal.

Step-1 proposals will be checked for compliance, but they will not be evaluated. The expected content is described below. Submission of the Step-1 proposal does not obligate the offerors to submit a Step-2 (full) proposal later.

2.3.1 *Step-1 Proposal Content*

The Step-1 proposal is restricted to the 4000-character Proposal Summary text box on the NSPIRES web interface cover pages. References and any other supporting material are not required, but, if included, must fit within the limit.

The Step-1 proposals must include the following:

- The science goals and objectives to be addressed by the proposal;
- A brief statement of the methodology to be used, including what data, models, and analysis will be used for completing the investigation;
- A brief statement of the relevance of the problem to the Heliophysics overarching goal or specific objectives as described in B.1

No PDF attachment is required or permitted for Step-1 proposal submission. Proposers will be invited by NSPIRES when they are able to submit their Step-2 proposals.

Proposers are strongly encouraged to provide names and contact information of five experts qualified to review their proposal. These experts must not be from the institutions of the PI or Co-Is. This information can be supplied in response to NSPIRES cover page questions at the time of submission of the Step-1 proposal.

2.4 Step-2 Proposals

A Step-2 (full) proposal must be submitted electronically by the Step-2 due date (see Table 2 and Table 3 of ROSES). The Step-2 proposal must be submitted via NSPIRES or Grants.gov by the organization's Authorized Organizational Representative (AOR). A budget and other specified information is required.

Because potential reviewers are solicited based on the Step-1 proposal, the investigators cannot be changed between the Step-1 and Step-2 proposals, unless prior approval is obtained from the Program Officer of the element. The title and broad science goals of the proposal cannot be changed such that they would significantly affect the scientific or technical expertise required to properly evaluate a proposal. Changes in a step-2 proposal that impact the review will result in a proposal being declared non-compliant.

Proposers must have submitted a Step-1 proposal to be eligible to submit a Step-2 proposal. Proposers that received a noncompliant letter are not eligible to submit a Step-2 proposal.

2.4.1 *Step-2 Proposal Content*

The process for preparation and submission of the Step-2 (full) proposals is the same as that for any other ROSES proposal. Guidelines for content and formatting Step-2 full proposals are specified in the *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation*. Proposals must adhere to formatting requirements (e.g., margins, font sizes, line spacing).

Proposals are restricted to fifteen (15) pages for the Scientific/Technical/Management section and must include the following sections with the preferred order:

- The science objectives and perceived impact of the proposed work to the state of knowledge in the field; references to existing work in the field should be limited to that which is needed to justify the value of the science proposed;
- The data and methodology to be employed in conducting the proposed research; the proposal must demonstrate (1) that the data are appropriate to address the science objectives, and (2) that the methodology is both appropriate and feasible to make substantial progress on the science objectives;
- The relevance of the proposed work to the Heliophysics overarching goal or specific objectives as described in B.1;
- A general plan of work, the management structure for the proposal personnel, and a description of the expected contribution to the proposed effort by the PI and each person as identified in the proposal, whether or not they derive support from the proposed budget. Postdoctoral fellows and students need not be named.

In addition, a Current and Pending Support statement must be included for all Co-Is, regardless of committed time to the project.

Historically, proposals that address a single well-focused compelling science objective with a limited set of specific science questions have been more successful at constructing methodologies that are demonstrably feasible and appropriate, as compared with those that propose to address a large number of science questions or that are directed at an overly-broad science topic.

2.4.2 *Step-2 Evaluation Criteria*

Compliant proposals will be evaluated according to the criteria specified in the *ROSES Summary of Solicitation* Section VI (a) and the *NASA Guidebook for Proposers*. These criteria are Relevance, Merit, and Cost reasonableness. Clarifications and additions specific to this program element are listed below.

The evaluation of scientific and technical merit will include the following:

- Compelling nature and scientific priority of the proposed investigation's science goals and objectives, including the importance of the problem within the broad field of Heliophysics; the unique value of the investigation to make scientific progress in the context of current understanding in the field, and the importance of carrying out the investigation now.
- Appropriateness and feasibility of the methodology, including the appropriateness of the selected data, models, and analysis for completing the investigation and the feasibility of the methodology for ensuring scientific success.

Based on these two factors, the evaluation will consider the overall potential science impact and probable success of the investigation.

Relevance to and priority within the H-SR program will be assessed based on criteria discussed in Section 1. Each proposal must demonstrate that the investigation is relevant and of high priority.

The evaluation of cost reasonableness includes the amount of work to be accomplished versus the amount of time proposed. Open-ended proposals or those with a large number of science questions to be addressed typically do not fare well in this

evaluation. Only necessary Co-Investigators and Collaborators should be included, and their specific tasks and roles in the investigation must be clearly laid out.

3. Available Funds

It is expected that there will be approximately ~$6.5M available in Fiscal Year (FY) 2020 to support new Heliophysics SR investigations selected through this program element. Due to the increase in the proposed scope and complexity, annual funding is expected to fall into the ~$200-$250K range per investigation.

4. Award Types

The Heliophysics SR program will award funds through three vehicles: (1) grants, (2) interagency transfers, and (3) awards to NASA Centers. The Heliophysics SR program will not award contracts.

5. Summary of Key Information

Expected program budget for first year of new awards	~$6.5M
Number of new awards pending adequate proposals of merit	~27-30
Maximum duration of awards	3 years
Due date for Step-1 proposal	See Tables 2 and 3 of this ROSES NRA
Due date for full proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	6 months after full proposal due date.
Page limit for the central Science-Technical-Management section of full proposal	15 pp; see also Table 1 of the *ROSES Summary of Solicitation* and Section 3.7 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the Heliophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section 3 of the *NASA Guidebook for Proposers* and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of Step 1 and Step 2 proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)

Web site for submission of Step 1 and Step-2 proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-HSR
Point of contact concerning this program.	Patrick Koehn Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-3636 Email: patrick.koehn@nasa.gov

B.3 HELIOPHYSICS THEORY, MODELING, SIMULATIONS

NOTICE: The Heliophysics Theory, Modeling, Simulations Program is not being solicited in ROSES-2020. It is only solicited every third year. It is anticipated that it will be next solicited in 2022.

1. Scope of Program

The Heliophysics Theory, Modeling, Simulations (H-TMS) program is a component of the Heliophysics Research Program. Proposers interested in this program element are encouraged to see the overview of the Heliophysics Research Program in Appendix B.1 of this ROSES NRA.

The H-TMS program was previously one element of the Heliophysics Grand Challenges Research (H-GCR) program (H-GCR-TMS, last competed in ROSES-2016 as program element B.5). Before that it was called "Heliophysics Theory Program" (HTP, last competed in ROSES-2013). For simplification, this program is now referred to as the Theory, Modeling, and Simulations (TMS) element in the Heliophysics program.

The former Heliophysics Theory Program provides the foundation of the TMS element. Increasingly, as computing power becomes more affordable and more available, numerical simulations and modeling become tools that can and have been used synergistically with data analyses and rigorous theory development to solve the fundamental problems of Heliophysics. Artificial intelligence (AI) and its subset, machine learning (ML), techniques have become potentially effective means for achieving scientific goals, collecting and analyzing large data sets. Scientists have begun to use "theory-aided" or "knowledge-aided" AI to achieve breakthroughs. All of these tools and techniques can lead the way to new understanding and drive science concepts for future strategic missions.

TMS investigations may use any of these methodologies, separately or together to address a specific science problem. Theory investigations alone are encouraged. Investigations using the concepts of AI are encouraged. More traditional modeling and simulation are also acceptable for this TMS solicitation. All investigations must compare against observations for ground truth. The ultimate goal of TMS investigations is to provide a complete chain of reasoning extending from the basic laws of nature to comparison with observation to the identification of future quantitative tests of the behavior of the environment. NASA acknowledges this and renames the element "Theory, Modeling, and Simulations".

TMS investigations must address one of the four high level science goals from the Heliophysics Decadal survey (*Solar and Space Physics: A Science for a Technological Society* www.nap.edu/catalog.php?record_id=13060) that are:

1. Determine the origins of the Sun's activity and predict the variations in the space environment;
2. Determine the dynamics and coupling of Earth’s magnetosphere, ionosphere, and atmosphere and their response to solar and terrestrial inputs;
3. Determine the interaction of the Sun with the solar system and the interstellar medium;

4. Discover and characterize fundamental processes that occur both within the heliosphere and throughout the universe.

2. Summary of Key Information

Point of contact concerning this program.	Katya Verner Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1213 Email: ekaterina.m.verner@nasa.gov

B.4 HELIOPHYSICS GUEST INVESTIGATORS - OPEN

NOTICE: Clarified June 25, 2020. The summary table of the key requirements for anonymized proposals, reproduced from the "Guidelines for Anonymous Proposals" in Section 2.5.1 has been modified to indicate that not just the budget justification but also the (redacted) budget numbers should be included in the anonymized proposal. New text is in bold.

April 17, 2020. Sections 1.1 and 2.5.2 have been changed to clarify the proportion of time required to be devoted to data analysis. At least two-thirds of the effort must be dedicated to data analysis. New text is in bold and deleted text is struck through. The due dates remain unchanged.

Amended March 26, 2020. To allow the science community time to adapt to the new environment with coronavirus, this Amendment delays both Step-1 and Step-2 due dates for this program element. Step-1 proposals are now due April 29, 2020, and Step-2 proposals are now due July 29, 2020.

Starting this year proposals submitted to this program will be evaluated using a dual-anonymous review process. Proposals must be prepared according to the guidelines in Section 2.2 and in the associated "Guidelines for Anonymous Proposals" document under "Other Documents" on the NSPIRES page for this program element.

Step-2 proposals are limited to ten (10) pages.

The data management plan (DMP) will be evaluated as part of the Intrinsic Merit of the proposal and must be included in a special section (see below).

1. Scope of Program

The Heliophysics Guest Investigator Open (H-GIO) program is intended to maximize the scientific return from operating missions by providing support for research that is beyond the scope of work of the mission science teams. All H-GIO investigations must be intensive data analysis efforts; any additional resources (e.g. simulations, secondary data sets, or machine learning tools) to help analyze HSO observations must be justified.

HGIO is a component of the Heliophysics Research Program and proposers interested in this program element are encouraged to see the overview of the Heliophysics Research Program in Appendix B.1 for Heliophysics-specific requirements. Common requirements for all ROSES elements and proposals are found in the ROSES *Summary of Solicitation* and the *Proposer's Guidebook* and the order of precedence for proposers is the following: This document takes precedence, followed by ROSES Element B.1, followed by the ROSES *Summary of Solicitation*, and the *Proposer's Guidebook*. Proposers should be familiar with all of these resourceses.

1.1 Solicited Investigations **[Clarified April 17, 2020]**

The HGIO program is for investigations with a primary emphasis on the analysis of data from currently operating missions in the Heliophysics System Observatory. The list of operating HSO missions is found at:

https://science.nasa.gov/missions-page?field_division_tid=5&field_phase_tid=29.

The HGIO program provides support for analysis of observations from both extended missions and from missions in their prime phase (Phase E). Proposals must either (1) address the goals of the mission(s) that generated the data on which the investigation is focused, or (2) use the mission data to address the Heliophysics overarching goal or a specific objective as described in B.1. Proposers must demonstrate that data analytic tasks constitute at least two **thirds** ~~years worth~~ of **the** effort in the proposed research plan. Proposers should be aware that for many of these missions, the mission science teams and others have already accomplished a substantial amount of research. Proposals must demonstrate that the proposed research will extend the frontier of existing knowledge in a fundamental and important manner.

In support of any H-GIO proposal, investigations may employ theory, models, and data from other sources, as needed, to interpret and analyze data from NASA's Heliophysics System Observatory (HSO), but only as a secondary emphasis. In any such instance, the proposal must clearly demonstrate that the theory, models, and/or data in question are necessary support for interpretation of the HSO data and are not, themselves, the primary object of the investigation. Work efforts not related to analysis of data should be limited to one year of the proposed research plan. Development of new models and theories is not solicited in this call.

1.2. Data Usage and Availability

HGIO investigations must demonstrate that the proposed effort can be accomplished using data that was publicly available 30 days before the Step-2 submission deadline. All spacecraft mission data must be available in the Solar Data Analysis Center (SDAC) or the Space Physics Data Facility (SPDF), or an equivalent, publicly accessible archive with a link to archive included in the proposal.

HGIO investigations focused on Van Allen Probes are permitted while the mission is in Phase (F). Check for NASA spacecraft mission data compliance as specified in the overview B.1.

HGIO investigations focused on Global Observations of Limb and Disk (GOLD) and/or Ionospheric Connection Explorer (ICON) data are not permitted. These investigations should be submitted to B.14 GOLD/ICON Guest Investigators (GIGI).

HGIO investigations focused on Parker Solar Probe (PSP) data are not permitted. These investigations should be submitted to B.15 PSP Guest Investigators (PSPGI).

HGIO investigations focused on the All Sky Imagers (ASI) and Ground Magnetometers (GMAG) associated with the THEMIS mission are permitted as they are considered to be part of the Heliophysics System Observatory (HSO). Check NASA spacecraft mission data compliance as specified in the overview B.1.

1.3 Limitations in Scope

Proposals outside the scope of H-GIO include the following:

- Proposals that do not focus on analysis of data from currently-operating HSO missions;
- Proposals focused on GOLD, ICON, or PSP data; those have separate Guest Investigator elements (see B.1);
- Proposals for the same or essentially the same work submitted concurrently to other program elements in Appendix B or E, as specified in B.1 Section 1;
- Work for which the proposing organization (or investigators) are already funded by NASA. Where projects might appear to overlap, proposals must show that the proposed effort does not duplicate other awards, including awards as part of operating space flight missions;
- Proposals for model, tool, or theory development (see Section 1.1);
- The routine, long-term gathering of observational data;
- Investigations with the main purpose of supporting ground-based infrastructure or facilities.

A PI or a Co-I on a qualifying Heliophysics mission may also propose as a PI or Co-I to the H-GIO program. However, such Heliophysics mission personnel must include in their proposal a description of their mission duties and clearly distinguish the proposed new activity from their existing responsibilities for mission operations and data analysis. (See special instructions for dual anonymous reviews in Section 2.2.)

2. Submission and Evaluation Guidelines

The HGIO program will be executed in a "dual-anonymous" fashion, where not only are proposers unaware of the identity of the members on the review panel, but the reviewers do not have explicit knowledge of the proposal teams (see Section 2.2).

To broaden access to the results of NASA-funded research, proposals must include a data management plan (DMP). DMPs must be placed in a 2-page section entitled "Data Management Plan" immediately following the references and citations for the S/T/M Section. A template is available, see Section 1.5 of B.1 the Heliophysics Division Research Overview. Since proposals to this program element will be evaluated using dual-anonymous peer review, the DMP in the main proposal PDF must be anonymized.

2.1 General Considerations

Each Principal Investigator (PI) is allowed to submit one and only one Step-1 proposal to this program element. In that proposal, the Principal Investigator or Science PI must invest at least 2 months of their time to the investigation in order to adequately ensure the conduct of the investigation. Co-investigators (Co-Is) must each have a specific and defined task in the project, and the task must be essential to completion of the project. Collaborators must show outside support for any defined tasks which must be essential to completion of the project. Proposals may be declared noncompliant based on either the Step-1 or Step-2 proposal if they are outside the scope of the H-GIO program (see Section 1 above), or if they fail to meet submission guidelines specified below in Sections 2.3-2.5, or if they have egregiously violated the dual-anonymous guidelines for writing proposals (Section 2.2).

2.2 Special Instructions for Proposals under Dual Anonymous Review

Proposals submitted to this program will be evaluated using a dual-anonymous peer review process in which, not only are proposers unaware of the identity of the members on the review panel, but the reviewers are not told the identity of the proposers until after the evaluation of the merit, relevance and cost reasonableness of the proposal. The overarching objective of dual-anonymous peer review is to reduce unconscious bias in the evaluation of the merit of a proposal.

Proposers should consult the "Guidelines for Anonymous Proposals" document under "Other Documents" on the NSPIRES page for this program element for detailed instructions on writing proposals appropriate for dual-anonymous peer review. Neither Step-1 nor Step-2 proposals may include anything that identifies the names of investigators or their institutions. When submitting Step-2 proposals all proposers must also upload a separate "Expertise and Resources – Not Anonymized" document, which is not anonymized. The "Guidelines for Anonymous Proposals" contains complete information on how to write this separate document.

The forms filled out on the NSPIRES web pages with Proposal Summary, Budget, Proposal Team and Program Specific and Business Data known as the NSPIRES "cover pages" will not be seen by peer reviewers. This has two implications: 1) The Proposal summary must also be included as the first page of the proposal PDF and 2) proposers must upload a separate "Expertise and Resources - Not Anonymized" document, that contains all of the personally (and organizational) identifying information.

In order to meet the objectives of dual-anonymous peer review, review panels will be instructed to evaluate the anonymized Step-2 proposals based on their scientific merit, without taking into account the proposing team qualifications. As a final check, and only after the scientific evaluation is finalized for all proposals, the panel will be provided with the "Expertise and Resources – Not Anonymized" documents. The panel will assess the qualifications of the team in order to allow the reviewers to assess the team capabilities required to execute a given proposed science investigation.

A summary of the key factors for PIs to keep in mind are:

- Step-1 and Step-2 Proposals may not include language that identifies the names of investigators or their institutions, as discussed in the Guidelines for Anonymous Proposals
- PIs are required to upload along with their Step-2 proposal an additional "Expertise and Resource – Not Anonymized" PDF through NSPIRES as a separate upload when submitting the Step-2 Proposal.
- SMD understands that dual-anonymous peer review represents a major shift in the evaluation of HGIO proposals and, as such, there may be occasional slips in writing anonymized proposals. However, SMD reserves the right to return without review proposals that are particularly egregious in terms of the identification of the proposing team.

2.3. Two-Step Submission Process

To provide adequate notice to potential reviewers, this program uses a two-step proposal submission process. The overall description of a two-step process can be found in Section IV(b)vii of the ROSES *Summary of Solicitation*.

In the two-step process a Step-1 proposal is required. Potential reviewers are solicited based on the Step-1 proposal. The investigators may not be changed between the Step-1 and Step-2 proposals, unless prior approval is obtained from the Program Officer of the element. The title and broad science goals of the proposal may not be changed such that they would significantly affect the scientific or technical expertise required to properly evaluate a proposal. Changes in a proposal that impact the review will result in a proposal being declared non-compliant.

2.4 Step-1 Proposals

A Step-1 proposal is required and must be submitted electronically by the Step-1 due date (see Table 2 and Table 3 of ROSES). The Step-1 proposal must be submitted by the organization's Authorized Organizational Representative (AOR). No budget or other elements are required. Only proposers who submit a Step-1 proposal are eligible to submit a full proposal.

Step-1 proposals will be checked for compliance, but they will not be evaluated. The expected format is described below. Submission of the Step-1 proposal does not obligate the offerors to submit a Step-2 (full) proposal later.

2.4.1 *Step-1 Proposal Content*

The Step-1 proposal is restricted to the 4000-character Proposal Summary text box on the NSPIRES web interface cover pages. References and any other supporting material are not required, but, if included, must fit within the limit. Step-1 proposals must be anonymized using the "Guidelines for Anonymous Proposals" document in the "Other Documents" section of the NSPIRES page.

The Step-1 proposal must include the following information:

- The science goals and objectives to be addressed by the proposal;
- A listing of the mission data to be used in the investigation;
- A listing of the data analysis methodology and any models or simulations to be used;
- A brief statement of the relevance of the problem to the goals of the mission(s) on whose data the investigation is focused, or the Heliophysics overarching goal or specific objectives as described in B.1 addressed using mission data.

No PDF attachment is permitted for Step-1 proposal submission. Proposers will be notified by email when they are able to submit their Step-2 proposals.

Proposers are strongly encouraged to provide names and contact information of five experts qualified to review their proposal. These experts must not be from the institutions of the PI or Co-Is. This information can be supplied in response to NSPIRES cover page questions at the time of submission of the Step-1 proposal.

2.5 Step-2 Proposals

A Step-2 (full) proposal (with a Scientific/Technical/Management section of no more than 10 pages) must be submitted electronically by the Step-2 due date (see Table 2 and Table 3 of ROSES). The Step-2 proposal must be submitted by the organization's Authorized Organizational Representative (AOR). A budget and other specified information is required.

Because potential reviewers are solicited based on the Step-1 proposal, the team members may not be changed between the Step-1 and Step-2 proposals, unless prior approval is obtained from the Program Officer of the element. The title and broad science goals of the proposal may not be changed such that they would significantly affect the scientific or technical expertise required to properly evaluate a proposal. Significant changes in a Step-2 proposal that may impact the review will result in a proposal being declared non-compliant.

Proposers must have submitted a Step-1 proposal to be eligible to submit a Step-2 proposal. Proposers that received a noncompliant letter are not eligible to submit a Step-2 proposal.

2.5.1 *Step-2 Proposal Format*

Step-2 proposals must be anonymized using the "Guidelines for Anonymous Proposals" document in the "Other Documents" section of the NSPIRES page. Guidelines for formatting full proposals are specified in the *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation*. Specific requirements below supersede those sources.

The Scientific/Technical/Management section is restricted to ten (10) pages and must include the following sections with the preferred order:

- Page 1 must be the anonymized proposal abstract from the Step-1 proposal.
- The science objectives and perceived impact of the proposed work to the state of knowledge in the field; references to existing work in the field should be limited to that which is needed to justify the value of the science proposed;
- The data and methodology to be employed in conducting the proposed research; the proposal must demonstrate (1) that the data are appropriate to address the science objectives and (2) that the methodology is both appropriate and feasible to make substantial progress on the science objectives;
- The relevance of the proposed work to the goals of the mission(s) on whose data the investigation is focused; or to the Heliophysics overarching goal or specific objectives as described in B.1 addressed using mission data.
- The general plan of work, anonymized by listing only roles or titles (e.g., The Co-I will commit two months of time as the data analyst in Year 2.)

A separate "Expertise and Resources – Not Anonymized" document must contain the following information:

- The management structure for the proposal personnel, and a description of the expected contribution to the proposed effort by the PI and each person as identified in the proposal whether or not they derive support from the proposed budget, presented in a table, expressed numerically as Full Time Equivalents

(FTEs). Postdoctorals and students do not need to be identified by name. This section is restricted to one page.
- Required material that outlines both the background and availability of the proposing team members (i.e., Curriculum Vitae, pending/current support).
- Facilities and Equipment
- HEC requests that identify proposers.

Historically, proposals that address a single well-focused science objective with a limited set of specific science questions have been more successful at constructing methodologies that are demonstrably feasible and appropriate, as compared with those that propose to address a large number of science questions or that are directed at an overly-broad science topic.

A summary of the main requirements for anonymized Step-2 proposals, reproduced from the "Guidelines for Anonymous Proposals" document, is listed below.

Item	Requirement
References	References must be in the [1], [2] format.
Proposal summary	Enter as part of the NSPIRES cover page and on the first page of the uploaded proposal PDF file.
Page limits	10 pages for the central Science/Technical/Management section of proposal (that includes the one-page proposal summary above).
Biographical Sketches	Do not include in main proposal document. Include in separate "Expertise and Resources - Not Anonymized" document.
Current and Pending Support	Do not include in main proposal document. Include in separate "Expertise and Resources - Not Anonymized" document.
Redacted Budget **and** Narrative	Include **both redacted budget and narrative** in main proposal document in an anonymized format. **[Clarified June 25, 2020]**
Summary Table of Work Effort	Include in an anonymized fashion (e.g., PI; Co-I#1; Co-I#2) in the main proposal document and in non-anonymized fashion in the separate "Expertise and Resources – Not Anonymized" document.
Facilities and Equipment	Do not include in main proposal document. Include in separate "Expertise and Resources - Not Anonymized" document.
Data Management Plan	Include as an anonymized 2-page section immediately following the references and citations for the S/T/M Section.
High End Computing request	Submit PDF HEC form as document type "Appendix" in NSPIRES.

Separate "Expertise and Resources - Not Anonymized" document	Submit as document type "Appendix" in NSPIRES. This document provides a one-page section listing all team members, their roles, expertise, and contributions to the work. The document should also present Facilities and Equipment, and must include a Summary Table of Work Effort and Current and Pending Support. Letters of support, e.g., from facilities or archives, must be included in this section, if applicable.

2.5.2 *Step-2 Evaluation Criteria* **[Clarified April 17, 2020]**

Compliant proposals will be evaluated vs. Intrinsic Merit, Cost, and Relevance, consistent with Section VI (a) of the *ROSES Summary of Solicitation* and as defined Appendix D of the *NASA Guidebook for Proposers*. Clarifications and additions specific to this program element are listed below.

The evaluation of scientific and technical merit will include the following:

- Compelling nature and scientific priority of the proposed investigation's science goals and objectives, including the importance of the problem within the broad field of Heliophysics, the unique value of the investigation to make scientific progress in the context of current understanding in the field, and the importance of carrying out the investigation now.
- Appropriateness and feasibility of the methodology, including the appropriateness of the selected data, models, and analysis for completing the investigation and the feasibility of the methodology for ensuring scientific success.

Based on these two science and technical factors, the evaluation will consider the overall potential science impact and probability of success of the investigation.

Relevance to and priority within this H-GIO program element will be assessed based on criteria discussed in Section 1. Each proposal must demonstrate that ~~the investigation includes~~ at least two **thirds** ~~years worth~~ of **the** effort **is** dedicated towards analysis of data (HSO data primarily) and supplemental tasks are limited to no more than one **third** ~~year~~ of the proposed research plan.

Cost reasonableness includes assessing the amount of work to be accomplished versus the amount of time proposed. Open-ended proposals or those with a large number of science questions to be addressed typically do not fare well in this evaluation. Only necessary Co-Investigators and Collaborators should be included, and their specific tasks and roles in the investigation must be clearly defined in the separate "Team Expertise and Background" document.

3. Available Funds

It is expected that there will be approximately $5.0M available in Fiscal Year (FY) 2020 to support new Heliophysics GI investigations selected through this program element. It is anticipated that there may be $5.0 M in 2021 and $5.0 M in 2022. It is expected that the combined 3-year total budget of most proposals to be approximately $525K.

4. Award Types

The H-GIO program will primarily award funds through three vehicles: (1) grants, (2) interagency transfers, and (3) awards to NASA Centers. The H-GIO program will not award contracts. An institution that has received a contract previously can receive funds as a grant by not charging a fee.

5. Summary of Key Information

Expected annual program budget for new awards.	See Section 3
Number of new awards pending adequate proposals of merit	~30
Maximum duration of awards	3 years; shorter-term proposals are allowed
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA
Due date for full Step-2 proposals	See Tables 2 and 3 of this ROSES NRA
Page limit for the central Science-Technical-Management section of proposals	10 pages; see also Table 1 of ROSES.
Planning date for start of investigation	8 months after proposal due date
Relevance	This program is relevant to Heliophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See *the ROSES Summary of Solicitation*.
General requirements for content of proposals	See B.1 The Heliophysics Research Program Overview and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers*, Section IV(b) of *the ROSES Summary of Solicitation, and* Guidelines for Anonymous Proposals.
Submission medium	Electronic proposal submission is required; no hard copy is permitted
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202 479-9376)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-HGIO

Point of contact concerning this program	Galen Fowler Heliophysics Division Science mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: 202-358-0039 Email: galen.fowler@nasa.gov

B.5 HELIOPHYSICS LIVING WITH A STAR SCIENCE

NOTICE: Amended July 28, 2020. The Step-1 due date for this program has been delayed. The Step-1 due date is now September 3, 2020. The Step-2 due date remains unchanged.

Amended on April 10, 2020. This Amendment presents final text for this program element. ~~Step-1 proposals are due August 27~~, 2020, and Step-2 proposals are due November 12, 2020.

This program element requires a statement on the NSPIRES cover page regarding the potential contribution to the Focused Science Team effort (see Section 6.3.2).

1. Scope of Program

The Living With a Star (LWS) Program emphasizes the science necessary to understand those aspects of the Sun and Earth's space environment that affect life and society. The ultimate goal of the LWS Program is to provide a scientific understanding of the system that leads to predictive capability of the space environment conditions at Earth, other planetary systems, and in the interplanetary medium. Every year the LWS Program solicits Focused Science Topics (FSTs) that address some part of this goal. This year's FSTs are described in Sections 1.2 and 2-5 below.

This goal poses two great challenges for the LWS program. First, the program seeks to address large-scale problems that cross discipline and technique boundaries (e.g., data analysis, theory, modeling, etc.); and second, the program will identify how this new understanding has a direct impact on life and society. Over time, the Targeted Investigations have provided advances in scientific understanding that address these challenges.

LWS is a component of the Heliophysics Research Program and proposers interested in this program element should read B.1, the Heliophysics Research Program Overview for Heliophysics-specific requirements. Defaults for all ROSES elements are found in the ROSES *Summary of Solicitation* and for all NASA solicitations in the *Guidebook* for *Proposers* (https://www.hq.nasa.gov/office/procurement/nraguidebook). The order of precedence is the following: This document (B.5) followed by B.1, followed by the ROSES *Summary of Solicitation*, and the *Guidebook for Proposers*. Proposers should review all of these resources to ensure compliance with Program requirements.

1.1 General LWS Goals and Background

The LWS program goals are as follows:

1. Understand how the Sun varies and what drives solar variability.
2. Understand how the Earth and planetary systems respond to dynamic external and internal drivers.
3. Understand how and in what ways dynamic space environments affect human and robotic exploration activities.

The LWS Program seeks to make progress in understanding the complex Heliophysics system, focusing on the fundamental science of the most critical interconnections. Further information on the LWS Program can be found at the LWS website

(http://lwstrt.gsfc.nasa.gov/). The LWS Science program maintains a strategy with three components, namely, Strategic Capabilities, Targeted Investigations, and Cross-Disciplinary Infrastructure Building programs. Only the Targeted Investigations will be competed in this program element. Proposers interested in Strategic Capabilities should see program element B.6 Living With a Star Strategic Capabilities. Cross-Disciplinary Infrastructure Building may be competed in a separate future element.

Further background material concerning relevant research objectives can be found on the LWS website, and in the following documents:

- The LWS TR&T SDT Report (https://lwstrt.gsfc.nasa.gov/images/pdf/TRT_SDT_Report.pdf)
- The LWS *10-Year Vision Beyond 2015 Report* (http://lwstrt.gsfc.nasa.gov/images/pdf/LWS_10YrVision_Oct2015_Final.pdf)
- The Revised Strategic Science Areas (https://lwstrt.gsfc.nasa.gov/assets/docs/lpag/LPAG_EC_report_2019_12_31.pdf)
- The National Research Council Decadal Survey Report *Solar and Space Physics: A Science for a Technological Society* (http://www.nap.edu/openbook.php?record_id=13060).

1.2 Solicited Investigations

To be responsive, proposed investigations must have objectives suitable for one of the four following Focused Science Topics (FSTs). Detailed descriptions of each FST are given in Sections 2-5.

The FSTs solicited for proposals this year are as follows:

1) Modeling and Validation of Ionospheric Irregularities and Scintillations (described in Section 2);
2) Understanding and Predicting Radiation Belt Loss in the Coupled Magnetosphere (described in Section 3);
3) The Origin and Consequences of Suprathermal Particles that Seed Solar Energetic Particles (described in Section 4); and
4) Long Term Variability and Predictability of the Sun-Climate System (described in Section 5).

NASA desires a balance of research investigation techniques for each FST, including theory, modeling, data analysis, and simulations. This program element accepts proposals that lack a complete scientific study but instead describe a project that would enable or enhance the FST's activities (e.g., develop a data set or implement a model for use by the FST Team). Regardless of the project, all proposals must identify science questions responsive to the FST's goals that are addressed by the proposed work. FST teams will be formed from individual proposals that each address an aspect of the FST, and together attack the breadth of the FST (see Section 1.3 below).

A critical element in enhancing understanding and developing predictive capabilities is the determination of whether the model or data products being developed, and any associated simulations, are accurate and reliable. Consequently, a methodology for verification and validation of results, and quantification of uncertainty, is required as a key component of the proposed research. As mentioned below (Sections 2.4, 3.4, 4.4,

or 5.4), all proposals must address data and model uncertainty. This is mentioned in Section 3.13 of the *NASA Guidebook for Proposers*, which indicates that all proposals must address "sources of error and uncertainties and what effect they may have on the robustness of potential results and conclusions." Proposers are free to choose any appropriate method of uncertainty analysis or validation of results, but it must be clearly addressed in the body of the proposal.

1.3 Focused Science Teams

The selected investigators will form a Focused Science Team and coordinate their research programs after selection of proposals. In order to foster the collaborations required to coordinate these team research efforts, one of the Principal Investigators (PIs) will serve as the Team Leader for the FST for which he/she proposed. The Team Leader will organize team meetings and will be responsible for producing a yearly report to NASA Headquarters describing team activities and progress in addition to the required annual progress report for their specific award.

Proposers wishing to serve as a Team Leader must state so in their proposal and must include a separate section immediately following the Science/Technical/Management section describing their qualifications, interest, and approaches to team leadership. Up to one extra page, separate from the Science/Technical/Management section, is allowed for this description. The selection of the Team Leader will be recommended by the LWS staff and made by the Heliophysics selecting official. Guidance for the team development process will be provided by NASA after selection of the Team Leader.

Past experience has shown that Focused Science Teams usually need a year to get organized since team members may not have worked together before, followed by another three years to make significant progress on the FST. Thus, the expected duration of FST awards is four years. While proposals with shorter duration are allowed, proposers are encouraged to propose up to four years to ensure maximum overlap between individual contributions to the team efforts.

All proposers must include sufficient travel funds in their budgets to cover two team meetings per year. In an effort to leverage travel costs, one meeting per year may be held in conjunction with a major U.S. scientific meeting. Successful teams will participate in a Kickoff Workshop where the selected team members will meet and develop work plans for the anticipated period of performance, generally 4 years, based on the requirements of the FST and the composition of the selected team.

1.4 Data Use in the LWS Program

This program element has policies on the use of data in proposals that expand upon and supersede those given in B.1, The Heliophysics Research Program Overview. Proposals to this program may only require the use of data that is in a publicly available archive at no cost at least 30 days prior to the Step-2 deadline for successful completion of the proposed project. This applies to both space-based and ground-based observations, as well as any data products derived from them. This latter point does not exclude data products to be developed as part of a proposed study, only those existing in advance of Step-2 submission. Any questions about whether a data set or data

product qualifies as publicly available must be submitted to the Program Officer of the element at least 10 days before the Step-1 deadline.

After an award is made, projects may incorporate new data that becomes available at no cost in a public archive, provided that their use does not alter the goals and objectives of the selected proposal. Any planned changes in the data used must be described in the annual progress report submitted by the PI and approved by the LWS Program Scientist.

While the inclusion of useful ground-based observations is allowed, proposals are expected to incorporate space-based observations. Further, the Step-2 evaluation process (see Section 6.3.4) will include the consideration of the presence and importance of space-based or ground-based observations in the proposals. Regardless of the type of data that would be utilized in the proposed study, space-based, ground-based, or some combination, the proposal must clearly demonstrate why the proposed data set or data sets are sufficient to address the proposed goals and objectives.

2. FST #1: Modeling and Validation of Ionospheric Irregularities and Scintillations

2.1 Target Description

Ionospheric scintillations are rapid fluctuations in the amplitude, phase and angle of arrival of received radio signals due to irregularities in the ionospheric plasma that the signals traverse. Scintillations occur at a range of frequencies. L-Band scintillation adversely impacts the continuous tracking of Global Navigation Satellite System (GNSS) signals for position, navigation, and timing services. At UHF and lower frequencies, scintillation leads to intermittent communications outages, sometimes with serious impacts.

Scintillations are most frequent and severe at low- and high-geomagnetic latitudes. There are a number of reasons for this latitudinal dependence. The structure, orientation, and onset of irregularities can be influenced by the latitude-dependent orientation of magnetic field lines. The generation mechanisms can also vary with latitude due to changing conditions in the ionosphere as it responds to latitude-dependent inputs from space above (solar irradiance, solar wind, and magnetosphere) and from the atmosphere below. Further scientific understanding is required to model the latitudinal variation of these phenomena. At low latitudes, this includes the role of ambient ionospheric and thermospheric weather conditions, including electrodynamics and wind, as well as the gradient of bottom-side electron density and rising of the ionospheric F layer. At high latitudes, understanding is needed about the impacts of a host of instability mechanisms that drive severe plasma density, temperature and velocity irregularities imbedded in a time-dependent magnetic field, as well as other processes. At mid latitudes, storm-time drivers become important. The storm-time mid-latitude ionosphere is not well understood, and particularly the generation mechanisms of various types of irregularities that may produce GNSS scintillations during storm-time conditions. Improved ionospheric HF radars now make more measurements of the mid-latitude ionosphere that can support development and validation of new models for mid-latitude irregularities. Some

specific candidates are the temperature gradient, gradient drift, and ion frictional heating instabilities.

At all latitudes, the generation mechanisms of ionospheric irregularities have not been investigated to a sufficient degree to understand their role in producing GNSS scintillations, HF radar scatter, and VHF/HF communications disruptions. Achieving these capabilities will require data analysis and modeling investigations of the conditions, mechanisms and processes leading to the formation of ionospheric irregularities, as well as the dynamics driving their evolution and the impact on radio signals passing through them.

This FST is timely for a number of reasons:

- The upcoming availability of ICON and GOLD observations;
- The growth of the number of high-latitude flights and the opening of the Arctic to shipping and tourism;
- The expansion of technological systems that are vulnerable to disruption due to ionospheric irregularities and scintillations; and
- Increases in observational capabilities as well as models of ionospheric instability that can be tested against these measurements.

This FST is relevant to Decadal Survey Key Science Goal 2 (Determine the dynamics and coupling of Earth's magnetosphere, ionosphere, and atmosphere and their response to solar and terrestrial inputs), and several LWS Strategic Science Areas including SSA-IV (Variability of the Geomagnetic Environment), SSA-V (Dynamics of the Global Ionosphere and Plasmasphere), and SSA-VI (Localized Ionospheric Irregularities).

2.2 Goals, Objectives, and Measures of Success

The main goal of this FST is to understand and model the conditions that lead to the onset and evolution of ionospheric irregularities and resulting scintillation events at low, mid and high latitudes. To address this goal, proposed investigations should include one or more of the following objectives:

- Identify the mechanisms and structures that are responsible for ionospheric irregularities and scintillations at various latitudes (low, mid, and high latitudes) and longitudes;
- Determine growth rates, spectral characteristics, the nonlinear evolution associated with specific generation mechanisms and their role in scintillations;
- Identify the relationship between scintillation at various frequencies; and
- Identify the instability mechanisms responsible for polar F-region irregularities;

Measures of success include, but are not limited to:

- Advance our understanding of the temporal, spatial, and magnitude variability in ionospheric scintillation through data analysis and modeling studies.

2.3 Types of Investigations

An improved theoretical understanding of the initiation and evolution of ionospheric irregularities resulting in scintillation is critical to enabling a physics-based prediction capability of scintillation. Investigations include, but are not limited to, studies that address:

- The properties of instabilities at high-latitude including, but not limited to, irregularities associated with polar cap patches in regions of enhanced particle precipitation and Interhemispheric aspects of scintillation-inducing irregularities in the polar cap;
- The geometries, scale sizes, and evolution of irregularities;
- Seeding mechanisms by which the instabilities initiate and evolve including comparison between model and observed scintillation data;
- Simulations of the structure and/or motions of plasma density at various latitudes;
- Quantification and simulation of the effects of the longitudinal structure of energy transport (traveling ionospheric disturbances and traveling atmospheric disturbances); and
- Determination of the dynamics and spatial scales of the instability after it grows.

Investigations within this FST may include theoretical, numerical, and data analysis methods. Relevant observational sources for these studies include present-epoch spacecraft and ground-based observations. Details of the data use policy are discussed in Section 1.4.

2.4 Predictability, Interaction with User Communities, and Uncertainty

In order to improve the usefulness of the results from this FST, all investigations in this FST must consider data and model uncertainty and how sources of error impact the results (see Section 6.3.4).

3. FST #2: Understanding and Predicting Radiation Belt Loss in the Coupled Magnetosphere

3.1 Target Description

It is understood that radiation belt dynamics are determined by the changes in multiple plasma particle populations, which inherently involves the interactions that impact particle sources, losses, and their transport. The outer belt can experience variations in the trapped flux by two orders of magnitude over timescales ranging from a few hours to days, but there is also significant variation in where the peak flux location is observed. The Van Allen Probes mission has greatly improved the understanding of individual processes in the relevant regions, but as a whole, the sum of the interactions between different plasma populations has not yet provided a global perspective of the entirety of radiation belt dynamics. This is especially true for understanding and predicting the loss of radiation belt fluxes in this dynamic system.

To date, there are two major loss processes that have been the focus of research, wave-particle interactions that induce pitch-angle scattering into the loss cone or

magnetopause shadowing which leads to non-adiabatic dropouts. In the case of wave-particle interactions, particles are pitch-angle scattered into the atmospheric loss cone when multiple plasma populations are co-located in regions such as the plasmasphere, the radiation belts, and the ring current. In the case of magnetopause shadowing, trapped particles reside on drift trajectories that intersect the magnetopause when there is sudden compression of the magnetosphere. Additional radiation belt loss processes that have been considered also include the possibility of rapid deceleration due to nonlinear wave-particle interactions. This focused science topic will address the degree to which various processes are responsible for radiation belt losses.

This FST addresses the Decadal Survey Key Science Goal 2 (Determine the dynamics and coupling of Earth's magnetosphere, ionosphere, and atmosphere and their response to solar and terrestrial inputs), and several LWS Strategic Science Areas including SSA-IV (Variability of the Geomagnetic Environment) and SSA-VIII (Radiation and Particle Environment from Near Earth to Deep Space).

3.2 Goals, Objectives, and Measures of Success

The main goal for this FST is to make significant progress towards understanding and predicting radiation belt loss processes within the inner magnetosphere. To address this goal, proposed investigations should include one or more of the following objectives:

- Provide better understand and ability to predict how the overlapping plasma populations can impact the radiation belt loss processes of electrons which in turn is correlated to the resulting wave particle interactions;
- Improved understanding and ability to predict the radiation loss processes are impacted by non-adiabatic dropout events; and
- Examine other potential loss processes, such as non-linear wave-particle interactions.

Compared to the energization of radiation belt particles and the study of radiation belt transport, the analysis, understanding, and prediction of the loss of radiation belt particles lags in progress. Therefore, this FST specifically focuses on enhancing our understanding of radiation belt loss processes within the framework of LWS needs. Studies to improve the understanding of radiation belt transport or energization are not considered an objective of this FST except where their inclusion is required to address loss processes.

Measures of success include, but are not limited to:

Demonstrate (1) understanding and (2) predictive capability of temporal, spatial, and magnitude of characteristics related to relativistic electron loss by using observations and existing models.

Magnetospheric research has seen a recent boon of observations (e.g., Van Allen Probes, Firebird, BARREL, ARASE, MMS, THEMIS) and historic ones (e.g., SAMPEX) that have greatly expanded the availability of the high quality data. Thus, there is a wide array of data that includes wave characteristics, *in situ* particles, and precipitating particles. During this same windfall era of premium data, radiation belt models have also benefited from this unprecedented wealth of information against which their performance can be measured and improved. Thus, this FST encourages data analysis

and modeling studies that focus on the loss of radiation belt electrons from the inner magnetosphere to down to altitudes where atmospheric loss occurs.

3.3 Types of Investigations

In general, studies could include investigations that target a physical understanding of loss processes, improve our empirical understanding of the spatial and temporal characteristics of loss processes, or improve the predictability of relativistic electron loss and the presence (or absence) of conditions amenable to such loss. These investigations include, but are not limited to the following types of studies:

- Analysis of correlated wave and particle measurements that study localized interactions or reveal more about the magnetosphere-to-atmosphere relationships;
- Quantifying electron loss with respect to the spatial overlap between radiation belts and plasmasphere and associated wave phenomena;
- Quantifying the relative roles played by precipitation into the atmosphere versus non-adiabatic loss processes; and
- Modeling non-adiabatic radiation belt drop-out events to understand the underlying physical processes.

Investigations within this FST may include theoretical, numerical, and data analysis methods. Relevant observational sources for these studies include present-epoch spacecraft and ground-based observations, as well as historical records of proxy observations of the electron loss processes. Details of the data use policy are discussed in Section 1.4.

3.4 Predictability, Interaction with User Communities, and Uncertainty

In order to improve the usefulness of the results from this FST, all investigations in this FST must consider data and model uncertainty and how sources of error impact the results (see Section 6.3.4).

4. FST #3: The Origin and Consequences of Suprathermal Particles that Seed Solar Energetic Particles

4.1 Target Description

Substantial improvements in our understanding of the sources and acceleration mechanism(s) of Solar Energetic Particles (SEPs) are essential for development of a predictive capability of potentially hazardous SEP events at Earth and elsewhere in the heliosphere. It is well established that suprathermal ions (ions of a few times the solar wind thermal particle energy up to hundreds of keV per nucleon) play a significant role as the seed population in the acceleration of SEPs by coronal mass ejection (CME) shocks. SEP measurements at ~1 AU from the Sun reveal highly variable intensity–time profiles, spectral shape, and charge-to-mass ratio dependence due to a combination of effects from seed particle acceleration and injection, shock acceleration and SEP transport. In the quest for a reliable prediction of the properties of large SEP events, it is necessary to understand and quantify the sources of variability from each of those processes. Predicting these variations requires refreshed observations and theories for suprathermal ion seed particles and their effects in producing the variability in SEP

events. This focused science topic will bring together observers, modelers, and theorists in a collaborative effort.

There does not exist a community consensus to explain the source(s) and acceleration mechanism(s) of suprathermal particles and how exactly the seed particles contribute to large SEP events. The suprathermal particles that contribute to the largest SEP events must be produced close to the Sun, and their production process is likely smeared due to mixing, transport, and other effects by the time that they are observed at 1 AU or beyond. Observations from Parker Solar Probe and Solar Orbiter will fill this gap by providing *in situ* energetic particle measurements close to the Sun. This focused science topic will help with interpreting these data and will help to define science requirements for future measurements of suprathermal particles.

This FST is relevant to the Decadal Survey Key Science Goal 1 (Determine the origins of the Sun's activity and predict the variations in the space environment), Key Science Goal 3 (Determine the interaction of the Sun with the solar system and the interstellar medium), and Key Science Goal 4 (Discover and characterize fundamental processes that occur both within the heliosphere and throughout the Universe). It also addresses several LWS Strategic Science Areas including SSA-II (Solar Eruptive and Transient Heliospheric Phenomena) and SSA-III (Acceleration Transport of Solar Energetic Particles).

4.2 Goals, Objectives, and Measures of Success

The primary goal of this FST is to understand the origin of suprathermal particles and their effects in producing temporal and spatial variations and different spectral properties of SEPs. To address this goal, proposed investigations should include one or more of the following objectives:

- Understand the relative roles of solar flares and CMEs in producing large SEP events;
- Investigate particle acceleration mechanisms for producing suprathermal particles at the Sun and in the heliosphere and for accelerating these particles to high energies; and
- Understand particle transport, mixing, and other effects that result in the observed variability in the properties of SEP events at 1 AU.

Measures of success include, but are not limited to:

- Demonstrate understanding of the origins and acceleration of suprathermal particles and their role as seed particles for SEP events;
- Demonstrate understanding of temporal, spatial, and spectral variations in the properties of SEP events;
- Demonstrate a predictive capability for the properties of SEP events at various locations in the heliosphere.

The outcome from this FST will significantly advance our understanding of variations in large SEP events.

4.3 Types of Investigations

Investigations within this FST may include theoretical, numerical, and data analysis methods to enable a holistic approach to achieve the science goals. Investigations that address the FST's science goals and objectives include, but are not limited to:

- Analysis and modeling of suprathermal particles and SEPs with different species using observations from existing missions, including *in situ* spacecraft measurements as a function of time and location in the heliosphere, as well as remote sensing observations of seed particles in their source regions;
- Modeling and simulations to prepare for analysis of suprathermal particle and SEP measurements from recently launched and upcoming missions;
- Analysis and modeling of the evolution of suprathermal particles and SEP events as a function of time and location in the heliosphere (including the evolution of such events with distance from the Sun); and
- Development of realistic flare and CME models as well as particle acceleration and transport models including suprathermal particles and large-scale shock acceleration, and validation of these models using observations.

Currently available data sources for this FST include spacecraft data from ACE, Wind, SOHO, STEREO, GOES, Parker Solar Probe, and AMS-02. Potential sources of future data include Parker Solar Probe, Solar Orbiter, STPSat-6, and IMAP. Details of the data use policy are discussed in Section 1.4.

4.4 Predictability, Interaction with User Communities, and Uncertainty

In order to improve the usefulness of the results from this FST, all investigations in this FST must consider data and model uncertainty and how sources of error impact the results (see Section 6.3.4).

5. FST #4: Long Term Variability and Predictability of the Sun-Climate System

5.1 Target Description

Variations in the geospace environment are driven by changes in solar inputs and yield a variety of terrestrial responses to this time-varying input. These changes in solar input include both electromagnetic and particle radiation, as well as solar modulation of galactic cosmic rays. They occur over a range of time scales that include short-term events such as solar eruptions, quasi-periodic phenomena such as daily-to-decadal variations in irradiance and high-speed solar wind streams, and longer-term variations such as changes in the sunspot cycle and the associated fluctuations in the magnetic field structure that impact the terrestrial system. This FST will examine the sources and effects of these changes in solar input and how they directly influence the geospace environment. In addition, solar-induced variations in the coupling of various processes throughout geospace give rise to important, second-order effects. Of primary interest are solar-driven impacts on regional and global terrestrial weather and climate, on time scales ranging from weeks (solar rotation) to years (solar cycle) to centuries (solar cycle variation). While shorter-term, impulsive events (flares, CMEs, etc.) are known to produce terrestrial responses, studies of these shorter-term processes will not be considered for this FST.

As with all areas of Heliophysics considered by the LWS program, this FST pursues studies which lead to predictive capabilities that require detailed knowledge of the physical processes related to the solar forcing that impact the Earth's environment. These studies include examinations of historical proxies of both solar activity and the associated terrestrial responses. In addition, the lengthening satellite record provides new opportunities for calibrating these proxies as well as utilizing more recently developed proxies and estimates of the relationship between solar and geophysical activity. Considering these recent and longer-term relationships, proposed studies should emphasize acquiring or refining our understanding of how solar variability and solar-driven geomagnetic variability lead to or alter atmospheric structure and coupling, with the intent of including these processes in global terrestrial climate models. It is expected that proposals submitted in response to this solicitation would focus on specific aspects of this goal. In order to limit the focus of this FST, only studies that primarily examine the solar inputs and/or responses of the terrestrial atmosphere will be included. Studies that focus primarily on ocean variability will not be considered.

Originally, LWS opportunities of this kind were competed under the Sun−Climate theme. This topic is now included as an FST to provide the benefits of a team approach to a specific topic. Despite the complex web of physical processes to be studied, the LWS Science program plays an important role in the overall study of long-term solar and terrestrial variability. In particular, these studies require expertise close to the core of the LWS goals, namely understanding solar and heliospheric activity and the physical processes that couple this activity to the Earth's climate system. Work accomplished as part of this topic will enable the science community to move beyond simple correlations between solar variability and climate parameters, and instead to define the relevant physical connections.

This FST addresses Decadal Survey Key Science Goal 2 (Determine the dynamics and coupling of Earth's magnetosphere, ionosphere, and atmosphere and their response to solar and terrestrial inputs) and the LWS Strategic Science Area SSA-IX (Solar Impacts on Climate).

5.2 Goals, Objectives, and Measures of Success

The overarching goal of this FST is to provide reliable insight into how longer-term solar variability affects terrestrial variability in the face of natural and anthropogenic changes to the geospace system. To address this goal, this FST will cover two sets of objectives that involve solar or terrestrial studies on time scales ranging from weeks to years to centuries.

The objectives of studies that focus on the solar contributions should include one or more of the following:

- Development and utilization of improved historical proxies or models of changes in solar irradiance, particle, and magnetic inputs to improve the comparison of historical estimates to more recent observations; and
- Transition from proxy-based irradiance prediction to spectrally resolved irradiance that range from the x-ray to the infra-red. This includes the use of

models with spectrally resolved irradiance rather than coarse spectral bins, based on either observational or synthetic spectra that vary over time.

The objectives of studies that focus on the impacts of solar variability on the terrestrial climate must examine processes that directly or indirectly amplify the effects on the Earth of solar variability and solar-driven geomagnetic variability and should address one or more of the following:

- Large-scale structure and dynamics of the magnetosphere-ionosphere-thermosphere-mesosphere system with coupling to the lower atmosphere;
- Variations in atmospheric temperature, winds, and composition;
- Atmospheric waves and circulation;
- Clouds and precipitation;
- Modes of variability (e.g. El Nino-Southern Oscillation (ENSO), North Atlantic Oscillation (NAO), Pacific-North American Oscillation (PNA), Artic Oscillation (AO), Antarctic Oscillation (AAO), Quasi-Biennial Oscillation (QBO)); and
- Radiative process and forcing including the absorption and scattering of total and spectral solar irradiance.

Measures of success include, but are not limited to:

- Show how and to what extent various mechanisms couple and redistribute solar energy at Earth;
- Determine the radiative, magnetic, dynamical, and chemical feedbacks that control weather and climate throughout the atmosphere; and
- Link the regions driven directly by solar influences to tropospheric process where human activities are concentrated.

5.3 Types of Investigations

Investigations that address the goals of this FST will address time scales ranging from weeks (solar rotation) to years (solar cycle) to centuries (solar cycle variation). These investigations include, but are not limited to, the following types of investigations:

- Data analysis, modeling, and prediction of solar inputs such as modulation of irradiance, energetic-particle flux, and solar magnetic field modulation that impact processes in the terrestrial system.
- Data analysis, modeling, and prediction of terrestrial responses, such as: response to variations in the input, coupling, and transport within geospace; and
- Coordinated modelling and data analysis studies that examine the relationship between long-term solar variability and atmospheric and geospace responses including:
    - Predictions of the Earth system response to solar and geomagnetic forcing under future climate scenarios (e.g. the response of current or future terrestrial atmospheres to various possible solar input scenarios);
    - Analysis of the impact on weather and climate of a Maunder-like minimum or an extended period of enhanced solar maxima;
    - Analysis of the effect of long-term solar-driven impacts on large-scale atmospheric circulations; and

- Analysis of changes in the interactions between different regions of the terrestrial atmosphere under various solar inputs and configurations of atmospheric structure and composition.

Investigations within this FST may include theoretical, numerical, and data analysis methods. Relevant observational sources for these studies include present-epoch spacecraft and ground-based observations, as well as historical records of proxy observations of the varying solar irradiance, particle, and magnetic inputs. Details of the data use policy are discussed in Section 1.4.

5.4 Predictability, Interaction with User Communities, and Uncertainty

In order to improve the usefulness of the results from this FST, all investigations in this FST must consider data and model uncertainty and how sources of error impact the results (see Section 6.3.4).

6. Submission and Evaluation Guidelines

Each PI, or the Science PI if applicable, is allowed to submit one and only one proposal to this program element. The expectation is that the PI (or Science PI) will invest at least 20% of their time to the investigation.

In addition to the general requirements and restrictions (e.g., in Table 1 of the *ROSES-2020 Summary of Solicitation* and in B.1 Heliophysics Research Program Overview) this program element has specific compliance constraints for both format (e.g., Sections 6.2.1 and 6.3.1) and content, e.g., involving data (see Sections 1.4 and 6.3.4). These compliance rules ensure fairness and are enforced strictly by the Heliophysics Division. Proposals that are deemed noncompliant may be returned without review or declined following review if violations are found during the evaluation process.

6.1 Two-Step Submission Process

To provide adequate notice to potential reviewers, this program uses a two-step proposal submission process. The overall description of a two-step process can be found in Section IV(b)vii of the ROSES *Summary of Solicitation*.

In the two-step process a Step-1 proposal is required. Because potential reviewers are solicited based on the Step-1 proposal, investigators cannot be changed between the Step-1 and Step-2 proposals, unless prior approval is obtained from the Program Officer of the element. The title and broad science goals of the proposal cannot be changed such that they would significantly affect the scientific or technical expertise required to properly evaluate a proposal.

6.2 Step-1 Proposals

A Step-1 proposal is required and must be submitted electronically by the Step-1 due date given in Tables 2 and 3 of ROSES-2020. The Step-1 proposal must be submitted by an Authorized Organizational Representative (AOR) from the PI institution. No budget or other uploaded files are required. Step-1 proposals will be checked for compliance, but they will not be evaluated. Only proposers who submit a Step-1 proposal and who are invited are eligible to submit a Step-2 (full) proposal.

Submission of a Step-1 proposal does not obligate the offerors to submit a Step-2 (full) proposal.

6.2.1 *Step-1 Proposal Format*

The Step-1 proposal is restricted to a 4,000-character Proposal Summary text box on the NSPIRES web interface cover pages. It must include the following information:

- A description of the science goals and objectives to be addressed by the proposal;
- A brief description of the methodology to be used to address the goals and objectives; and
- A brief description of the relevance of the proposed study to the scientific objectives of the FST, and the potential contributions of the proposed study to the Focused Science Team's effort.

No PDF attachment is required or permitted for Step-1 proposal submission. Proposers will be notified by NSPIRES whether they are invited to submit their Step-2 proposals. Proposers are strongly encouraged to provide names and contact information of up to five experts qualified to review their proposal. These experts must not be from the institutions of the PI or Co-Is. This information can be supplied in response to NSPIRES cover page questions at the time of submission of the Step-1 proposal.

6.2.2 *Step-1 Compliance Criteria*

Step-1 proposals may be declared noncompliant if they fail to meet the submission guidelines or if they are outside the scope of the LWS Science program. PIs of noncompliant proposals will not be invited through NSPIRES to submit the associated Step-2 proposal and will be notified through NSPIRES to this effect.

6.3 Step-2 Proposals

A Step-2 (full) proposal must be submitted electronically by the Step-2 due date (see below and Tables 2 and 3 of ROSES-2020). The Step-2 proposal must be submitted by an Authorized Organizational Representative (AOR) from the PI institution. A budget and other specified information is required.

Only proposers who submit a Step-1 proposal and who are invited are eligible to submit a Step-2 (full) proposal. Proposers that have received a noncompliance letter in response to their Step-1 proposal are not eligible to submit a Step-2 proposal.

6.3.1 *Step-2 Proposal Format*

All proposals submitted to ROSES must strictly conform to the formatting instructions specified in the *ROSES-2020 Summary of Solicitation* except were superseded by the requirements in this program element. Proposals that violate these instructions may be returned without review or declined following review if violations are found during the evaluation process.

Proposals are restricted to fifteen (15) pages for the Science/Technical/Management section. Proposals for Team Leader additionally may use up to one extra page to describe the proposed team leader activities (see Section 1.3).

6.3.2 *Required Additional Section in Step-2 Proposal Cover Pages: Proposed Contribution to the Focused Science Team Effort*

Proposals to this program element must address the proposed contribution to the Focused Science Team effort in a 4,000-character plain text box on the NSPIRES web interface cover pages. Since it is no longer included in the main body of the proposal, this text does not count against the 15-page limit for the Scientific/Technical/ Management section. Proposals that fail to address the proposed contribution to the Focused Science Team effort may be declared noncompliant and will typically be returned without review or declined following review if violations are found during the evaluation process.

This section must summarize the following three topics:

- The relevance of the proposed study to the scientific objectives (Goals, Objectives, and Measures of Success) of the FST outlined in Sections 2.2, 3.2, 4.2, or 5.2;
- The potential contributions of the proposed study (Type of Investigation) to the Focused Science Team's effort outlined in Sections 2.3, 3.3, 4.3, or 5.3; and
- Metrics and milestones for determining the successful progress and outcome of the proposed research.

This summary must describe the goals of the proposed project and why they are aligned with the FST goals outlined in Sections 2.2, 3.2, 4.2, or 5.2. For proposals that address a Type of Investigation that is listed in Sections 2.3, 3.3, 4.3, or 5.3, this summary must also describe briefly how the proposed investigation addresses one or several of those investigations.

For proposals that address a type of investigation that is NOT listed in the FST description, the summary must briefly describe the proposed Type of Investigation and how the proposed investigation will meet the FST Goals and Measures of Success.

In addition, all proposers are expected to provide a set of metrics that they will use to identify progress toward their proposed goals. Proposers must also provide a set of milestones that should indicate the anticipated timing of the major achievements during the course of the proposed study. These metrics and milestones may change once the Focused Science Team is formed so the proposed metrics and milestones should be based on the proposed study as a stand-alone effort.

The review panel will only consider material in this section when the potential contribution of the proposal to the Focused Science Team effort is evaluated (see Section 6.3.4).

6.3.3 *Step-2 Compliance*

Noncompliant Step-2 proposals will be returned without review or may be declined if the noncompliance is found during the evaluation process. Step-2 proposals may be declared noncompliant if:

- The title has substantially changed from that of the Step-1 proposal;
- Investigators have changed since the Step-1 proposal without prior approval of the Program Officer;

- The science goals and objectives have substantially changed from that of the Step-1 proposal;
- The proposal has the same (or essentially the same) team and objectives as a Step-2 (full) proposal submitted to another Heliophysics program;
- The proposal violates the restrictions in Section 1.4 regarding use of data; or
- The proposal violates the formatting instructions in Section 6.3.1.

6.3.4 *Step-2 Evaluation Criteria*

Compliant proposals will be evaluated according to three main criteria: (1) Intrinsic Merit, (2) Potential Contribution to the Focused Science Team Effort (Relevance), and (3) Cost Reasonableness. The data management plan, described in Section 1.5 of B.1, the Heliophysics Research Program Overview, will also be evaluated. The Intrinsic Merit and Cost criteria will be evaluated primarily as specified in Section VI of the *ROSES-2020 Summary of Solicitation* and defined in the *NASA Guidebook for Proposers*, but Relevance is handled differently. Clarifications and additions specific to this program element are listed below.

The evaluation of intrinsic merit will include the following:

- Scientific Merit: Compelling nature and scientific priority of the proposed investigation's science goals and objectives, including the importance of the problem within the broad field of Heliophysics; the unique value of the investigation to make scientific progress in the context of current understanding in the field, and the importance of carrying out the investigation now; and
- Technical Merit: Appropriateness and feasibility of the methodology, including the appropriateness of the selected data, models, and analysis for completing the investigation and the feasibility of the methodology for ensuring scientific success.

The treatment of uncertainty will be evaluated as a methodology issue (intrinsic merit) and the review panel will assign a strength or weakness based on the treatment presented in the proposal. Proposals that fail to address uncertainty will be assigned a Major Weakness in the evaluation and may be considered unselectable.

Based on the above two factors (Scientific and Technical Merit), the evaluation will consider the overall potential science impact and probable success of the investigation and an adjectival grade for Intrinsic Merit will be assigned. The evaluation of the potential contribution to the Focused Science Team effort (Section 6.3.2) will serve as the Relevance evaluation and an adjectival grade for Relevance will be assigned. Please note that the review panel will consider only the response to this NSPIRES cover page question (described in Section 6.3.2) in the evaluation of this criterion and will not consider information in the main body of the proposal.

The final adjectival grade assigned to the overall evaluation will be the lower of the two adjectival grades for Intrinsic Merit and Relevance.

Evaluation of Cost Reasonableness will include a comparison of the scope of the proposed study to the proposed resources (personnel-time allocated, necessary computer resources, etc.). The panel will provide feedback to SMD but will not assign a

grade and this information will be considered by the Heliophysics selecting official during the selection process.

7. Award Types

The Heliophysics LWS Science program will only award funds through three vehicles: (1) grants, (2) interagency transfers, and (3) awards to NASA centers. This call will not award contracts, as it is not appropriate for the nature of the work. Please also see the *ROSES-2020 Summary of Solicitation*, Section II a.

8. Available Funds

Given the strategic nature of LWS, and the fact that strategically feasible tasks require sufficient investment, it is anticipated that FST proposals will have annual budgets in the range of $180K-$250K per year. (This includes fully encumbered Civil Servant labor, where appropriate.) It is left to individual PIs to decide whether a strategically feasible award size could be achieved by increased collaborative efforts, greater time commitment of investigators, or a mix of the two. PIs should be cognizant, however, that verification of the level of effort versus the actual work proposed will be part of the review panel process. Given the submission of proposals of adequate number, merit, and range of investigative techniques, NASA anticipates forming teams of ~5-7 selections for each of the four FST topics.

Team Leader activities should not be included in the proposal budget. The Team Leader will receive up to an additional $25,000 per year to support his/her leader activities, and the Team Leader's budget will be revised during final award negotiations.

9. Summary of Key Information

Expected annual program budget for new awards	~ $5M, see also Section 8, above.
Number of new awards pending adequate proposals of merit	~ 20-28, see also Section 8, above.
Maximum duration of awards	4 years
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	No earlier than 6 months after the Step-2 proposal due date.
Page limit for the central Science/Technical/Management section of proposal	15 pages; one extra page permitted for a separate section for proposals to be Team Leader of a Focused Science Team; see also Table 1 of the *ROSES-2020 Summary of Solicitation* and the *NASA Guidebook for Proposers*.
Relevance	Proposals that are relevant to the FSTs in this program element are, by definition, relevant to NASA. See Section 6.3.4 regarding criteria.
General information and overview of this solicitation	See the *ROSES-2020 Summary of Solicitation*.

General requirements for content of proposals	See Section 3 of the *NASA Guidebook for Proposers* and Section IV and Table 1 of *the ROSES-2020 Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES-2020 Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-LWS
Points of contact concerning this program	Simon Plunkett Heliophysics Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-2034 Email: simon.p.plunkett@nasa.gov Jeff Morrill Heliophysics Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-3744 Email: jeff.s.morrill@nasa.gov

B.6 HELIOPHYSICS LIVING WITH A STAR STRATEGIC CAPABILITIES

NOTICE: The Heliophysics Division plans to offer Living With a Star Strategic Capabilities as program element B.6 of ROSES-2020. Final text will be released and due dates established by an amendment no fewer than 90 days in advance of the Step-2 proposal due date.

1. Introduction

The Living With a Star (LWS) Program emphasizes the science necessary to understand those aspects of the Sun and Earth's space environment that affect life and society. The ultimate goal of the LWS Program is to provide a scientific understanding of the system that leads to predictive capability of the space environment conditions at Earth, other planetary systems, and in the interplanetary medium.

The LWS program objectives are as follows:

1. Understand how the Sun varies and what drives solar variability.
2. Understand how the Earth and planetary systems respond to dynamic external and internal drivers.
3. Understand how and in what ways dynamic space environments affect human and robotic exploration activities.

The LWS Program seeks to make progress in understanding the complex Heliophysics system, focusing on the fundamental science of the most critical interconnections. Further information on the LWS Program can be found at the updated LWS website (http://lwstrt.gsfc.nasa.gov/). The LWS Science program maintains a strategy with three components, namely, Strategic Capabilities, Targeted Investigations, and Cross-Disciplinary Infrastructure Building programs. Only the Strategic Capabilities are solicited in this announcement. Proposers interested in Targeted Investigations should see program element B.5.

2. Points of Contact

Points of contact concerning this program all of whom share this mailing address: Heliophysics Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001	Jeff Morrill Telephone: (202) 358-3744 Email: jeff.s.morrill@nasa.gov Simon Plunkett Telephone: 202-358-2034 Email: simon.p.plunkett@nasa.gov

B.7 SPACE WEATHER SCIENCE APPLICATION OPERATIONS-TO-RESEARCH

NOTICE: Amended March 25, 2020. This Amendment presents final text for this program element. Step-1 proposals are due December 16, 2020, and Step-2 proposals are due February 17, 2021.

The requirement to address relevance of the Step-2 proposal to this program element is provided in Sections 1.3 and 2.4.2. Please note that the response to this requirement must be provided in a 4000-character text box on the NSPIRES cover page, not in the 10-page main body of the proposal. Section 2.5 explains how the evaluation criteria explicitly include assessment of the proposal relevance.

New this year is the requirement for a data management plan (DMP). The DMP will be evaluated as part of the Intrinsic Merit of the proposal. DMPs will not be collected via the NSPIRES web pages. Instead, the DMP must be included in the proposal (see Section 2.4.1).

1. Scope of Program

The primary goal of the Space Weather Science Application Operations-to-Research (SWO2R) program is to support research to improve numerical models and/or data utilization techniques that could advance specification and/or forecasting capabilities and which could also lead to improved scientific understanding.

SWO2R is a component of the Heliophysics Research Program and proposers interested in this program element are encouraged to read B.1, The Heliophysics Research Program Overview, for Heliophysics-specific requirements. Common requirements for all ROSES elements and proposals are found in the ROSES *Summary of Solicitation* and *The Proposer's Guidebook* and the order of precedence for proposers is the following: This document takes precedence followed by B.1, The Heliophysics Research Program Overview, followed by this year's ROSES *Summary of Solicitation* and, finally, the *Proposer's Guidebook*. Proposers should be familiar with all of these resources.

1.1 Solicited Investigations

There are two focus areas for this opportunity:

- Satellite Drag: Improve the specification and forecast of neutral density in the thermosphere as it pertains to satellite drag and orbital operations.
- Ionospheric Disturbances: Improve forecasts and/or specifications of ionospheric disturbances that impact: 1. positioning, navigation, and timing (PNT) derived from the Global Navigation Satellite System, and/or 2. radio communication.

The primary goal of this solicitation is to support research to improve numerical models and/or data utilization techniques that could advance forecasting and/or specification capabilities and which could also lead to improved scientific understanding. Effective utilization of available data is encouraged. Employing advanced techniques for data assimilation, ensemble, and/or machine-learning is also encouraged. Improved neutral density specification and forecast capabilities could include, for example, effects of forcing from below, effects of variations in solar EUV flux, effects of heating from particle

precipitation and joule dissipation, assimilation of satellite drag data, and regional variations in density. Improved neutral density specification and forecasts can support numerous applications, including satellite drag and orbit propagation, meeting Orbital Debris Mitigation Standard Practices (ODMSP), and planning satellite mega-constellation operations. Improved forecasting and specification of the ionosphere could include the dynamics of total electron content, ionospheric scintillation, and electron density structure.

1.2 Background

In March 2019 the National Science and Technology Council (NSTC) in the Executive Office of the President released released the National Space Weather Strategy and Action Plan (NSW-SAP). The objectives of the actions described in the NSW-SAP are to improve the understanding of, forecasting of, and preparedness for space weather events, recognizing the need for close cooperation among the federal agencies.

The NSW-SAP call for NASA, National Science Foundation (NSF), and Department of Defense (DOD) to identify and support basic research on space weather. They also direct NASA, Department of Commerce (DOC), and DOD to identify and support research opportunities that address targeted operational space-weather needs. Furthermore, they direct NASA, NSF, DOC, and DOD to facilitate the transition of space weather information and prediction capabilities to the Nation's space weather service providers (research-to-operations and operations-to-research).

In response to the need to advance and coordinate the Nation’s space weather research and operations capabilities, NASA established the Heliophysics Space Weather Science Application (SWxSA) program, of which this operations-to-research (O2R) call is a part. NASA is supporting this funding opportunity in coordination with DOC/National Oceanic and Atmospheric Administration (NOAA) to promote O2R activities.The objective of O2R efforts is broadly defined as the joint pursuit of improvements of operational capabilities and advancements in related fundamental research.

NASA's role as codified in its SWxSA program is to implement and support a national research program to understand the Sun and its interactions with Earth and the Solar System to advance space weather modeling and prediction capabilities applicable to space weather forecasting; develop and operate space-weather-related research missions, develop instrument capabilities, and models; and support the transition of space weather models and technology from research to operations and from operations to research.

NOAA's role is to provide timely and accurate operational space weather forecasts, watches, warnings, alerts, and real-time space weather monitoring for the government, civilian, and commercial sectors, exclusive of the responsibilities of the Secretary of Defense; and to ensure the continuous improvement of operational space weather services, utilizing partnerships, as appropriate, with the research community, including academia and the private sector, and relevant agencies to develop, validate, test, and transition space weather observation platforms and models from research to operations and from operations to research.

1.3 Relevance

Work proposed in response to this call must be in support of one or more NASA and/or NOAA goals and objectives described above, with attention to transitioning from science research to application driven by the expressed need of the users. To demonstrate the relevance of the research, the proposal must address how the research will directly improve the ability of the user community to utilize space weather information in the proposed topical area. See Section 2.4.2 for additional information.

2. Submission and Evaluation Guidelines

2.1 General Considerations

Each Principal Investigator (PI) is allowed to submit one and only one Step-1 proposal to this program element. Within the proposing team, the PI and Co-Investigators (Co-Is) must each have specific and defined tasks in the project, and the tasks must be essential to the completion of the project. Collaborators must show outside support for any defined tasks which must be essential to completion of the project. Proposers are strongly encouraged to include industry participants on their teams.

Proposals may be declared noncompliant based on either the Step-1 or Step-2 proposal if they are outside the scope of the SWO2R program (see Section 1 above) or if they fail to meet submission guidelines specified below (Section 2.2-2.4).

2.2 Two-Step Submission Process

To provide adequate notice to potential reviewers, this program uses a two-step proposal submission process. The overall description of a two-step process can be found in Section IV(b)vii of the ROSES *Summary of Solicitation*.

In the two-step process a Step-1 proposal is required. Potential reviewers are solicited based on the Step-1 proposal. The proposal team members may not be changed between the Step-1 and Step-2 proposals, unless prior approval is obtained from the Program Officer of the element. The title and broad science goals of the proposal may not be changed such that they would significantly affect the scientific or technical expertise required to properly evaluate a proposal. Changes in a proposal that impact the review will result in a proposal being declared non-compliant.

2.3 Step-1 Proposals

A Step-1 proposal is required and must be submitted electronically by the Step-1 due date (see Table 2 and Table 3 of ROSES). The Step-1 proposal must be submitted by the organization's Authorized Organizational Representative (AOR). No budget or other elements are required. Only proposers who submit a Step-1 proposal are eligible to submit a full proposal.

Step-1 proposals will be checked for compliance, but they will not be evaluated. The expected content is described below. Submission of the Step-1 proposal does not obligate the offerors to submit a Step-2 (full) proposal later.

2.3.1 *Step-1 Proposal Content*

The Step-1 proposal is restricted to the 4000-character Proposal Summary text box on the NSPIRES web interface cover pages. References and any other supporting material are not required, but, if included, must fit within the limit.

The Step-1 proposal must include the following information:

- Identification of which science topic, Satellite Drag or Ionospheric Disturbances, is being addressed;
- The science goals and objectives to be addressed by the proposal;
- The expected forecast/specification/observation capabilities, and/or O2R enhancements that will be developed;
- The expected metrics and validation methods that will be applied;
- A brief statement of the relevance of the problem to the focus area of this SWO2R announcement.

No PDF attachment is required or permitted for Step-1 proposal submission. Proposers will be invited by NSPIRES when they are able to submit their Step-2 proposals.

Proposers are strongly encouraged to provide names and contact information of five experts qualified to review their proposal. These experts must not be from the institutions of the PI or Co-Is. This information can be supplied in response to NSPIRES cover page questions at the time of submission of the Step-1 proposal.

2.4 Step-2 Proposals

A Step-2 (full) proposal of no more than 10 pages must be submitted electronically by the Step-2 due date (see Table 2 and Table 3 of ROSES). The Step-2 proposal must be submitted via NSPIRES or Grants.gov by the organization's Authorized Organizational Representative (AOR). A budget and other specified information is required.

Because potential reviewers are solicited based on the Step-1 proposal, the investigators cannot be changed between the Step-1 and Step-2 proposals, unless prior approval is obtained from the Program Officer of the element. The title and broad science goals of the proposal cannot be changed such that they would significantly affect the scientific or technical expertise required to properly evaluate a proposal. Changes in a step-2 proposal that impact the review will result in a proposal being declared non-compliant.

Proposers must have submitted a Step-1 proposal to be eligible to submit a Step-2 proposal. Proposers that received a noncompliant letter are not eligible to submit a Step-2 proposal.

2.4.1 *Step-2 Proposal Content*

The process for preparation and submission of the Step-2 (full) proposals is the same as that for any other ROSES proposal. Guidelines for content and formatting Step-2 full proposals are specified in the *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation*. Proposals must adhere to formatting requirements (e.g., margins, font sizes, line spacing).

Proposals are restricted to ten (10) pages for the Scientific/Technical/Management section and must include the following sections:

(1) The Space Weather O2R goals this proposal will enable and the appropriateness of the currently existing data sets (ground-based and/or space-based), models (Community Coordinated Modeling Center (CCMC) hosted or other accessible resource), and/or other publicly available and utilized resource;
(2) The existing O2R need that is being addressed and its importance relative to current operational and forecasting capabilities;
(3) A full description of the methods and validation, resources needed, and the technical approach to providing the proposed forecast products, specification capability, and/or O2R-enabling enhancement;
(4) Plans to provide public access to the models, tools, and value-added products developed;
(5) The forecast/specification/observation capabilities, and/or O2R-enabling enhancement that will be developed, the timetable for producing them;
(6) The metrics and validation methods that will be used to evaluate forecast products, specification capability, and/or O2R-enabling enhancement.
(7) A Data Management Plan (DMP) must be included in the body of the proposal and not as a separate document. For the required content, please consult the ROSES Appendix B.1, section 1.5.

Proposers contemplating software development are strongly encouraged to read Section 1.5 of B.1 the Heliophysics Division Research Program Overview.

2.4.2 *Required Additional Section in Step-2 Proposal Front Pages: Proposed Relevance to the Program Element.*

Proposals to this program element must address the relevance of the proposal, as described in Section 1, in a 4000-character plain text box on the NSPIRES cover pages and this will be peer reviewed as part of the evaluation (see Section 2.5). Since it is not included in the main body of the proposal, this text does not count against the 10-page limit for the Scientific/Technical/Management section. Proposals that fail to address relevance will typically be declined despite any merits that may have been found by peer review.

2.5 Evaluation Criteria

Compliant proposals will be evaluated according to the criteria specified in the *ROSES Summary of Solicitation* Section VI (a) and the *NASA Guidebook for Proposers*. These criteria are Relevance, Merit, and Cost reasonableness. Clarifications and additions specific to this program element are listed below.

The assessment of relevance will be based on the goals and objectives of the agencies and the O2R objective, as summarized in this program element. Please note that the review panel will consider only the response to this NSPIRES cover page question (described in Section 2.4.2) in the evaluation of this criterion.

The evaluation of the scientific and technical merit will include:

- The potential for improving specifications and/or forecasts of space weather phenomena;

- The potential value of the proposed metrics to establishing the state-of-the-art and to measuring progress in specifying/forecasting space weather, and;
- The degree to which the resulting product can be ingested into an operational environment in a timely manner.

Moreover, part of the assessment of the impact of the proposed work (which is part of Merit) will include consideration of whether and how software will be made available for non-commercial use (e.g., as described in Section 2 of this program element and Section 1.5 of B.1 the Heliophysics Research Program Overview Overview), as well as whether or not industry participation is included in the team. Participants of the team must be listed in the standard Summary Table of Work Effort described in Section IV(b)iii of the *ROSES Summary of Solicitation*. As these aspects of the proposed effort are encouraged, rather than required, their inclusion may result in strengths in the proposal evaluation, but their absence will not result in weaknesses.
Cost reasonableness will include assessing the amount of work to be accomplished versus the amount of time proposed.

2.6 Joint Agency/Community Evaluation

Given the unique nature of this opportunity to support the Space Weather Science Application program, proposal reviewers will include both scientific peers and knowledgeable representatives from the space weather operations community. Proposals must discuss the relationship of the proposed effort to the advancement of the Space Weather O2R objective.

NASA (on behalf of NASA and NOAA) will review the proposals in accordance with NASA's processes/criteria connected to the O2R objective. The final award recommendations will be made in consultation with both agencies' program officers. Final selections will be made by the NASA Selecting Official.

3. Available Funds

The total funding available for the first year of new proposals submitted in response to this solicitation is expected to be about $2.0M. This funding is expected to support at approximately six awards depending upon funds available. Awards will not be more than two years in duration. It is expected that combined 2-year budgets of most proposals will not exceed $500K.

4. Summary of Key Information

Expected program budget for first year of new awards	$2.0M
Number of new awards pending adequate proposals of merit	~6
Maximum duration of awards	2 years
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA

Planning date for start of investigation	6 months after proposal due date
Page limit for the central Science-Technical-Management section of proposal	10 pages; see also Table 1 of the ROSES *Summary of Solicitation* and Section 3.7 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to Heliophysics Space Weather Operations-to-Research in NASA and NOAA. Proposals that are relevant to this program are, by definition, relevant to one or more of the supporting agencies.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*
General requirements for content of proposals	See Section 3 of the *NASA Guidebook for Proposers* and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/, the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted
Web site for submission of full proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-SWO2R
Point of contact concerning this program element	James Spann Heliophysics Division Science mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: 202-358-0574 Email: jim.spann@nasa.gov

B.8 HELIOPHYSICS TECHNOLOGY AND INSTRUMENT DEVELOPMENT FOR SCIENCE

NOTICE: Amended August 6, 2020. This Amendment delays the proposal due date for this program element by 2 weeks. Proposals are now due September 9, 2020.

This year, proposal submission will not use the two-step process. Neither Step-1 proposals nor NOIs are requested for this program element. See Section 4 for details.

1. Scope of Program

The Heliophysics Instrument Development for Science (H-TIDeS) program requires the development and application of innovative new instruments, technologies and capabilities to enhance the ability to achieve significant progress toward the scientific and technical challenges in heliophysics in the coming years.

H-TIDeS is a component of the Heliophysics Research Program and proposers interested in this program element are encouraged to read B.1, The Heliophysics Research Program Overview for Heliophysics-specific goals and requirements. Common requirements for all ROSES elements and proposals are found in *the ROSES Summary of Solicitation*. and the *Proposer's Guidebook* and the order of precedence for proposers is the following: ROSES Element B.8 (this document) takes precedence followed by B.1, The Heliophysics Research Program Overview, followed by the ROSES *Summary of Solicitation* and, finally, the *Proposer's Guidebook*. Proposers should be familiar with all of these resources.

1.1 Solicited Investigations

H-TIDeS seeks to advance the development of new instruments and technologies and their application to enable investigation of key heliophysics science questions. This is done through incubating innovative concepts and development/maturation of instruments and technologies. It is intended that instruments and technologies developed and matured through H-TIDeS would then be proposed for demonstration in flight. This could be done by proposing to H-LCAS, H-FOS, or H-FORT to mature by demonstration in a relevant environment. In addition, instruments and technologies advanced through H-TIDeS may be demonstrated in space through a ride share opportunity. Promising instruments and technologies (such as sensors and detectors) are sought, as described below. To advance the Technology Readiness Levels of promising instruments and technologies, H-TIDeS utilizes the following sub-elements:

- Laboratory Nuclear, Atomic, and Plasma Physics (LNAPP) Program: The LNAPP program supports studies that probe fundamental nuclear, atomic, and plasma physical processes and produce chemical and spectroscopic measurements that support spacecraft observations and atmospheric models (see Section 2 below).
- Instrument Technology Development (ITD) Program: This program includes innovative instrument and technology development that may be proposed as candidate experiments for future space flight opportunities (see Section 3 below).

Proposals to the H-TIDeS program shall link the proposed work to the NASA Heliophysics Science Plan as documented in the proposal traceability matrix (Table 1 of this program element) and supported by the proposal text:

A) NASA Heliophysics Science Goal(s);
B) The science questions to be answered in achieving the science goals;
C) The proposed investigation objective(s) required to address the science goals (either technological or observational or both)

Table 1. Example Science Traceability Matrix

A. Science Goal(s)	B. Science Questions	C. Investigation Objective Requirements			Future Mission, Top Level Requirements
		Measurement	Requirement	Projected Performance	
Goal # Goal # Etc.	Question # Question # Etc.	Examples: Temporal Resolution Etc.	XX Sec.	XXX Sec.	Examples: Observing strategies: requires yaw and elevation maneuvers Launch window: to meet nadir and limb overlap requirements. Window applies day to day
		Precision	YY%	YYY%	
		Accuracy	ZZ %	ZZZ%	

The Heliophysics Science Goals have a broad scope, while a proposed objective is a more narrowly focused part of a strategy to achieve the goal(s) (e.g. identify specific science questions to be addressed and/or demonstrate a new technology is capable of obtaining future measurements that may bring closure to the science questions or goals). Proposed investigations must achieve their proposed technological objectives (letter C, above).

The ability to determine whether a proposed investigation is successful depends on a well-formulated articulation of the proposed science question(s) and investigation objectives. Each proposal shall clearly define its science question(s), shall demonstrate how the science questions are derived from the high-level science goals, and shall show how the science question(s) lead to investigation objectives that subsequently map into measurement, data and instrument requirements. Instructions for proposal submission are provided in Section 4.

Of particular interest are high-impact investigations of high (intellectual) risk, as defined below (see also Section VI(b) of the *ROSES Summary of Solicitation*):

High Risk: The proposed investigation will test novel or significant hypotheses, for which there are scant precedents or preliminary data or that run counter to the existing scientific consensus.

High Impact: The proposed investigation, if successful, will have a large effect on current thinking, methods or practice.

As part of the proposal submission process, PIs will be asked if their proposal is high risk and high impact and invited to provide a justification in response to an NSPIRES cover page question. Proposals that are submitted as high risk and high impact will be evaluated accordingly.

2. Laboratory Nuclear, Atomic and Plasma Physics (LNAPP)

The LNAPP program supports studies that probe fundamental nuclear, atomic, and plasma physical processes and produce chemical and spectroscopic measurements that support spacecraft observations and atmospheric models. They provide benchmarks for integrating theory and modeling with observation in heliophysics. Laboratory experiments allow the use of a controlled environment to perform reproducible measurements that shed light on key processes with the heliophysics environment. These experiments are directed toward understanding basic processes. Additionally, there are also important experiments that are directly used to facilitate the interpretation of spacecraft observations, e.g., spectroscopic or cosmic ray measurements. As such, LNAPP encompasses measurements of fundamental atomic parameters, e.g., cross sections associated with various processes.

3. Instrument Technology Development (ITD) Program

The ITD program supports the development of instruments, sensors/detectors concepts that show promise for use in scientific investigations on, or give rise to, future heliophysics missions. Proposals for ITD must demonstrate relevance to the Heliophysics Program, including clearly defined scientific goals appropriate for future heliophysics missions. The goal of the program is to define and develop scientific instruments and/or technologies that may be proposed in response to future Announcements of Opportunity, and which will enable future Heliophysics Science investigations.

Either new concepts or methods to improve the performance of existing instruments or technologies may be proposed, provided they would be candidates for use in space. Among the characteristics typically desirable in space-quality detection systems are high sensitivity to relevant signals, low mass, low vulnerability to particle radiation effects, low power consumption, compactness, ability to operate in a vacuum (such that high-voltage arcing is minimized), vibration tolerance, ease and robustness of integration with instrumentation, and ease of remote operation, including reduced transient effects and ease of calibration.

Small satellites are increasingly playing a larger role in NASA planning as a means to execute scientific missions at far lower cost and complexity than typical space science missions. As such, the Heliophysics Division seeks to make ITD awards across a range of mission concepts, including technologies that will enable smaller missions in deep space.

4. Proposal Submission Content and Evaluation

4.1 Proposal Submission

This year, proposal submission will not use the two-step process. Neither Notices of Intent (NOIs) nor Step-1 proposals are requested for this program element. The guidelines for submitting proposals are provided below.

Each Principal Investigator is allowed to submit one and only one proposal to each sub-element (LNAPP, ITD) of this solicitation. The Principal Investigator is expected to invest a substantial portion of his/her time, 25-30%, to the investigation. Co-investigators must each have a specific and defined task in the project, and the task must be essential to completion of the project. Use of multiple team members is discouraged, and team members are expected to have defined tasks in the project. Collaborators are expected to have defined tasks in the project with a separate source of funding identified for completion of the tasks. Proposals may be declared non-compliant if they are outside the scope of the H-TIDeS Program as defined in previous sections, or if they fail to meet submission guidelines specified below.

Proposals must be submitted electronically by the due date given in Tables 2 and 3 of ROSES. An Authorized Organizational Representative (AOR) from the institution of the PI must submit the proposal. A budget and other specified information is required.

4.2 Proposal Content

Guidelines for content and formatting of proposals are specified in Section IV(b)ii and Table 1 of the *ROSES Summary of Solicitation*.

Important Note: A science traceability matrix is required for every proposal. The matrix must show the connection between the relevant science goals, the proposal objectives and the measurements required to achieve those objectives. An example science traceability matrix is provided in Table 1 of this program element.

Proposals must demonstrate relevance to the Heliophysics Program, including clearly defined scientific goals appropriate for current and/or future heliophysics missions and linkage to the proposal objectives, and that the proposed work is a necessary precursor to solving specific scientific problems. The proposers are not expected to apply the results of their efforts to the science problem(s) within the time period of the proposed effort. Proposals for projects that aim to produce data products for wide use across the heliophysics community should explain how those products would be made available to the intended users in a stable fashion. Proposals to the H-TIDeS program must contain the following elements within the Science/Technical/Management (S/T/M) section:

I) The proposal shall describe the investigation to be performed, the types of measurements to be taken; the characteristics, precision, and accuracy required to attain the investigation objectives; and the projected instrument performance. This section shall describe the data to be returned in the course of the investigation. The quality (e.g., resolution, coverage, pointing accuracy, measurement precision, signal to noise ratio, background identification/removal, etc.) and quantity (bits, images, etc.) of data shall be described. The relationship between the proposed data products (e.g., ancillary or calibration data, theoretical calculations, higher order

analytical or data products, laboratory data, etc.) and the investigation objectives, as well as the expected results, shall be described. How the science products and data obtained will be used to fulfill the scientific requirements shall be demonstrated and supported by quantitative analysis.

II) A traceability matrix from science goals to measurement requirements to instrument requirements (functional and performance), and to top-level mission requirements shall be provided in tabular form and supported by narrative discussion. Note that the term "mission" refers to future mission(s) envisioned to address the proposed science question and utilizing the research and/or technology development being investigated. Projected instrument performance shall be compared to instrument performance requirements. This matrix provides the reference points and tools needed to track overall investigation requirements. A sample science traceability matrix is shown in Table 1 of this program element.

III) A science data management plan is required for all proposed investigations. All data obtained through H-TIDeS funded efforts shall be made public in a prompt manner. Proposals must describe the management plan of any science data obtained in the investigation described. Proposals must describe the management plan of any science data obtained in the investigation described. ITD proposals must discuss the release of data obtained in an investigation characterizing the performance of an instrument technology, although it is permissible to summarize this data. In addition to the public release of data, proposals must describe the analysis, interpretation, and dissemination in professional meetings and publications of the results of the proposed investigation. The Data Management Plan requirements are described in B.1, The Heliophysics Research Program Overview.

IV) Proposals submitted to ITD are required to include a technology summary section, as shown in Table 2 of this program element. This section requires an assessment of the Technology Readiness Level (TRL) at the start of the proposed work, and the projected TRL at the conclusion of the proposed work.

Table 2. An Assessment of Technology Benefits and Advancements

Primary Taxonomy Area (TA)	Refer to NASA Technology Taxonomy. Provide TA number down to level 2 or 3.
Target Destination (The Sun, Earth, Moon, Mars, Others inside the Solar System, Outside the Solar System, Foundational Knowledge)	Select up to 3.
Start TRL*	
Estimated End TRL*	
Anticipated Benefits	

* Refer to https://www.nasa.gov/pdf/458490main_TRL_Definitions.pdf

One of the goals of the H-TIDeS program is to identify promising technologies for enabling future heliophysics missions. The TRL is a metric-based assessment of the maturation of new technologies. The NASA Technology Readiness Level definitions are provided at https://www.nasa.gov/pdf/458490main_TRL_Definitions.pdf. The primary

technology area refers to the technology areas defined in the NASA Technology Taxonomy (https://www.nasa.gov/offices/oct/taxonomy/index.html).

4.3 Proposal Evaluation

Proposals will be evaluated according to the criteria specified in the *ROSES Summary of Solicitation* Section VI(a) and the *NASA Guidebook for Proposers*. These criteria are Relevance, Merit, and Cost reasonableness. Clarifications and additions specific to this program element are listed below.

The evaluation of scientific and technical merit will include the scientific impact of the proposed technology development, if successful. The review process naturally favors proposals that are deemed high impact and low risk by the evaluators. Investigations identified as high impact by the evaluators and high intellectual risk, as defined in Section 1.1, above, (as opposed to high technical risk) will considered for selection for programmatic reasons (e.g., as described in Section VI(b) of the ROSES Summary of Solicitation).

The evaluation of relevance will include evaluation of the required traceability matrix.

Proposers are strongly encouraged to provide names and contact information of five experts qualified to review their proposal. These experts must not be from the institutions of the PI or Co-Is. The PI can confidentially provide this information by sending an email to the Point of Contact listed in Section 6 of this Program Element by the proposal due date.

Proposers are expected to respond to requests to conduct reviews for up to four proposals in the H-TIDeS, H-LCAS, H-FOS, or H-FORT programs. Much of the science expertise lies in the PIs and Co-Is, since nearly the entire heliophysics community proposes. In order to maintain a high caliber review process, it is important to request that the heliophysics experts conduct reviews.

5. Award Duration and Type

The maximum duration of LNAPP and ITD awards is three years. H-TIDeS will not award contracts. H-TIDeS does not make separate awards to the Principal Investigator (PI) and Co-Investigators (Co-Is) of the same investigation at different institutions, except in those cases where a Co- Investigator is affiliated with a U.S. Government Laboratory (see Section IV(d) of the *ROSES Summary of Solicitation*), in which case NASA separately funds that Co-Investigator through a direct transfer of funds. In all other cases, the PI institution is expected to fund participating Co-I(s). No separate Co-I cost proposals will be accepted.

6. Summary of Key Information

Projected program budget for first year of new awards	ITD: $4M LNAPP: $0.5M
Anticipated number of new awards pending adequate proposals of merit	ITD: 10-15 LNAPP: 3-5
Maximum duration of awards	3 years.
Neither Step-1 proposals nor NOIs are requested for this program element.	

Due date for proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of LNAPP and ITD Investigations	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal.	15 pages; see also Table 1 of ROSES *Summary of Solicitation* and the *NASA Guidebook for Proposers*.
General information and overview of this solicitation	See *ROSES Summary of Solicitation.*
General requirements for content of proposals	See B.1 the Heliophysics Research Program Overview, and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-HTIDS
Point of contact concerning this program	Roshanak Hakimzadeh Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0784 Email: hakimzadeh@nasa.gov

B.9 HELIOPHYSICS LOW COST ACCESS TO SPACE

NOTICE: NOTICE: Amended July 20, 2020. This Amendment delays the proposal due date for B.9 H-LCAS by six weeks. Proposals are now due October 7, 2020. Notices of intent are not requested for this program element.

The flight opportunities of the Heliophysics Division research program have been split into three separate program elements for improved clarity: Low Cost Access to Space (H-LCAS, this element, B.9); Flight Opportunities Studies (H-FOS, B.10); and the remaining SmallSats and Rideshare Opportunities, solicited in Flight Opportunities for Research and Technology (H-FORT, B.11).

Proposal submission will not use the two-step process. Step-1 proposals are not requested for this program element. See Section 4 for details.

1. Scope of Program

The Heliophysics Low Cost Access to Space (H-LCAS) program seeks to advance the development of technologies and their application to enable investigation of key heliophysics science questions in the coming years. This is done through demonstration of innovative technologies and associated science investigations that can be carried out with instruments flown on NASA suborbital rockets, NASA stratospheric balloons, or NASA airborne platforms, collectively referred to as Low Cost Access to Space.

It is anticipated that some of the technologies developed through H-TIDeS (program element B.8) might be proposed to H-LCAS to mature by demonstration in a relevant environment, however, this is not a prerequisite for submitting a proposal to H-LCAS.

H-LCAS is a component of the Heliophysics Research Program and proposers interested in this program element are encouraged to see B.1 The Heliophysics Research Program Overview, for Heliophysics-specific requirements. Default requirements for all ROSES elements are found in the ROSES *Summary of Solicitation* and for all Agency solicitations in the *Proposer's Guidebook* (https://www.hq.nasa.gov/office/procurement/nraguidebook).

The order of precedence is the following: Program Element B.9 (this document), followed by B.1 The Heliophysics Research Program Overview, followed by the ROSES *Summary of Solicitation*, and last the *Proposer's Guidebook*. Proposers should be familiar with all of these resources.

1.1 Solicited Investigations

The LCAS program supports investigations addressing NASA Heliophysics Science Goals using investigator-developed instrumentation that must be completed through suborbital flights. Proposals submitted to H-LCAS must have the following characteristics:

1. The investigation objectives must address NASA Heliophysics Science Goals and Objectives (see Heliophysics Overview, B.1);
2. The investigation must develop or enhance an instrument/sensor for flight;

3. NASA-managed flight is required to achieve investigation objectives;
4. Data acquired from flight is reduced, analyzed, and interpreted in terms of investigation objectives;
5. The reduced (calibrated) data is archived in a NASA on-line facility and the interpretation is published in professional journals;
6. The investigation is completed within a time interval less than or equal to four years, typically three years for all but complex investigations;
7. The investigation cost is consistent with the available program funding (Section 6 of this program element);
8. The Principal Investigator (PI) manages all the program resources (including schedule and cost) and no reserve is held by NASA.

Suborbital launch vehicle services include those provided by the NASA Sounding Rocket Program Office (SRPO), the NASA Balloon Program Office (BPO), and NASA Airborne Science Program (ASP). Detailed information, including suborbital specifications and points of contact, is found in the *ROSES Summary of Solicitation*, Section V(b), Suborbital-Class Investigations:

I. NASA-provided Sounding Rocket Services;
II. NASA-provided Balloon Services;
III. NASA-provided Airborne Services.

LCAS is expected to lead the way in the development of much of the instrument concepts for future solar, heliospheric, magnetospheric, and ionosphere-thermosphere-mesosphere (ITM) missions. LCAS-investigations provide unique opportunities not only for executing intrinsically meritorious science investigations, but also for advancing the technology readiness levels of future space flight sensors and supporting technologies and for preparing future leaders of NASA space flight missions, such as junior researchers and graduate students.

1.2 Traceability Matrix

Proposals to H-LCAS shall link the proposed work to the NASA Heliophysics Science Objectives (see B.1), documented in the proposal traceability matrix (Table 1 of this program element) and supported by the proposal text:

A) NASA Heliophysics Science Goal(s);
B) The investigation-specific science goals, formulated as questions, proposed to achieve significant progress toward the Heliophysics Science Objectives.
C) The proposed investigation objective(s) required to address the science goals (either technological or observational or both)

The three Heliophysics Science Goals have a broad scope, while an objective is a more narrowly focused part of a strategy to address the investigation-specific science goal (s). While a successful proposal is expected to bring closure to the proposed investigation objectives, it is not necessary to provide closure to the science goals and it is unlikely to bring closure to the associated Heliophysics Science Objective(s). For example, identify specific science questions to be addressed and/or demonstrate a new technology is capable of obtaining future measurements that may bring closure to the science questions or goals. Proposed investigations must achieve their proposed technological objectives (letter C in Table 1 of this program element, below).

Table 1. Example Science Traceability Matrix

A. Science Goal(s)	B. Science Questions	C. Investigation Objective Requirements			Mission Top Level Requirements
		Measurement	Requirement	Projected Performance	
Goal # Goal # Etc.	Question # Question # Etc.	Examples: Temporal Resolution Etc.	XX Sec.	XXX Sec.	Examples: Observing strategies: requires yaw and elevation maneuvers. Launch window: to meet nadir and limb overlap requirements. Window applies day to day.
		Precision	YY%	YYY%	
		Accuracy	ZZ %	ZZZ%	

The ability to determine whether a proposed investigation is successful depends on a well-formulated articulation of the proposed science question(s) and investigation objectives. Each proposal shall clearly define its science question(s), shall demonstrate how the science questions are derived from the high-level Science Goals, and shall show how the science question(s) lead to investigation objectives that subsequently map into measurement, data and instrument requirements. Instructions for proposal submission are provided in Section 4.

1.3 High Risk High Impact Investigations

Of particular interest are high-impact investigations of high (intellectual) risk, as defined below (see also Section VI(b) of the ROSES Summary of Solicitation):

High Risk: The proposed investigation will test novel or significant hypotheses, for which there are scant precedents or preliminary data or that run counter to the existing scientific consensus.

High Impact: The proposed investigation, if successful, will have a large effect on current thinking, methods or practice.

As part of the proposal submission process, PIs will be asked if their proposal is high risk and high impact and invited to provide a justification in response to an NSPIRES cover page question. The review process naturally favors proposals that are deemed high impact and low risk by the evaluators. Investigations identified as high impact by the evaluators and high intellectual risk, as defined above, (as opposed to high technical risk) will considered for selection for programmatic reasons (e.g., as described in Section VI(b) of the ROSES *Summary of Solicitation*).

1.4 Export Control

Export Control: Export licenses are required for all foreign persons accessing flight programs. H-LCAS Principal Investigators (PIs) should contact the program office with whom they are working regarding PI responsibilities in this arena. Procuring the required State Department licenses can take some time, so PIs are urged to begin the process well before team members need access to the actual flight hardware. Appendix

A of the *NASA Guidebook for Proposers* includes links to information regarding U.S. export regulations, export-control guidelines applicable to proposals including foreign participation, and how to handle export-controlled material in proposals.

2. Proposal Submission Guidelines

2.1 General Guidelines

Proposal submission will not use the two-step process. Neither Notices of Intent (NOIs) nor Step-1 proposals are requested for this program element. The guidelines for the technical contents of the proposal are provided in Section 2.2.

A proposal must be submitted electronically by the due date given in Table 2 and Table 3 of ROSES. An Authorized Organizational Representative (AOR) from the institution of the PI must submit the proposal. A budget and other specified information is required.

Each Principal Investigator is allowed to submit one and only one proposal to H-LCAS. The Principal Investigator is expected to invest a substantial portion of his/her time. Co-investigators must each have a specific and defined task in the project, and the task must be essential to completion of the project. Use of multiple team members is discouraged, and team members are expected to have defined tasks in the project. Collaborators are expected to have defined tasks in the project with a separate source of funding identified for completion of the tasks.

The number of investigations that can be supported is limited and heavily dependent on the funds available to this program. Note that NASA does not carry reserves to accommodate any cost overrun incurred by a particular investigation, including the loss of the payload owing to a flight system failure. Therefore, failure to achieve the proposed goals within the proposed time and budget could require either de-scoping the initially proposed investigation, delaying it, canceling a particular launch date opportunity, or canceling the investigation altogether.

Science support elements, such as science radars, lidars, ionosondes, optical sites, and the associated logistics, can be supported, when appropriate. The funding for these support elements must be included in science proposal budgets.

Proposals may be declared non-compliant if they are outside the scope of the H-LCAS Program as defined in previous sections, or if they fail to meet submission guidelines specified below.

Proposers are strongly encouraged to provide names and contact information of five experts qualified to review their proposal. These experts must not be from the institutions of the PI or Co-Is. The PI can confidentially provide this information by sending an email the Point of Contact listed in Section 6 of this program element by the due date of the proposal.

2.2 Proposal Content

Proposals must be for a complete investigation, based on clearly defined investigation objectives that address scientific questions appropriate for the Heliophysics missions linked back to Heliophysics Science Objectives (see B.1). The investigation objectives must be achieved through a process, including payload construction, space or near-

space flight, data analysis, data archiving, and publication of results. In addition, proposals must also provide sufficient information on the flight performance characteristic and the mission requirements in order to demonstrate the feasibility of the investigation.

The Science/Technical/Management (S/T/M) section of proposals is restricted in the number of pages (see Section 4 of this program element). In addition to the requirements provided in Checklist for Proposers (Table 1) of *ROSES Summary of Solicitation,* the S/T/M section must include the following information:

I) The proposal shall describe the investigation to be performed, the types of measurements to be taken; the characteristics, precision, and accuracy required to attain the investigation objectives; and the projected instrument performance. This section shall describe the data to be returned in the course of the investigation. The quality (e.g., resolution, coverage, pointing accuracy, measurement precision, signal to noise ratio, background identification/removal, etc.) and quantity (bits, images, etc.) of data that must be returned shall be described. The relationship between the proposed data products (e.g., flight data, ancillary or calibration data, theoretical calculations, higher order analytical or data products, laboratory data, etc.) and the investigation objectives, as well as the expected results, shall be described. How the science products and data obtained will be used to fulfill the scientific requirements shall be demonstrated and supported by quantitative analysis.

II) A traceability matrix from investigation-specific science goals to measurement requirements to instrument requirements (functional and performance), and to top-level mission requirements shall be provided in tabular form and supported by narrative discussion. Projected instrument performance shall be compared to instrument performance requirements. This matrix provides the reference points and tools needed to track overall investigation requirements. A sample science traceability matrix is shown in Table 1 of this program element. The science traceability matrix shall be included as a table within the S/T/M section. This matrix should summarize how the instrument performance requirements are a direct consequence of the proposed science questions and investigation objectives. The traceability matrix is a critical tool in both the evaluation of a proposed investigation as well as the management and implementation of a selected investigation.

III) A science data management plan is required for all proposed investigations. All data obtained through H-LCAS funded efforts shall be made public in a prompt manner. Proposals must describe the management plan of any science data obtained in the investigation described. Proposals must describe the management plan of any science data obtained in the investigation described. Proposals must discuss the release of data obtained in an investigation characterizing the performance of an instrument technology, although it is permissible to summarize this data. In addition to the public release of data, proposals must describe the analysis, interpretation, and dissemination in professional meetings and publications of the results of the proposed investigation.

IV) If technology development and/or maturation is a component of the proposed investigation, then a technology summary section is required, as shown in Table 2 of this program element (below). This section requires an assessment of the Technology Readiness Level (TRL) at the start of the proposed work, and the

projected TRL at the conclusion of the proposed work. The TRL is a metric-based assessment of the maturation of technologies.

The NASA Technology Readiness Level definitions are provided at https://www.nasa.gov/pdf/458490main_TRL_Definitions.pdf. The primary technology area refers to the technology areas defined in the 2020 NASA Technology Taxonomy (https://www.nasa.gov/offices/oct/home/taxonomy).

Table 2. An Assessment of Technology Benefits and Advancements

Primary Technology Area (TA)	Refer to NASA Space Technology Roadmaps. Provide TA number down to level 2 or 3.
Target Destination (The Sun, Earth, Moon, Mars, Others inside the Solar System, Outside the Solar System, Foundational Knowledge)	Select up to 3.
Start TRL*	
Estimated End TRL*	
Anticipated Benefits	

* Refer to https://www.nasa.gov/pdf/458490main_TRL_Definitions.pdf

Performance characteristics (which shall be considered as requirements on the flight system) shall include mass, power, volume, data rate(s), thermal, pointing (such as control, stability, jitter, drift, accuracy, etc.), spatial and spectral resolution, observable precision, retrieved parameter sensitivity and accuracy, and calibration requirements. This section shall demonstrate that the instrumentation can meet the measurement requirements, including factors such as retrieval results for each remote sensor, error analysis of the information in all sensors, vertical and horizontal resolution, signal-to-noise (S/N) calculations, and any other aspects of the instrumentation upon which the observations depend.

The mission requirements that the science goals and investigation objectives impose on the mission design elements, including mission design, instrument accommodation, platform design, required launch vehicle capability, ground systems, communications approach, and mission operations plan, shall be provided in tabular form in the mission requirements column of the traceability matrix, and supported by narrative discussion.

Reference for management of H-LCAS investigations is found in NPR 7120.8. Typically, management compliance of projects conducted under the NASA Sounding Rocket, Balloon, and Airborne Programs is ensured by their respective Program Offices.

To allow advance planning, all proposal Budgets must cover complete investigations, including payload development and construction, instrument calibration, launch activities, and data analysis. Proposals must supply information that is needed in order to generate an estimate of the costs associated with the operational requirements for the proposed investigation. For example, for sounding rockets, this information is the envisioned vehicle type and quantity, payload mass, trajectory requirements, launch

site, telemetry requirements, attitude control or pointing requirements, and any plans for payload recovery and reuse. Balloon projects needing unique engineering and/or technical support services and/or vehicles and/or the Wallops Arc-Second Pointing System (WASP) should contact the Balloon Program Office (BPO) directly for an estimate of the Government Furnished Equipment (GFE) cost of the desired support. It is advisable that PIs contact SRPO or BPO before submitting proposals requesting large amounts of resources (e.g., high number of rocket flights) to determine if the proposed investigation is realistic.

Note: Data returned from flight investigations shall be deposited in a publicly accessible NASA repository, such as the Solar Data Analysis Center (SDAC) or Space Physics Data Facility (SPDF). Quick look data shall be deposited as soon as possible after it is acquired and all reduced data shall be deposited before the end of the investigation.

All investigations with unique requirements must obtain a letter of mission feasibility from the relevant program office point of contact (listed in Section V(b) of the *ROSES Summary of Solicitation*). Unique requirements include, but are not limited to, remote launch campaigns and phenomenological constraints on the time of launch. The mission feasibility letter must be included in the proposal submission, but it does not count against the proposal page limit.

3. Award Duration and Type

H-LCAS awards are expected to be three years, with a maximum of four years for investigations that require the extra time. H-LCAS will not award contracts as it would not be appropriate given the nature of the work solicited. H-LCAS does not make separate awards to the Principal Investigator (PI) and Co-Investigators (Co-Is) of the same investigations at different institutions, except in those cases where a Co-Investigator is affiliated with a U.S. Government Laboratory (see Section IV(d) of the *ROSES Summary of Solicitation*), in which case NASA separately funds that Co-Investigator through a direct transfer of funds. In all other cases, the PI institution is expected to fund participating Co-I(s). No separate Co-I cost proposal will be accepted.

4. Summary of Key Information

Projected program budget for first year of new awards	$5-6M
Anticipated number of new awards pending adequate proposals of merit	6-7
Maximum duration of awards	4 years.
Neither Step-1 proposals nor NOIs are requested for this program element.	
Due date for proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of LCAS Investigations	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of the proposal	20 pages
General information and overview of this solicitation	See *ROSES Summary of Solicitation*.

General requirements for content of proposals	See Section IV and Table 1 of *the* ROSES Summary of Solicitation and the *NASA Guidebook for Proposers*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the* ROSES Summary of Solicitation.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-HLCAS
Point of contact concerning this program	Dan Moses Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0558 Email: dan.moses@nasa.gov

B.10 HELIOPHYSICS FLIGHT OPPORTUNITIES STUDIES

NOTICE: Amended on September 2, 2020. This amendment releases the final text for this program element. Notices of intent to propose are not requested. The due date for proposals is December 3, 2020.

The flight opportunities of the Heliophysics Division research program have been split into three separate program elements for improved clarity: Low Cost Access to Space (B.9), Flight Opportunities Studies (this element, B.10), and the remaining SmallSats and Rideshare Opportunities are solicited in Flight Opportunities for Research and Technology (B.11).

Proposal submission will not use the two-step process. Step-1 proposals are not requested for this program element. See Section 4 for details.

1. Scope of Program

The Heliophysics Flight Opportunities Studies (H-FOS) program solicits proposals for up to twelve-month studies to enable application of new technologies (platform and/or instrumentation) to heliophysics flight missions. NASA intends to award a range of studies across the spectrum of heliophysics science and mission cost. Investigations must be responsive to the science goals of the Heliophysics Division Science Goals and have identified a potential future mission proposal.

H-FOS is a component of the Heliophysics Research Program and proposers interested in this program element are encouraged to read the overview of the Heliophysics Research Program in B.1 The Heliophysics Research Program Overview, for Heliophysics-specific requirements. Common requirements for all ROSES elements are found in the ROSES *Summary of Solicitation* and the *Proposer's Guidebook* (https://prod.nais.nasa.gov/pub/pub_library/srba/propsers_guidebooks.html).

The order of precedence is the following: Program Element B.10 (this document), followed by B.1 The Heliophysics Research Program Overview, followed by the ROSES *Summary of Solicitation* and, last, the *Proposer's Guidebook*. Proposers should be familiar with all of these resources.

2. Solicited Investigations

The H-FOS program supports investigations addressing NASA Heliophysics Science Goals using investigator-developed instrumentation. The goal of H-FOS is to provide an early investment in studies for potential future proposed missions that enable meritorious science investigations. Examples of activities that would be considered for an H-FOS investigation include 1) refinement of scientific methodology for new applications in future space missions, 2) trade studies for implementation, and 3) mission concept studies to determine optimal orbits, mass and power requirements, etc. These examples are not prescriptive or exhaustive; any activities to mature a mission concept is solicited through H-FOS. Note that H-FOS does not solicit investigations that are primarily instrument or technology development, which are commonly funded through the Instrument and Technology Development Program (B.8 Heliophysics Technology and Instrument Development for Science).

All proposed H-FOS investigations must identify a potential future mission proposal and shall link the future proposed mission to the NASA Heliophysics Science Objectives (see B.1), documented in a required science traceability matrix (see Section 4.2). The H-FOS proposal must then demonstrate the necessity of completing the proposed H-FOS investigation prior to submitting the future mission proposal. Proposers to H-FOS are encouraged to consider the platforms available through the H-FORT program element to capitalize on research and technology enabled by smaller and significantly lower cost missions.

H-FOS solicits proposals of high risk and high impact as defined below:

High Risk: The proposed investigation will test novel or significant hypotheses, for which there is scant precedent or preliminary data, or run counter to the existing scientific consensus.

High Impact: The proposed investigation, if successful, will have a large effect on current thinking, methods or practice.

Export Control: Export licenses are required for all foreign persons accessing flight programs. Appendix A of the *Proposer's Guidebook* includes links to information regarding U.S. export regulations, export-control guidelines applicable to proposals including foreign participation, and how to handle export-controlled material.

3. Requirements for H-FOS Investigations that include Mission Concept Study

If a mission concept study is included as part of an H-FOS investigation, proposals should include team members to conduct trades, explore feasibility, and refine the mission concept and/or a statement that arrangements have been made to partner with an appropriate NASA mission design team. Since some science teams may lack access to the necessary mission design capability, NASA field centers can provide study teams access to mission design assistance if needed. It is up to the proposing team to contact one of the field centers to determine the cost associated with the support required. The negotiated cost is to be included in the proposal as a separate line item. For evaluation purposes, the design assistance cost will be considered part of the entire cost of the study. If you are at a NASA center and using your local design center, this cost should be included along with other costs in the main part of your budget. If you are not, please include this cost in Section F ("Other Direct Costs") of the budget pages, line 8 or 9, labeled with the name of the center facility, e.g., Ames Research Center - Mission Design Center". These funds will be sent directly to the center and proposers may not charge overhead on this portion of the award.

Design Assistance Points of Contact
Ames Research Center - Mission Design Center
http://www.nasa.gov/centers/ames/engineering/divisions/missiondesign/
Ryan Vaughan, ryan.vaughan@nasa.gov, 650-604-3109.

Goddard Space Flight Center's Wallops Flight Facility – Mission Planning Lab
https://sites.wff.nasa.gov/mpl/index.html
Benjamin Cervantes, benjamin.w.cervantes@nasa.gov, 757-824-1526.

Jet Propulsion Laboratory, Team Xc
http://jplfoundry.jpl.nasa.gov/

https://www.jpl.nasa.gov/cubesat/teamxc.php
Keith Grogan, keith.grogan@jpl.nasa.gov, 818-354-2617.

Johnson Space Center - Partnerships Office
http://www.nasa.gov/centers/johnson/partnerships/JSC-Partnership-Gateway/
Linda Ham, linda.j.ham@nasa.gov, 281-483-6881.

Marshall Space Flight Center - Advanced Concepts Office
https://www.nasa.gov/centers/marshall/capabilities/advanced_concepts.html
Joseph Casas, joseph.casas@nasa.gov, 256-961-3029.

Kennedy Space Center – University Partnerships and Small Sat Capabilities
https://kscpartnerships.ksc.nasa.gov
Jose Nunez, jose.l.nunez@nasa.gov, 321-867-5922.

Langley's Engineering Design Studio
https://eds.larc.nasa.gov/
David Goggin David.G.Goggin@nasa.gov, 757-864-5705.

4. Proposal Submission Guidelines

4.1 General Guidelines

Proposal submission will not use the two-step process. Neither Notices of Intent (NOIs) nor Step-1 proposals are requested for this program element. The guidelines for the technical contents of the proposal are provided in Section 4.2.

To be eligible, a proposal must be submitted electronically by the due date given in Table 2 and Table 3 of ROSES. An Authorized Organizational Representative (AOR) from the institution of the PI must submit the proposal. A budget and other specified information is required.

Each Principal Investigator (PI) is allowed to submit one and only one proposal to H-FOS. Studies must be led by a designated PI with a small science and engineering team. Student involvement is welcome. Co-investigators must each have a specific and defined task in the project, and the task must be essential to completion of the project. Collaborators are expected to have defined tasks in the project with a separate source of funding identified for completion of the tasks. Since proposal teams have the option of being partnered with NASA mission designers, proposal teams are encouraged, but not required, to have members with engineering or mission design expertise. Proposals may be declared non-compliant if they are outside the scope of the H-FOS Program as defined in previous sections, or if they fail to meet submission guidelines specified below.

Proposers are strongly encouraged to provide names and contact information of five experts qualified to review their proposal. These experts must not be from the institutions of the PI or Co-Is. The PI can confidentially provide this information by sending an email the Point of Contact listed in Section 6 of this program element by the due date of the proposal.

4.2 Proposal Content

The Science/Technical/Management (S/T/M) section of proposals is restricted to 15 pages. In addition to the requirements provided in Checklist for Proposers (Table 1) of the ROSES *Summary of Solicitation*, the S/T/M section must include the following information:

I) Proposals must identify a potential future mission and include a baseline spacecraft design and architecture from which the study will begin, though it is recognized that this design may change significantly during an H-FOS investigation.

II) A traceability matrix from science goals to measurement requirements to instrument requirements (functional and performance), and to top-level future mission requirements shall be provided in tabular form in the S/T/M section. A sample science traceability matrix is shown in Table 1 of this program element, below. This matrix must summarize (under Investigation Objective Requirements) how the instrument performance requirements are a direct consequence of the proposed science questions and investigation objectives.

Table 1. Example Science Traceability Matrix

A. Science Objective(s)	B. Science Questions	C. Investigation Objective Requirements			Mission Top Level Requirements
		Measurement	Requirement	Projected Performance	
Objective # Objective # Etc.	Question # Question # Etc.	Examples: Temporal Resolution Etc.	XX Sec.	XXX Sec.	Examples: Observing strategies: requires yaw and elevation maneuvers. Launch window: to meet nadir and limb overlap requirements. Window applies day to day.
		Precision	YY%	YYY%	
		Accuracy	ZZ %	ZZZ%	

Important Note: A science traceability matrix is required for every proposal. Proposals without a science traceability matrix may be returned without review.

The top-level mission requirements that the science goals and investigation objectives impose on the mission design elements, including mission design, instrument accommodation, platform design, required launch vehicle capability, ground systems, communications approach, and mission operations plan, shall be provided in the science traceability matrix.

Given the page limits and the nature of H-FOS investigations, an extensive discussion of the science goals, science requirements, and mission requirements in the text is not required. It is suggested that, at most, 3-5 pages be devoted to these topics and the remainder of the proposal be devoted to the activities to be completed during the H-FOS investigation.

III) Proposals must clearly describe the nature of work to be carried out during the proposed study and should include a work plan for the study.

4.3 Additional Required Content

A new requirement in ROSES 2020 is that all proposals must contain a Data Management Plan (DMP), which will be evaluated as part of the Intrinsic Science Merit. Proposers are strongly encouraged to review Section 1.5 of B.1 The Heliophysics Research Program Overview for the required content of the DMP. The DMP must describe the management plan of all data obtained in the investigation described. The DMP is limited to two pages and must appear after the S/T/M section and citations. The DMP does not count against the S/T/M page limit.

Given the unique nature of H-FOS, consider the following guidelines when developing a DMP:

- Any data obtained through H- FOS funded efforts shall be made public in a prompt manner.
- If a mission concept study is conducted through an H-FOS investigation, proposers will be required to produce a publicly releasable mission concept study summary and fact sheet.
- All successful H-FOS proposers will be required to present a summary of their study at a domestic science conference.

5. Award Duration and Type

H-FOS awards are expected to be, at most, 12 months in duration. H-FOS will not award contracts as it would not be appropriate given the nature of the work solicited. H-FOS does not make separate awards to the Principal Investigator (PI) and Co-Investigators (Co-Is) of the same investigations at different institutions, except in those cases where a Co-Investigator is affiliated with a U.S. Government Laboratory (see Section IV(d) of the ROSES *Summary of Solicitation*), in which case NASA separately funds that Co-Investigator through a direct transfer of funds. In all other cases, the PI institution is expected to fund participating Co-I(s). No separate Co-I cost proposal will be accepted.

6. Summary of Key Information

Projected program budget for new awards	$900K
Anticipated number of new awards pending adequate proposals of merit	6-9
Maximum duration of awards	12 months
Neither Step-1 proposals nor NOIs are requested for this program element.	
Due date for proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of H-FOS Investigations	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of the proposal	15 pages
General information and overview of this solicitation	See *the* ROSES *Summary of Solicitation*.

General requirements for content of proposals	See Section 3 of the *NASA Guidebook for Proposers* and Section IV and Table 1 of *the* ROSES *Summary of Solicitation*
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the* ROSES *Summary of Solicitation*
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-HFOS
Point of contact concerning this program	Dan Moses Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0558 Email: dan.moses@nasa.gov

B.11 HELIOPHYSICS FLIGHT OPPORTUNITIES IN RESEARCH & TECHNOLOGY

NOTICE: NASA intends to solicit this program element in ROSES-2020. The final text will be released as an amendment to ROSES-2020 with a submission deadline no fewer than 90 days after the release of the amendment.

What had previously been Heliophysics Flight Opportunities for Research and Technology (H-FORT) has been split into three separate solicitations for improved clarity: Low Cost Access to Space (H-LCAS, B.9), Flight Opportunities Studies (H-FOS, B.10), and the remaining SmallSats and Rideshare Opportunities are solicited here in H-FORT.

1. Scope of Program

The Heliophysics Flight Opportunities in Research & Technology (H-FORT) program seeks to advance the development of technologies and their application to enable investigation of key heliophysics science questions in the coming years. This is done through demonstration of innovative technologies and associated science investigations that can be carried out with instruments flown on SmallSats (including CubeSats) or payloads on the International Space Station (ISS), Department of Defense (DoD), or other rideshare opportunities.

It is anticipated that some of the technologies developed through H-TIDeS might be proposed to H-LCAS, H-FOS, or H-FORT to mature by demonstration in a relevant environment, however, this is not a prerequisite for submitting a proposal to H-LCAS, H-FOS, or H-FORT.

H-FORT is a component of the Heliophysics Research Program and proposers interested in this program element are encouraged to see the overview of the Heliophysics Research Program in Appendix B.1 of this ROSES NASA Research Announcement, for Heliophysics-specific requirements. Common requirements for all ROSES elements are found in the ROSES *Summary of Solicitation* and the *Proposer's Guidebook* (https://www.hq.nasa.gov/office/procurement/nraguidebook).

The order of precedence is the following: ROSES Element B.11 (this document) followed by ROSES Element B.1, followed by the ROSES *Summary of Solicitation*, and the *Proposer's Guidebook*. Proposers should be familiar with all of these resources.

1.1 Solicited Investigations

The H-FORT program supports investigations addressing NASA Heliophysics Science Goals using investigator-developed instrumentation that must be completed through SmallSats (including CubeSats), payloads on the ISS, and all other rideshare opportunities. Proposals submitted to H-FORT must have the following characteristics:

1. The investigation objectives must address NASA Heliophysics Science Goals and Objectives (see Heliophysics Overview, B.1);
2. The investigation must develop or enhance an instrument/sensor;
3. Spaceflight is required to achieve investigation objectives;

4. Data acquired is reduced, analyzed, and interpreted in terms of investigation objectives;
5. The reduced (calibrated) data is archived in a NASA on-line facility and the interpretation is published in professional journals;
6. The investigation is completed within a time interval less than or equal to four years;
7. The investigation cost is consistent with the available program funding;
8. The Principal Investigator (PI) manages all the program resources (including schedule and cost) and no reserve is held by NASA.

H-FORT investigations are solicited to achieve: 1) validation of scientific observables for future space missions, 2) execution of intrinsically meritorious science investigations, and 3) advancement of the technology readiness levels of future space flight sensors, detectors, instruments and supporting technologies. In addition, investigations provide an important opportunity for preparing future leaders of NASA space flight missions, by involving the investigation teams in all aspects of achieving science goals via space flight.

Point of contact concerning this program	Dan Moses Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0558 Email: dan.moses@nasa.gov

B.12 HELIOPHYSICS DATA ENVIRONMENT ENHANCEMENTS

NOTICE: Amended March 26, 2020. To allow the science community time to adapt to the new environment with coronavirus, this Amendment delays both Step-1 and Step-2 due dates for this program element. Step-1 proposals are now due May 8, 2020, and Step-2 proposals are now due July 1, 2020. Also, please note that this year there are two types of proposals with two different page limits and dollar values. See Section 1.3. New text is in bold and deleted text is struck through.

Resident Archives are no longer being offered; the data from missions is now flowing directly to Final Archives, and the "ramp-down funding" when a mission ends will be expected to cover any final expenses for transitioning data to a final archive.

The Data Upgrades portion of the HDEE will not be offered this year since there has been a strongly declining interest in proposing relevant projects, and a new avenue is open for producing datasets in conjunction with science proposals.

What is solicited are directed Value Added Enhancement projects aimed at furthering the use of Python in Heliophysics. These are to be treated similarly to the LWS Focus Topics in that all the selected proposers will be expected to work together in the context of the whole project.

Data Management Plans will not be collected via the NSPIRES web pages for this element. Instead proposers should refer to the requirement for Archive and Dissemination Plan in section 2.4.1.

1. Scope of Program

The Heliophysics Data Environment Enhancements (HDEE) program encompasses the data environment needs throughout Heliophysics, including Solar, Heliospheric, Magnetosphere, and Ionosphere/Thermosphere/Mesosphere (ITM).

As part of a mission-oriented agency, the Heliophysics Python Project (HPP) preferentially seeks to fund those efforts that directly impact NASA missions or interpretation of their data. Therefore, investigations that are judged to be more appropriate for submission to other Federal agencies (because, for example, the datasets involved do not belong to NASA), even if of considerable merit, will not be given high priority for funding through this program element, although they may be considered if they are generally relevant to NASA Heliophysics (HP) research.

The specific context of this call is provided by the *NASA Heliophysics Science Data Management Policy* (https://hpde.gsfc.nasa.gov/Heliophysics_Data_Policy_v1.2_2016Oct04.html).

HDEE is a component of the Heliophysics Research Program and proposers interested in this program element are encouraged to see the overview of the Heliophysics Research Program in Appendix B.1 for Heliophysics-specific requirements. Common requirements for all ROSES elements and proposals are found in the *ROSES Summary*

of Solicitation and the *Proposer's Guidebook* and the order of precedence for proposers is the following: ROSES Element B.12 (this document) takes precedence followed by ROSES Element B.1, followed by the *ROSES Summary of Solicitation*, and the *Proposer's Guidebook*. Proposers should be familiar with all of these resources.

1.1 Solicited Investigations

This call solicits proposals (Value Added Enhancements) to advance the goal of a robust, vital, and cohesive Python environment for Heliophysics. Types of projects to be proposed under this call may include but are not limited to:

- Data readers/writers for standard formats (FITS, CDF, NetCDF)
- Analysis code, e.g., SPEDAS or SolarSoft components; common research methods.
- Visualization: improvements on common packages, focused on our needs including graphics from line graphs to 2D and 3D representations of data and simulations.
- Large data and large simulation use; parallel implementations; data mining.
- Specific science tasks that require either wrappers of, e.g., SciPy and NumPy routines or novel code.

Groups that anticipate working directly on assisting others with tasks such as code optimization and clean-up can ask for funding to do this. Each group should be working on this for itself, but some may wish to offer services for others.

Submitting a proposal to this program element implies that if an award is made, code that is produced will be open source and provided to the community through mechanisms to be agreed upon by the Python in Heliophysics Community (PyHC; see http://heliopython.org/) and NASA.

1.2 Background on Python Value Added Enhancement Proposals

A significant goal of this second-year effort is to continue to establish clear directions for the HPP, including its governance structure, expected goals for software development in support of HP science, and an associated funding plan. Useful information about the current status of work in this area can be found in the recently published overview paper by Burrell, et al. [Snakes on a Spaceship, 2018, https://doi.org/10.1029/2018JA025877], and more recent information can be found on the PyHC web site, http://heliopython.org/. The latter site is evolving, but it is the central locus of information about this project.

The philosophy of this call is that the best way to make progress is to work on real projects of scientific community interest, with the aim to make functional code and to incorporate it into the PyHC framework. In the process, the community will decide which efforts constitute "core" code that should be stable and maintained in a central repository, and which are more specialized tasks, still to be held to high standards, but the responsibility of a specific group. Future calls are likely to focus on the maintenance and upgrading of core functionality, but this is still to be determined.

The HP community has been developing a wide variety of tools for data access, production, and analysis based on the high-level, general-purpose Python programming

language. Early career researchers, especially, tend to come from backgrounds where Python is the norm and languages such as IDL and MatLab are seldom used. Many senior researchers are also finding that Python provides a very natural way to conduct analysis and data-processing tasks. Python has the advantage over some other currently popular languages in that it is open source, and thus provides no economic barriers for use. It is widely used, with a model for namespaces that encourages the development of packages of code centered on a particular task; this has led to the rapid development in recent years of many of the tools needed in HP research.

The flip side of all the above development is that there have been a large number of HP groups writing code, often for nearly identical tasks. This is clearly inefficient, as well as contrary to the spirit of Python code development. Starting in June, 2018, this program funded one person to begin to unify the HP efforts who has worked with the community to develop web pages, hold telecons, and to convene meetings of HP Python code developers (often the scientists using the codes). Much of the writing of Python code is carried out in the spare time of students and young researchers, but there is a perceived need to have at least part of the community funded to provide cohesion, high code standards, and completeness. Thus, a continuing topic of discussion has been what the best use of modest funding would be. This call for proposals is a result of that discussion. Over the last year, at the community's suggestion, the one organizing person has been expanded to include both additional support for assistance on basic meeting, web page, and related tasks, and for a "technical lead" who will work with developers to assure integration of efforts and compliance with PyHC standards. It is expected that the leadership structure of PyHC will continue to evolve through community efforts.

1.3 Small vs. Large Projects [Edits made March 26, 2020]

A change this year is that there will be two levels of projects: Small and Large. A Small proposal **is permitted** ~~requires~~ a **Science/Technical/Management Section of** five-pages (maximum) ~~proposal~~ for at most $25K to, for example, support a month or so of work and some travel for getting existing code into publicly useable shape (e.g., by refactoring), for translating some IDL or other code into Python, or for doing a small project from scratch. The Large proposal **is permitted** ~~requires~~ at most a ten-page **Science/Technical/Management Section** ~~proposal~~ for up to $75K for a more involved effort, although it could still be cleanup, translation, etc. Even larger and longer projects are not yet to be supported; such projects should be defined by the community and supported in future calls as appropriate.

1.4 Limitations in Scope

Proposers should not duplicate work already undertaken in both the general Python community and by specific groups, including others who could be included in this call. The PyHC website (http://heliopython.org) includes pointers to many of these efforts.

Resident Archives will no longer be supported; these are no longer needed as the data from current missions is flowing directly to Final Archives. Data Upgrades also will not be supported through this call, but anyone who finds a need for such an Upgrade is encouraged to contact Jeffrey Hayes, Aaron Roberts, or the HP archives (Space Physics Data Facility and Solar Data Analysis Center).

1.5 Heliophysics Data Policy Implementation

Consistent with the Heliophysics Data Policy, all projects under this program must involve scientific input, and all software and processes should support scientific utility, as evidenced by the support and participation of scientists. As a complement to this, all efforts must show evidence of good software engineering practices, for example, the use of clear, documented, tested, efficient code that fully accounts for IT security issues. Proposers to this call agree to the PyHC Standards (https://github.com/heliophysicsPy/standards/blob/master/standards.md) that include requirements to provide documentation, version control, testing, standard packaging, and other elements intended to optimize the utility of the results. In line with the recommendations of the NAS Space Studies Board report, *Best Practices for a Future Open Code Policy for NASA Space Science* (http://sites.nationalacademies.org/SSB/CurrentProjects/SSB_178892), the results of projects under this call will be made publicly available as open source software as detailed by the PyHC in conjunction with NASA. Each subgroup (separate grant effort under this call) must work in collaboration with the whole group for the benefit of all. The group as a whole decides on its governance, protocols, and procedures. Awardees are expected to attend group meetings and abide by group decisions. Proposals to this call should indicate explicitly the understanding of, and agreement with, the above points. After selection, any areas where there are questions or concerns in terms of governance, protocols, and procedures will be adjudicated by the cognizant NASA program officer.

Proposers should show an awareness of the wide variety of datasets now available through e.g., the Space Physics Data Facility (SPDF: https://spdf.gsfc.nasa.gov; see the "CDAWeb" link); the Virtual Solar Observatory (VSO: https://www.nso.edu/data/vso/; see the SolarSoft and SunPy links); the Virtual European Solar and Planetary Access site (VESPA: http://www.europlanet-vespa.eu/EPN2020.shtml); the European Space Astronomy Centre site (ESAC: https://www.cosmos.esa.int/web/esdc); the Coupling, Energetics, and Dynamics of Atmospheric Regions site (CEDAR: http://cedar.openmadrigal.org for “Madrigal” data access); and more specialized or related repositories (e.g., the LASP Interactive Solar Irradiance Data Center http://lasp.colorado.edu/lisird/; the Planetary Data Systems Planetary Plasma Interactions node https://pds-ppi.igpp.ucla.edu; or the “SuperMAG” ground-based magnetometer site http://supermag.jhuapl.edu among many others). Most of these repositories are available through “restful” Web Services or other machine-to-machine protocols, increasingly including the general Heliophysics Application Programmer Interface (HAPI: https://github.com/hapi-server). Proposers are also encouraged to utilize and contribute to the Heliophysics Data Portal (https://heliophysicsdata.gsfc.nasa.gov) that provides metadata, documentation, and access points for an increasingly complete set of HP data and other products.

2. Submission and Evaluation Guidelines

2.1 General Considerations

Within the proposing team, the PI, Science PI, and Co-Investigators (Co-Is) must each have specific and defined tasks in the project, and the tasks must be essential to the

completion of the project. Collaborators must show outside support for any defined tasks which must be essential to completion of the project. Proposals may be declared noncompliant based on either the Step-1 or Step-2 proposal if they are outside the scope of the HDEE program (see Section 1 above) or if they fail to meet submission guidelines specified below (Section 2.2-2.4).

2.2. Two-Step Submission Process

To provide adequate notice to potential reviewers, this program uses a two-step proposal submission process. The overall description of a two-step process can be found in Section IV(b)vii of the ROSES *Summary of Solicitation*.

In the two-step process a Step-1 proposal is required. Potential reviewers are solicited based on the Step-1 proposals. The proposal team members may not be changed between the Step-1 and Step-2 proposals, unless prior approval is obtained from the Program Officer of the element. The title and broad science goals of the proposal may not be changed such that they would significantly affect the scientific or technical expertise required to properly evaluate a proposal. Changes in a proposal that alter the title and/or broad science goals will result in a proposal being declared non-compliant.

2.3 Step-1 Proposals

A Step-1 proposal is required and must be submitted electronically by the Step-1 due date (see Table 2 and Table 3 of ROSES). The Step-1 proposal must be submitted by the organization's Authorized Organizational Representative (AOR). No budget or other elements are required. Only proposers who submit a Step-1 proposal are eligible to submit a full proposal.

Step-1 proposals will be checked for compliance, but they will not be evaluated. The expected format and evaluation criteria are described below. Submission of the Step-1 proposal does not obligate the offerors to submit a Step-2 (full) proposal later.

2.3.1 *Step-1 Proposal Content*

The Step-1 proposal is restricted to the 4000-character Proposal Summary text box on the NSPIRES web interface cover pages. It should include the following information:

- A description of the science goals this proposal is enabling and that are appropriate for Heliophysics investigations.
- A brief description of the methodology to be used to address the science goals and objectives. This will include a description of the Python products to be improved or produced and their relationship to the larger PyHC effort.

No PDF attachment is required or permitted for Step-1 proposal submission. Proposers will be invited by NSPIRES when they are able to submit their Step-2 proposals.

Proposers are strongly encouraged to provide names and contact information of five experts qualified to review their proposal. These experts must not be from the institutions of the PI or Co-Is. This information can be supplied in response to NSPIRES cover page questions at the time of submission of the Step-1 proposal.

2.4 Step-2 Proposals

A (maximum) 5- or 10-page Step-2 (full) proposal, depending on funding level, must be submitted electronically by the Step-2 due date (see Table 2 and Table 3 of ROSES). The Step-2 proposal must be submitted via NSPIRES or Grants.gov by the organization's Authorized Organizational Representative (AOR). A budget and other specified information is required.

Because potential reviewers are solicited based on the Step-1 proposal, the investigators cannot be changed between the Step-1 and Step-2 proposals, unless prior approval is obtained from the Program Officer of the element. The title and broad science goals of the proposal cannot be changed such that they would significantly affect the scientific or technical expertise required to properly evaluate a proposal. Changes in a step-2 proposal that impact the review will result in a proposal being declared non-compliant.

Proposers must have submitted a Step-1 proposal to be eligible to submit a Step-2 proposal. Proposers who received a noncompliance letter are not eligible to submit a Step-2 proposal.

2.4.1 *Step-2 Proposal Content*

The process for preparation and submission of the 5- or 10-page Step-2 (full) proposals is the same as that for any other ROSES proposal. Guidelines for content and formatting Step-2 full proposals are specified in the *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation*. Proposals must adhere to formatting requirements (e.g., margins, font sizes, line spacing).

Proposals for Value-Added Enhancement are restricted to five (5) or ten (10) pages for the Scientific/Technical/Management section and must include explicit subheadings as given in each of the bulleted points below, in the order below, with a discussion of each topic indicated (explicitly note if not applicable):

- *Software or enhancement to be produced*: A clear description of the code(s) to be produced or community assistance to be implemented, including the scientific or other problems solved and the basic methods used, and the relationship to NASA strategic plans and the HP Data Policy.
- *Scientific utility*: An argument for why the codes or assistance are scientifically relevant and useful, and the uniqueness or scientific advantages of the proposed approach compared to alternatives. Specific research projects should be mentioned, along with an assessment of whether these will bring qualitatively new insights. This should be supported by, e.g., refereed publications or other citations and uses by people outside the PI team. A poor justification would be: "This work supports projects involving long-term changes in the heliosphere" without specific examples. An excellent justification would be: "The following three groups are awaiting this code to be able to do these cutting-edge scientific studies …". In the case of very generic capabilities (e.g., a CDF reader), the breadth of the utility may be more important than the support of specific projects.

- *Method of Production*: How the Enhancement will be produced, details of the technical approach, its requirements and feasibility, including a presentation of relevant algorithms.
- *Current Status*: The current status of the code and its current means of support.
- *Documentation Plan*: A plan for providing required metadata and information needed for independent scientific usability.
- *Archive and Dissemination Plan*: A discussion of the use of GitHub or other code repositories and the methods of code distribution consistent with PyHC standards.
- *Need for Resources*: A discussion that demonstrates that the requested resources are necessary and sufficient for success in achieving the proposed effort. The resource discussion should include: how many hours of what specific level of support person are required, why and what level of science support is needed in terms of FTEs, and how HDEE resources complement other support.
- *Plans for collaboration* with other efforts under this call, including, but not limited to participation in telecons and meetings.
- *The relationship of the proposed effort to other areas*, including the present and anticipated state of knowledge in the field, to the relevant datasets and code that should be available from any related existing or planned missions, and to any related NASA community research efforts.

The discussion of each of these points may be brief, but each point must be clearly addressed, and these points are the key elements of a proposal.

2.4.2 *Step-2 Evaluation Criteria*

Compliant proposals will be evaluated according to the criteria specified in the *ROSES Summary of Solicitation* Section VI (a) and the *NASA Guidebook for Proposers*. These criteria are Relevance, Merit, and Cost. Clarifications and additions specific to this program element are listed below.

The evaluation of scientific and technical merit will include:

- Compelling nature and scientific priority of science goals enabled by the Value Added Enhancement, including the importance of the problem within the broad field of Heliophysics; the unique value of the investigation to enable scientific progress in the context of current understanding in the field, and the importance of carrying out the project now.
- Appropriateness and feasibility of the methodology, including the appropriateness of the selected algorithms for completing the development and the feasibility of the methodology for ensuring success.

Based primarily on these two factors within merit, the evaluation will consider the overall potential science impact and probable success of the investigation.

Relevance will be judged by whether the proposal addresses the goals and objectives of a Python Value Added Enhancement.

The evaluation of cost reasonableness will include assessing the amount of work to be accomplished versus the amount of time proposed. Only necessary Co-Investigators

and Collaborators should be included, and their specific roles in the investigation must be clearly laid out. Use of Collaborators whose only role is advisory is discouraged.

3. Available Funds

It is anticipated that approximately $500K will be made available to support new selections, all one-year awards, for Value Added Enhancements. As discussed above, there will be two levels of proposal; Small proposals of up to five pages for up to $25K, and Large proposals of up to ten pages for up to $75K. No higher amounts will be allowed. The discussion of funding requirements in the proposals should include the extent to which the particular project is currently being done in the context of missions or research grants. In general, the amount of funding available through this program is hoped to be sufficient to provide continuity and cohesion to the Python efforts in Heliophysics, rather than providing a funding source for all projects. It is expected that missions and other Heliophysics Elements (see B.1) will provide substantial support for required code development. In the long run, the HDEE effort will likely provide a larger context and, for example, resources to improve a particular group's code to make it useful to a wider community.

4. Summary of Key Information

Expected program budget for one-year awards	$500K
Number of new awards pending adequate proposals of merit	~5-12
Maximum duration of awards	1 year
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA
Due date for full Step-2 proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	6 months after Step-2 proposal due date.
Page limit for the central Science-Technical-Management section of proposal	5 pages ($25K max) 10 pages ($75K max) **see Section 1.3**.
Relevance	This program is relevant to the Heliophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section 3 of the *NASA Guidebook for Proposers* and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/, the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.

Web site for submission of Step 1 and Step 2 proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-HDEE
Points of contact concerning this program element.	Jeffrey J. E. Hayes Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0353 Email: jhayes@nasa.gov and D. Aaron Roberts Heliophysics Science Division Code 672 Goddard Space Flight Center Greenbelt MD 20771 Telephone: (301) 286-5606 Email: aaron.roberts@nasa.gov

B.13 HELIOPHYSICS U.S. PARTICIPATING INVESTIGATOR

NOTICE: Amended March 26, 2020. To allow the science community time to adapt to the new environment with coronavirus, this Amendment delays both Step-1 and Step-2 due dates for this program element. Step-1 proposals are now due May 8, 2020, and Step-2 proposals are now due July 1, 2020

1. Scope of Program

The Heliophysics U.S. Participating Investigator (H-USPI) program element solicits potential Heliophysics investigations in which investigators participate as a Co-Investigator (Co-I) for an instrument, experiment, or technology demonstration that is being built and flown by a sponsor agency other than NASA. A proposed investigation as an H-USPI on a non-NASA mission or instrument may take any form that clearly and demonstrably enhances the scientific output of the mission, benefits the U.S. scientific community, and enables the U.S. heliophysics science community access to a highly valued scientific data set.

Heliophysics USPI is a component of the Heliophysics Research Program and proposers interested in this program element are encouraged to B.1 The Heliophysics Research Program overview, for Heliophysics-specific requirements. Common requirements for all ROSES elements are found in the ROSES *Summary of Solicitation* and *The NASA Guidebook for Proposers*.

The order of precedence is the following: ROSES Element B.13 (this document) takes precedence followed by B.1 The Heliophysics Research Program overview, followed by the ROSES *Summary of Solicitation*, and the *Proposer's Guidebook*. Proposers should be familiar with all of these resources.

1.1 Solicited Investigations

Investigation are solicited from Co-Investigators (Co-I) on non-NASA space missions, that is for Co-Is for an instrument, experiment, or technology demonstration that is being built and flown by a sponsor agency other than NASA. The Co-I role can include, but is not limited to, instrument design, modeling and simulation of the instrument's operation and measurement performance, calibration of the instrument, scientific analysis and/or research of the data returned, and/or development of innovative data analysis techniques. The Co-I role can also include participation in science team activities, such as mission planning, mission operations, data processing, data analysis, and data archiving.

Regardless of the nature of the U.S. Participating Investigator role, an investigation proposed under this category must be for a science or technology investigation and must include some meaningful data analysis component, archiving of the complete data set, and the publication of science results in the peer reviewed literature. All aspects of the investigation through publication must be within the proposed cost.

The proposed investigations can vary in duration, to include just the prime science mission phase or to begin at the post-confirmation development phase (e.g., for calibration analysis) through the prime mission operational phase, depending on the

science requirements of the investigation. All investigations shall include adequate time for data analysis and archiving following the conclusion of the prime mission phase.

1.2 Limitations in Scope

Investigations requiring the provision of flight hardware are not solicited through this H-USPI solicitation.

This program element solicits new investigations only. Proposals whose intent or purpose is to extend or directly supplement existing investigations already funded for approved space flight missions or other NASA-supported research programs are not appropriate for this program element. Investigators who are members of the science teams of ongoing missions and who propose to use data from those missions must clearly demonstrate that the proposed research is distinct from their existing efforts.

1.3. Restrictions Involving China

Proposers should refer to Section III (c) of the *ROSES Summary of Solicitation* for restrictions involving China.

2. Submission and Evaluation Process

2.1 General Considerations

Each Principal Investigator (PI) is allowed to submit one and only one proposal to this solicitation. In that proposal, the Principal Investigator must invest a substantial portion of his/her time, of order 10-20%, to the investigation. Co-Investigators must each have a specific and defined task in the project, and the task must be essential to completion of the project. Use of collaborators is discouraged. Proposals may be declared noncompliant based on either the Step-1 or Step-2 proposal if they are outside the scope of the H-USPI program or if they fail to meet submission guidelines specified below.

2.2. Two-Step Submission Process

To provide adequate notice to potential reviewers, this program uses a two-step proposal submission process. The overall description of a two-step process can be found in Section IV(b)vii of the ROSES *Summary of Solicitation*.

In the two-step process a Step-1 proposal is required. Potential reviewers are solicited based on the Step-1 proposal. The proposal team members may not be changed between the Step-1 and Step-2 proposals, unless prior approval is obtained from the Program Officer of the element. The title and broad science goals of the proposal may not be changed such that they would significantly affect the scientific or technical expertise required to properly evaluate a proposal. Changes in a proposal that impact the review will result in a proposal being declared non-compliant.

2.3 Step-1 Proposals

A Step-1 proposal is required and must be submitted electronically by the Step-1 due date (see Table 2 and Table 3 of ROSES). The Step-1 proposal must be submitted by the organization's Authorized Organizational Representative (AOR). No budget or other elements are required. Only proposers who submit a Step-1 proposal are eligible to submit a full proposal.

Step-1 proposals will be checked for compliance, but they will not be evaluated. The expected format is described below. Submission of the Step-1 proposal does not obligate the offerors to submit a Step-2 (full) proposal later.

2.3.1 *Step-1 Proposal Content*

The Step-1 proposal is restricted to the 4000-character Proposal Summary text box on the NSPIRES web interface cover pages. References and any other supporting material are not required, but, if included, must fit within the limit.

The Step-1 proposals must include the following:

- The science goals and objectives to be addressed by the proposal;
- A brief statement of the methodology to be used, including what data, models, and analysis will be used for completing the investigation;
- A brief statement of the relevance of the problem to the Heliophysics overarching goal or specific objectives as described in B.1

No PDF attachment is required or permitted for Step-1 proposal submission. Proposers will be invited by NSPIRES when they are able to submit their Step-2 proposals.

2.3.2 *Request for reviewer names*

Proposers are strongly encouraged to provide names and contact information for up to five experts qualified to review their proposal. These experts must not be from the institutions of the PI or Co-Is or stand to benefit financially from the selection (or otherwise) of the proposal. This information can be supplied in response to NSPIRES cover page questions at the time of submission of the Step-1 proposal.

2.4 Step-2 Proposals

A Step-2 (full) proposal must be submitted electronically by the Step-2 due date (see Table 2 and Table 3 of ROSES). The Step-2 proposal must be submitted via NSPIRES or Grants.gov by the organization's Authorized Organizational Representative (AOR). A budget and other specified information is required.

Because potential reviewers are solicited based on the Step-1 proposal, the investigators cannot be changed between the Step-1 and Step-2 proposals, unless prior approval is obtained from the Program Officer of the element. The title and broad science goals of the proposal cannot be changed such that they would significantly affect the scientific or technical expertise required to properly evaluate a proposal. Changes in a Step-2 proposal that impact the review will result in a proposal being declared non-compliant.

Proposers must have submitted a Step-1 proposal to be eligible to submit a Step-2 proposal. Proposers that received a noncompliant letter are not eligible to submit a Step-2 proposal.

2.4.1 *Step-2 Proposal Content*

The process for preparation and submission of the Step-2 (full) proposals is the same as that for any other ROSES proposal. Guidelines for content and formatting Step-2 full proposals are specified in the *NASA Guidebook for Proposers* and the *ROSES*

Summary of Solicitation. Proposals must adhere to formatting requirements (e.g., margins, font sizes, line spacing).

Proposals are restricted to fifteen (15) pages for the Scientific/Technical/Management section and must include the following sections with the preferred order:

- The science objectives and perceived impact of the proposed work to the state of knowledge in the field; references to existing work in the field should be limited to that which is needed to justify the value of the science proposed;
- The data and methodology to be employed in conducting the proposed research; the proposal must demonstrate (1) that the data are appropriate to address the science objectives, and (2) that the methodology is both appropriate and feasible to make substantial progress on the science objectives;
- The relevance of the proposed work to the Heliophysics overarching goal or specific objectives as described in B.1;
- A general plan of work, the management structure for the proposal personnel, and a description of the expected contribution to the proposed effort by the PI and each person as identified in the proposal, whether or not they derive support from the proposed budget. Postdoctoral fellows and students need not be named.

Historically, proposals that address a single well-focused compelling science objective with a limited set of specific science questions have been more successful at constructing methodologies that are demonstrably feasible and appropriate, as compared with those that propose to address a large number of science questions or that are directed at an overly-broad science topic.

2.4.2 *Step-2 Evaluation Criteria*

Compliant proposals will be evaluated according to the criteria specified in the *ROSES Summary of Solicitation* Section VI (a) and the *NASA Guidebook for Proposers*. These criteria are Relevance, Merit, and Cost. Clarifications and additions specific to this program element are listed below.

The evaluation of scientific and technical merit will include the following:

- Compelling nature and scientific priority of the proposed investigation's science goals and objectives, including the importance of the problem within the broad field of Heliophysics; the unique value of the investigation to make scientific progress in the context of current understanding in the field, and the importance of carrying out the investigation now.
- Appropriateness and feasibility of the methodology, including the appropriateness of the selected data, models, and analysis for completing the investigation and the feasibility of the methodology for ensuring scientific success.

Based on these two factors, the evaluation will consider the overall potential science impact and probable success of the investigation.

Relevance to and priority within the H-USPI program will be assessed based on criteria discussed in Section 1. Each proposal must demonstrate that the investigation is relevant and of high priority.

The evaluation of cost reasonableness includes the amount of work to be accomplished versus the amount of time proposed. Open-ended proposals or those with a large

number of science questions to be addressed typically do not fare well in this evaluation. Only necessary Co-Investigators and Collaborators should be included, and their specific tasks and roles in the investigation must be clearly laid out.

2.5 Technical Requirements and Constraints

In addition to the requirements given in ROSES, all proposed investigations must also demonstrate: (1) their formal relationship with the sponsoring agency's mission (e.g., selected participant, invited participant, or proposed participant); (2) the status of the mission within the sponsoring agency (i.e., Preliminary Study (Pre-Phase A); Concept Study and Technology Development (Phase A); Preliminary Design and Technology Completion (Phase B); Final Design and Fabrication (Phase C); System Assembly, Integration and Test, and Launch (Phase D); Operations and Sustainment (Phase E)), including the level of commitment that the sponsoring agency has made to complete development; (3) a description of the type and the characteristics of the data from this investigation, as well as any ancillary science data, that will be archived as part of this investigation, and a description of the arrangements and resources included in the proposal to ensure the timely delivery of the necessary data in the required format; and (4) a detailed explanation of how the heliophysics science community benefits from this participation.

3. Available Funds

For individual investigators, the cost for selected proposals is expected to be on the order of $125K per selected investigation per year through the prime science mission phase, plus one year for additional data analysis and archiving for the baseline scientific investigation. For a team of investigators, the cost is expected to be on the order of $125K per investigator per year, up to a maximum combined team total of on the order of $375K per year, through the prime science mission phase, plus one year for additional data analysis and archiving.

Proposals must include archiving data such as raw data, reduced data (Level 2), instrument calibration data, observation geometry ancillary data, and derived products at an appropriate data archive.

NASA reserves the right to make no selection if there are no proposals of appropriate merit.

4. Maximum Duration of Awards

Proposals should be for the entire duration of the proposed investigation, up to a maximum of five years. This may be no more than through the prime science mission, plus one year for additional data archiving for the baseline scientific investigation. The budget justification in the body of the proposal should cover this entire period.

5. Award Management

Awards will likely be executed directly from NASA Headquarters, although NASA reserves the right to implement them through a NASA Center in order to facilitate coordination with related flight projects that the Center may be carrying out.

6. Summary of Key Information

Expected program budget for first year of new awards	See Section 3
Number of new awards pending adequate proposals of merit	Up to three awards
Maximum duration of awards	Through the end of the Prime Mission plus one year for data analysis and archiving, up to a maximum of 5 years. See Section 4.
Due date for Step-1 Proposal	See Tables 2 and 3 of this ROSES NRA
Due date for Step-2 (full) proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pages; see also Table 1 of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*
Relevance	See Section 2. This program is relevant to the Heliophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section 3 of the *NASA Guidebook for Proposers* and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/, the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy permitted.
Web site for submission of Step-1 and Step-2 proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of Step-1 and Step-2 proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-HUSPI

Point of contact concerning this program	Simon Plunkett Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-2034 Email: simon.p.plunkett@nasa.gov

B.14 HELIOPHYSICS - EARLY CAREER INVESTIGATOR PROGRAM

NOTICE: Amended March 26, 2020. To allow the science community time to adapt to the new environment with coronavirus, this Amendment delays both Step-1 and Step-2 due dates for this program element. Step-1 proposals are now due May 27, 2020, and Step-2 proposals are now due August 26, 2020.

Amended February 21, 2020. The description of the final requirement in Section 1.3 has been updated and the expected percentage time in Section 2.1 has been increased. New text is in bold and deleted text is struck through. ~~Due dates remain unchanged: Step-1 proposals are due May 13, 2020 and Step-2 proposals are due August 12, 2020~~.

1. Scope of Program

The Early Career Investigator Program (ECIP) in Heliophysics is designed to support outstanding scientific research and career development of scientists at the early stage of their professional careers. The program aims to encourage innovative research initiatives and cultivate diverse scientific leadership in Heliophysics. This program is designed to foster the empowerment, inspiration, and education of the next generation of space researchers, as part of the E of the DRIVE (Diversify, Realize, Integrate, Venture, Educate) initiative put forward as a high priority recommendation of the 2013 Solar and Space Physics Decadal Survey.

ECIP is a component of the Heliophysics Research Program and proposers interested in this program element are encouraged to read B.1, The Heliophysics Research Program Overview, for Heliophysics-specific requirements. Common requirements for all ROSES elements and proposals are found in this year's ROSES *Summary of Solicitation* and *the NASA Guidebook for Proposers* and the order of precedence for proposers is the following: This document takes precedence followed by B.1, The Heliophysics Research Program Overview, followed by the ROSES *Summary of Solicitation* and, finally, the *Proposer's Guidebook*. Proposers should be familiar with all of these resources.

1.1 Solicited Investigations

Science investigations are solicited with Heliophysics ECIP. These may include data analysis and interpretation of current or historical NASA-spacecraft observations or non-NASA observations. Investigations may include theory, numerical simulation, or modeling, but these must be substantiated with and guided by data. Investigations should address the Heliophysics overarching goal or a specific objective as described in B.1. System Science and interdisciplinary proposals are welcome. Innovative ideas and techniques are encouraged.

1.2 Data Usage and Availability

All data, whether of NASA or non-NASA origin, must be available from the Solar Data Analysis Center (SDAC), Space Physics Data Facility (SPDF), or at no cost from an equivalent, publicly accessible archive (with a link to archive included in the proposal) 30 days prior to the Step-2 (full-proposal) deadline. Proposals for projects that aim to

produce (e.g., combined non-NASA and NASA-) data products should explain how those products would be made publicly available through a data management plan.

1.3 Eligibility

An ECIP proposal PI (or Science PI) and any early career Co-I's must have a Ph.D. conferral date on or after January 1, 2010 (see also second bullet below).

To be eligible for an ECIP award, proposed PIs must meet the following requirements at the time of initially receiving funding of the award:

1. Be employed at a U.S. institution as long as the employing institution assumes the responsibility of submitting the proposal with the individual as the proposed PI or Science PI. Research faculty are eligible.
2. Despite being more than ten years beyond the receipt of their Ph.D. degrees, individuals who have interrupted their careers for reasons such as family leave or serious health problems may also be eligible. These applicants should make a written request to the NASA point of contact (Section 5) prior to the Step-1 due date to propose. NASA will provide a written response within three weeks.
3. Not hold or have held academic tenure (or equivalent at a non-academic institution).
4. Not be a current or former recipient of a Presidential Early Career Award for Scientists and Engineers (PECASE).
5. Not be a current or former recipient of an ECIP award or **PI or Science PI of** any other **current science or technology** ROSES **award (other than FINESST)** ~~as PI or Science PI~~. **[Amended 2/21/2020]**

2. Submission and Evaluation Process

2.1 General Considerations

Proposals submitted to this program element must be led by a single, eligible investigator (see Section 1.3 for eligibility) serving as the Principal Investigator (PI). Instead, serving as a Science PI is permissible for cases where the institution does not allow research or un-tenured faculty to lead proposals. No Co-Principal Investigators are permitted. Up to 2 early career Co-Investigators may be included. Students and postdoctoral fellows may participate as supported team members. A mentor may be named as a collaborator.

An early career researcher is allowed to be part of *one and only one* proposal to this program element as a PI or Co- Investigator. In that proposal, the Principal Investigator/ Science PI must invest a substantial portion of his/her time, ~~30~~ **at least 50**%, to the investigation. Co-Investigators must each have a specific and defined task in the project, and the task must be essential to completion of the project. Use of collaborators, other than a mentor, is not allowed. Proposals may be declared noncompliant based on either the Step-1 or Step-2 proposal if they are outside the scope of the H-ECIP program (Section 1) or if they fail to meet submission guidelines specified below. **[Amended 2/21/2020]**

2.2. Two-Step Submission Process

To provide adequate notice to potential reviewers, this program uses a two-step

proposal submission process. The overall description of a two-step process can be found in Section IV(b)vii of the ROSES *Summary of Solicitation*.

In the two-step process a Step-1 proposal is required. Potential reviewers are solicited based on the Step-1 proposal. The investigators may not be changed between the Step-1 and Step-2 proposals, unless prior approval is obtained from the Program Officer of the element. The title and broad science goals of the proposal may not be changed such that they would significantly affect the scientific or technical expertise required to properly evaluate a proposal. Changes in a proposal that impact the review will result in a proposal being declared non-compliant.

2.3 Step-1 Proposals

A Step-1 proposal is required and must be submitted electronically by the Step-1 due date (see Table 2 and Table 3 of ROSES). The Step-1 proposal must be submitted by the Authorized Organizational Representative (AOR). No budget or other elements are required. Only proposers who submit a Step-1 proposal are eligible to submit a full proposal.

Step-1 proposals will be checked for compliance, but they will not be evaluated. The expected format is described below. Submission of the Step-1 proposal does not obligate the offerors to submit a Step-2 (full) proposal later.

2.3.1 *Step-1 Proposal Content*

The Step-1 proposal is restricted to the 4000-character Proposal Summary text box on the NSPIRES web interface cover pages. References and any other supporting material are not required, but, if included, must fit within the limit.

The Step-1 proposals must include the following:

- The science goals and objectives to be addressed by the proposal;
- A brief statement of the methodology to be used, including what data, models, and analysis will be used for completing the investigation;
- A brief statement of the relevance of the problem to the Heliophysics overarching goal or specific objectives as described in B.1

No PDF attachment is required or permitted for Step-1 proposal submission. Proposers will be invited by NSPIRES when they are able to submit their Step-2 proposals.

Proposers are strongly encouraged to provide names and contact information of five experts qualified to review their proposal. These experts must not be from the institutions of the PI or Co-Is. This information can be supplied in response to NSPIRES cover page questions at the time of submission of the Step-1 proposal.

2.4 Step-2 Proposals

A Step-2 (full) proposal must be submitted electronically by the Step-2 due date (see Table 2 and Table 3 of ROSES). The Step-2 proposal must be submitted via NSPIRES or Grants.gov by the organization's Authorized Organizational Representative (AOR). A budget and other specified information is required.

Because potential reviewers are solicited based on the Step-1 proposal, the proposal team members may not be changed between the Step-1 and Step-2 proposals, unless

prior approval is obtained from the Program Officer of the element. The title and broad science goals of the proposal may not be changed such that they would significantly affect the scientific or technical expertise required to properly evaluate a proposal. Changes in a Step-2 proposal that impact the review will result in a proposal being declared non-compliant.

Proposers must have submitted a Step-1 proposal to be eligible to submit a Step-2 proposal. Proposers that received a noncompliant letter are not eligible to submit a Step-2 proposal.

2.4.1 *Step-2 Proposal Content*

The process for preparation and submission of the Step-2 (full) proposals is the same as that for any other ROSES proposal. Guidelines for content and formatting Step-2 full proposals are specified in the *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation*. Proposals must adhere to formatting requirements (e.g., margins, font sizes, line spacing). Proposers should list evidence of scientific leadership in their CV (see evaluation criteria in Section 2.4.2).

Proposals are restricted to ten (10) pages for the Scientific/Technical/Management section and must include the following sections with the preferred order:

- The science objectives and perceived impact of the proposed work to the state of knowledge in the field; references to existing work in the field should be limited to that which is needed to justify the value of the science proposed;
- The data and methodology to be employed in conducting the proposed research; the proposal must demonstrate (1) that the data are appropriate to address the science objectives, and (2) that the methodology is both appropriate and feasible to make substantial progress on the science objectives;
- The relevance of the proposed work to the Heliophysics overarching goal or specific objectives as described in B.1;
- A general plan of work, the management structure for the proposal personnel, and a description of the expected contribution to the proposed effort by the PI and each person as identified in the proposal, whether or not they derive support from the proposed budget. Postdoctoral fellows and students need not be named.

Historically, proposals that address a single well-focused compelling science objective with a limited set of specific science questions have been more successful at constructing methodologies that are demonstrably feasible and appropriate, as compared with those that propose to address a large number of science questions or that are directed at an overly-broad science topic.

2.4.2 *Step-2 Evaluation Criteria*

Compliant proposals will be evaluated according to the criteria specified in the *ROSES Summary of Solicitation* Section VI (a) and the *NASA Guidebook for Proposers*. These criteria are Relevance, Merit, and Cost. Clarifications and additions specific to this program element are listed below.

The evaluation of scientific and technical merit will include the following:

- Compelling nature and scientific priority of the proposed investigation's science goals and objectives, including the importance of the problem within the broad field of Heliophysics; the unique value of the investigation to make scientific progress in the context of current understanding in the field, and the importance of carrying out the investigation now.
- Appropriateness and feasibility of the methodology, including the appropriateness of the selected data, models, and analysis for completing the investigation and the feasibility of the methodology for ensuring scientific success.

Based on these two factors, the evaluation will consider the overall potential science impact and probable success of the investigation.

Relevance to and priority within the ~~H-SR~~ **ECIP** program will be assessed based on criteria discussed in Section 1, and will include an assessment of scientific leadership and vision evidenced by one or more of the following: **[Corrected 2/21/2020]**

- Extra activities such as, but not limited to, education of graduate students, involvement in policy-related committees, conference or workshop organization, professional society activities, journal reviewing, journal editorship, participation in public outreach (listed in PI or Science PI CV);
- Awards received; invited presentations (listed in PI or Science PI CV);
- The extent to which the scientific and/or technical innovation of the proposed research might positively impact the direction and progress in relevant scientific fields of research.

Each proposal must demonstrate that the investigation is relevant and of high priority.

The evaluation of cost reasonableness includes the amount of work to be accomplished versus the amount of time proposed. Open-ended proposals or those with a large number of science questions to be addressed typically do not fare well in this evaluation.

3. Available Funds

Proposals to the ECIP are intended to be openly solicited approximately every two years. The anticipated average award is $125-175 per year for a period of up to four years, subject to satisfactory progress and availability of funds.

4. Award Types

The Heliophysics ECIP program will primarily award funds through three vehicles: (1) grants, (2) interagency transfers, and (3) awards to NASA centers. This call will not award contracts, as it is not appropriate for the nature of the work.

5. Summary of Key Information

Expected annual program budget for new awards	~ $1.5M

Number of investigator awards pending adequate proposals of merit	~ 8-12 awards
Maximum duration of awards	4 years
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA
Due date for invited Step-2 proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	6 months after Step-2 proposal due date
Page limit for the central Science/Technical/Management section of proposal	10 pp; see also Table 1 of ROSES and *the NASA Guidebook for Proposers*.
Relevance	This program is relevant to the Heliophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See *the ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section 3 of *the NASA Guidebook for Proposers* and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of *the NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of Step-1 and Step-2 proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of Step-1 and Step-2 proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-ECIP
Point of contact concerning this program	Katya Verner Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: 202-358-1213 Email: Ekaterina.M.Verner@nasa.gov

B.15 GOLD ICON GUEST INVESTIGATORS

NOTICE: Amended July 28, 2020. The Step-1 due date for this program has been delayed. The Step-1 due date is now February 24, 2021. The Step-2 due date remains unchanged at April 14, 2021.

1. Scope of Program

The Global-scale Observations of the Limb and Disk (GOLD) and the Ionospheric Connection Explorer (ICON) Guest Investigators program (GIGI) is intended to maximize the scientific return from these missions by providing support for research beyond the scope of work of the mission science teams. It also allows scientists who are not associated with a mission team to participate in the mission science.

GIGI is a component of the Heliophysics Research Program and proposers interested in this program element are encouraged to read B.1, The Heliophysics Research Program Overview, for Heliophysics-specific requirements. Common requirements for all ROSES elements and proposals are found in the ROSES *Summary of Solicitation* and *The Proposer's Guidebook* and the order of precedence for proposers is the following: This document takes precedence followed by B.1, The Heliophysics Research Program Overview, followed by this year's ROSES *Summary of Solicitation* and, finally, the *Proposer's Guidebook*. Proposers should be familiar with all of these resources.

1.1 Solicited Investigations

The GIGI program is for investigations whose primary emphasis is the analysis of data from the GOLD and ICON missions. As with the H-GI Open program, investigations may employ theory, models, and data from other sources, as needed, to interpret and analyze NASA's GOLD and ICON data, but only as a secondary emphasis. That is, in any such instance, the proposal must clearly demonstrate that the theory, models, and/or data from other sources are not themselves the primary object of the investigation but are necessary for interpretation of the GOLD and/or ICON data. Investigations can use both GOLD and ICON data together, or either, separately.

GOLD Science objectives are the following:

- Determine how geomagnetic storms alter the temperature and composition of Earth's thermosphere
- Analyze the global-scale response of the thermosphere to solar extreme-ultraviolet variability
- Investigate the significance of atmospheric waves and tides propagating from below on the temperature structure of the thermosphere
- Resolve how the structure of the equatorial ionosphere influences the formation and evolution of equatorial plasma density irregularities

ICON Science questions are the following:

- What causes changes in the ionosphere, other than geomagnetic effects?
- How do large-scale atmospheric waves control the ionosphere at low latitudes?
- How do ion-neutral coupling processes respond to increases in solar forcing and geomagnetic activity?

1.2. Data Usage and Availability

This program element has policies on the use of data in proposals that expand upon and supersede those given in B.1 Heliophysics Research Program Overview.

Proposals submitted to the GIGI program must demonstrate that the proposed effort can be accomplished using data that was publicly available in the Space Physics Data Facility (SPDF), or an equivalent, publicly accessible archive, 30 days before the Step-2 submission deadline. This includes all GOLD and/or ICON mission data or other ground-based or space-based data that is required for the proposed effort. In order to determine the accessibility of data sets not in SPDF, a link to each necessary archive must be included in the proposal. Any questions about whether a data set or data product qualifies as publicly available must be submitted to the program element's point of contact at least 10 days before the Step-1 deadline.

Supporting space-based or ground-based data may be included as a part of the proposed effort. While the inclusion of useful ground-based or non-GOLD/ICON space-based observations is allowed, proposals are required to focus on GOLD and/or ICON observations. The use of the other data sets must not exceed 25% of the data required for the proposed study. Regardless of the type of data that would be utilized in the proposed study, space-based, ground-based, or some combination, the proposal must clearly demonstrate why the proposed data set or data sets are sufficient to address the proposed goals and objectives.

1.3 Limitations in Scope

Proposals outside the scope of GIGI include the following:

- Proposals that do not focus on analysis of data from GOLD and/or ICON missions;
- Proposals for the same or essentially the same work submitted concurrently to other program elements in Appendix B or E, as specified in B.1 Section 1;
- Proposals for the same or essentially the same work submitted concurrently to NSF;
- Proposals focused on ground-based observations supporting GOLD and/or ICON data analysis;
- Proposals for model, tool, or theory development (see Section 1.1);
- The routine, long-term gathering of observational data;
- Investigations with the main purpose of supporting ground-based infrastructure or facilities.

The mission science teams are already funded to do a substantial amount of research. A Co-Investigator (Co-I) on the target missions may propose as a PI or Co-I to this program element. However, such Heliophysics mission personnel must include in their proposal a description of their mission duties and clearly distinguish the proposed new activity from their existing responsibilities for mission operations and data analysis.

2. Submission and Evaluation Guidelines

2.1 General Considerations

Each Principal Investigator (PI) is allowed to submit one and only one Step-1 proposal to this program element. In that proposal, the Principal Investigator (or Science PI) must invest a substantial portion of their time, 20%, to the investigation in order to adequately ensure the conduct of the investigation. Within the proposing team, the PI, Science PI, and Co-Investigators (Co-Is) must each have specific and defined tasks in the project, and the tasks must be essential to the completion of the project. Collaborators must show outside support for any defined tasks which must be essential to completion of the project. Proposals may be declared noncompliant based on either the Step-1 or Step-2 proposal if they are outside the scope of the GIGI program (see Section 1 above) or if they fail to meet submission guidelines specified below (Section 2.2-2.4).

2.2 Two-Step Submission Process

To provide adequate notice to potential reviewers, this program uses a two-step proposal submission process. The overall description of a two-step process can be found in Section IV(b)vii of the ROSES *Summary of Solicitation*.

In the two-step process a Step-1 proposal is required. Potential reviewers are solicited based on the Step-1 proposal. The proposal team members may not be changed between the Step-1 and Step-2 proposals, unless prior approval is obtained from the Program Officer of the element. The title and broad science goals of the proposal may not be changed such that they would significantly affect the scientific or technical expertise required to properly evaluate a proposal. Changes in a proposal that alter the title and/or broad science goals will result in a proposal being declared non-compliant.

2.3 Step-1 Proposals

A Step-1 proposal is required and must be submitted electronically by the Step-1 due date (see Table 2 and Table 3 of ROSES). The Step-1 proposal must be submitted by the organization's Authorized Organizational Representative (AOR). No budget or other elements are required. Only proposers who submit a Step-1 proposal are eligible to submit a full proposal.

Step-1 proposals will be checked for compliance, but they will not be evaluated. The expected format is described below. Submission of the Step-1 proposal does not obligate the offerors to submit a Step-2 (full) proposal later.

2.3.1 *Step-1 Proposal Content*

The Step-1 proposal is restricted to the 4000-character Proposal Summary text box on the NSPIRES web interface cover pages. References and any other supporting material are not required, but, if included, must fit within the limit.

The Step-1 proposals must include the following:

- The science goals and objectives to be addressed by the proposal;
- A brief statement of the methodology to be used, including what data, models, and analysis will be used for completing the investigation;

- A brief statement of the relevance of the problem to the Heliophysics overarching goal or specific objectives as described in B.1

No PDF attachment is required or permitted for Step-1 proposal submission. Proposers will be invited by NSPIRES when they are able to submit their Step-2 proposals.

Proposers are strongly encouraged to provide names and contact information of five experts qualified to review their proposal. These experts must not be from the institutions of the PI or Co-Is. This information can be supplied in response to NSPIRES cover page questions at the time of submission of the Step-1 proposal.

2.4 Step-2 Proposals

A 10-page Step-2 (full) proposal must be submitted electronically by the Step-2 due date (see Table 2 and Table 3 of ROSES). The Step-2 proposal must be submitted via NSPIRES or Grants.gov by the organization's Authorized Organizational Representative (AOR). A budget and other specified information is required.

Because potential reviewers are solicited based on the Step-1 proposal, the investigators cannot be changed between the Step-1 and Step-2 proposals, unless prior approval is obtained from the Program Officer of the element. The title and broad science goals of the proposal cannot be changed such that they would significantly affect the scientific or technical expertise required to properly evaluate a proposal. Changes in a Step-2 proposal that impact the review will result in a proposal being declared non-compliant.

Proposers must have submitted a Step-1 proposal to be eligible to submit a Step-2 proposal. Proposers that received a noncompliant letter are not eligible to submit a Step-2 proposal.

2.4.1 *Step-2 Proposal Content*

The process for preparation and submission of the Step-2 (full) proposals is the same as that for any other ROSES proposal. Guidelines for content and formatting Step-2 full proposals are specified in the *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation*. Proposals must adhere to formatting requirements (e.g., margins, font sizes, line spacing).

Proposals are restricted to ten (10) pages for the Scientific/Technical/Management section and must include the following sections with the preferred order:

- The science objectives and perceived impact of the proposed work to the state of knowledge in the field; references to existing work in the field should be limited to that which is needed to justify the value of the science proposed;
- The data and methodology to be employed in conducting the proposed research; the proposal must demonstrate (1) that the data are appropriate to address the science objectives, and (2) that the methodology is both appropriate and feasible to make substantial progress on the science objectives;
- The relevance of the proposed work to the Heliophysics overarching goal or specific objectives as described in B.1;
- A general plan of work and estimated schedule, the management structure for the proposal personnel, and a description of the expected contribution to the

proposed effort by the PI and each person as identified in the proposal, whether or not they derive support from the proposed budget. Postdoctoral fellows and students need not be named.

Historically, proposals that address a single well-focused compelling science objective with a limited set of specific science questions have been more successful at constructing methodologies that are demonstrably feasible and appropriate, as compared with those that propose to address a large number of science questions or that are directed at an overly-broad science topic.

2.4.2 *Step-2 Evaluation Criteria*

Compliant proposals will be evaluated according to the criteria specified in the *ROSES Summary of Solicitation* Section VI (a) and the *NASA Guidebook for Proposers*. These criteria are Relevance, Merit, and Cost. Clarifications and additions specific to this program element are listed below.

The evaluation of scientific and technical merit will include the following:

- Compelling nature and scientific priority of the proposed investigation's science goals and objectives, including the importance of the problem within the broad field of Heliophysics; the unique value of the investigation to make scientific progress in the context of current understanding in the field, and the importance of carrying out the investigation now.
- Appropriateness and feasibility of the methodology, including the appropriateness of the selected data, models, and analysis for completing the investigation and the feasibility of the methodology for ensuring scientific success. The appropriateness of all data utilized to address the proposed science investigation, including GOLD and/or ICON data, and other supporting space-based or ground-based observations, will be evaluated.

Based on these two factors, the evaluation will consider the overall potential science impact and probable success of the investigation.

Relevance to and priority within the GIGI program will be assessed based on criteria discussed in Section 1. Each proposal must demonstrate that the investigation is relevant and of high priority.

The evaluation of cost reasonableness includes the amount of work to be accomplished versus the amount of time proposed. Open-ended proposals or those with a large number of science questions to be addressed typically do not fare well in this evaluation. Only necessary Co-Investigators and Collaborators should be included, and their specific tasks and roles in the investigation must be clearly laid out.

3. <u>Available Funds</u>

It is expected that there will be approximately ~$750K available to support the first year of new Heliophysics GIGI investigations selected through this program element. The average yearly budget of an GIGI proposal is expected to be $125-150K.

4. Award Types

The GIGI program will primarily award funds through three vehicles: (1) grants, (2) interagency transfers, and (3) awards to NASA Centers. The GIGI program will not award contracts, because it is not appropriate given the nature of the work solicited. An institution that has received a contract previously can receive funds as a grant by not charging a fee.

5. Summary of Key Information

Expected annual program budget for first year of new awards	~$750K; See Section 3
Number of new awards pending adequate proposals of merit	~5-6
Maximum duration of awards	3 years; shorter-term proposals are allowed
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA
Due date for full Step-2 proposals	See Tables 2 and 3 of this ROSES NRA
Page limit for the central Science-Technical-Management section of proposals	10 pp; see also Table 1 of the *ROSES Summary of Solicitation* and Section 3.7 of the *NASA Guidebook for Proposers*.
Planning date for start of investigation	8 months after Step-2 proposal due date.
Relevance	Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section 3 of the *NASA Guidebook for Proposers* and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-GIGI

Point of contact concerning this program element	Jeff Morrill Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-3744 Email: jeff.s.morrill@nasa.gov

B.16 PARKER SOLAR PROBE GUEST INVESTIGATORS

NOTICE: Please note that each PI is limited to submit one and only one proposal to this program.

1. Scope of Program

The Parker Solar Probe (PSP) Guest Investigators (PSP-GI) program, solicits proposals that focus on analysis of data from the PSP mission in the inner heliosphere. This program is intended to maximize the scientific return from the pioneering mission by providing support for research beyond presently funded investigations. Funded investigators (PIs and Co-Is) of this solicitation will be considered Guest Investigators of PSP for the duration of the award and will be invited to attend and present progress at PSP team meetings.

PSP-GI is a component of the Heliophysics Research Program and proposers interested in this program element are encouraged to read B.1, The Heliophysics Research Program Overview, for Heliophysics-specific requirements. Common requirements for all ROSES elements and proposals are found in the ROSES *Summary of Solicitation* and *The Proposer's Guidebook* and the order of precedence for proposers is the following: This document takes precedence followed by B.1, The Heliophysics Research Program Overview, followed by this year's ROSES *Summary of Solicitation* and, finally, the *Proposer's Guidebook*. Proposers should be familiar with all of these resources.

1.1 Solicited Investigations

The PSP-GI program is for investigations with primary emphasis on the analysis of data from the Parker Solar Probe mission. As with the open element of the H-GI program, investigations may employ theory, models, and data from other sources, as needed, to interpret and analyze NASA's PSP data, but only as a secondary emphasis. That is, in any such instance, the proposal must clearly demonstrate that the theory, models, and/or data in question are necessary for interpretation of PSP data and are not themselves the primary object of the investigation.

The overall science goal of the mission is: Determine the structure and dynamics of the Sun's coronal magnetic field, understand how the solar corona and wind are heated and accelerated, and determine what mechanisms accelerate and transport energetic particles.

The mission has three science objectives:

1. Trace the flow of energy that heats and accelerates the solar corona and solar wind.
2. Determine the structure and dynamics of the plasma and magnetic fields at the sources of the solar wind.
3. Explore mechanisms that accelerate and transport energetic particles.

The PSP mission launched on Aug. 12, 2018 as a mission to explore the innermost accessible region of the heliosphere.

1.2 Data Usage and Availability

PSP-GI investigations must demonstrate that all data to be used for the proposed investigation must be available in a public archive at least 30 days before the Step-2 deadline. All spacecraft mission data must be available in the Solar Data Analysis Center (SDAC), Space Physics Data Facility (SPDF), or an equivalent, publicly accessible archive with a link to archive included in the proposal.

PSP observations of the first two orbits were publicly released on Nov. 12, 2019.

1.3 Limitations in Scope

Proposals outside the scope of PSP-GI may be declared noncompliant based on either the Step-1 or Step-2 proposal. These include the following:

- Proposals for the same or essentially the same work submitted concurrently to other program elements in Appendix B or E, as specified in B.1 Section 1;
- Work for which the proposing organization (or investigators) are already funded by NASA. Where projects might appear to overlap, proposals must show that the proposed effort does not duplicate other awards, including awards as part of operating space flight missions;
- Proposals for model, tool, or theory development (see Section 1.1);
- Proposals that involve analysis of data that is not in a public archive 30 days prior to step-2 deadline;
- Investigations with the main purpose of supporting ground-based infrastructure or facilities.

The mission science team is already funded to do a substantial amount of research. A Principal Investigator (PI) or a Co-Investigator (Co-I) on the PSP missions may also propose as a PI or Co-I to this program element. However, such mission personnel must include in their proposal a description of their mission duties and clearly distinguish the proposed new activity from their existing responsibilities for mission operations and data analysis.

2. Submission and Evaluation Guidelines

2.1 General Considerations

Each Principal Investigator (PI) may submit one and only one Step-1 proposal to this program element. In that proposal, the Principal Investigator or Science PI must invest at least one month of labor to the investigation. Proposals utilizing a Science PI must mark that individual as such in NSPIRES and the individual must be named. Co-Investigators (Co-Is) must each have a specific and defined task in the project, and the task must be essential to completion of the project. Use of collaborators is discouraged. Proposals may be declared noncompliant based on either the Step-1 or Step-2 proposal if they a) do not adhere to the requirements outlined above, b) are outside the scope of the PSP-GI program (see Section 1.3, or c) fail to meet submission guidelines specified below (Sections 2.2-2.4 below).

2.2. Two-Step Submission Process

To provide adequate notice to potential reviewers, this program uses a two-step proposal submission process. The overall description of a two-step process can be found in Section IV(b)vii of the ROSES *Summary of Solicitation*.

In the two-step process a Step-1 proposal is required. Potential reviewers are solicited based on the Step-1 proposal. The Step-2 proposal title and science goals, must be the same as those in the Step-1 proposal. No additional investigators (Principal Investigator, Co-Investigators, Collaborators, Consultants, and Other Professionals) are allowed in the Step-2 proposal. The expected format, content and evaluation criteria are described below.
Submission of the Step-1 proposal does not obligate the offerors to submit a Step-2 (full) proposal later.

2.3 Step-1 Proposals

A Step-1 proposal is required and must be submitted electronically by the Step-1 due date (see Table 2 and Table 3 of ROSES). The Step-1 proposal must be submitted by the organization's Authorized Organizational Representative (AOR). No budget or other elements are required. Only proposers who submit a Step-1 proposal are eligible to submit a full proposal.

Step-1 proposals will be checked for compliance, but they will not be evaluated. The expected format is described below. Submission of the Step-1 proposal does not obligate the offerors to submit a Step-2 (full) proposal later.

2.3.1 *Step-1 Proposal Content*

The Step-1 proposal is restricted to the 4000-character Proposal Summary text box on the NSPIRES web interface cover pages. References and any other supporting material are not required, but, if included, must fit within the limit.

The Step-1 proposal must include the following:

- The science goals and objectives to be addressed by the proposal;
- A listing of the mission data to be used in the investigation.
- A listing of the data analysis methodology and any models or simulations to be used;
- A brief statement of the relevance of the problem to the program by using PSP data to address the relevant Decadal survey goal.

No PDF attachment is permitted for Step-1 proposal submission. All information will be entered within the 4000-character Proposal Summary text box on the NSPIRES web interface cover pages. Proposers will be notified when they are able to submit their Step-2 proposals.

Proposers are strongly encouraged to provide names and contact information of five experts qualified to review their proposal. These experts must not be from the institutions of the PI or Co-Is. This information can be supplied in response to NSPIRES cover page questions at the time of submission of the Step-1 proposal.

2.4 Step-2 Proposals

A 10-page Step-2 (full) proposal must be submitted electronically by the Step-2 due date (see Tables 2 and 3 of ROSES). The Step-2 proposal must be submitted via NSPIRES or Grants.gov by the organization Authorized Organizational Representative (AOR). A budget and other specified information is required.

Because potential reviewers are solicited based on the Step-1 proposal, the Step-2 proposal title and broad science scope/goals must be the same as those in the Step-1 proposal. No additional investigators (Principal Investigator, Co-Investigators, Collaborators, Consultants, and Other Professionals) are allowed in the Step-2 proposal.

Proposers must have submitted a Step-1 proposal to be eligible to submit a Step-2 proposal. Proposers that received a noncompliant letter are not eligible to submit a Step-2 proposal.

2.4.1 *Step-2 Proposal Content*

The process for preparation and submission of the Step-2 (full) proposals is the same for any other ROSES proposal. Guidelines for content and formatting full proposals are specified in Table 1 of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*. Proposals must adhere to formatting requirements (e.g., margins, font sizes, line spacing).

Proposals are restricted to ten (10) pages for the Scientific/Technical/Management section and must include the following sections with the preferred order:

- The science objectives and perceived impact of the proposed work to the state of knowledge in the field; references to existing work in the field should be limited to that which is needed to justify the value of the science proposed;
- The data and methodology to be employed in conducting the proposed research; the proposal must demonstrate (1) that the data is appropriate to address the science objectives and (2) that the methodology is both appropriate and feasible to make substantial progress on the science objectives;
- The relevance of the proposed work to the goals of the program. This section must demonstrate how the proposed work uses PSP data to address the Heliophysics overarching goal or specific objectives as described in B.1;
- A general plan of work, the management structure for the proposal personnel, and a description of the expected contribution to the proposed effort by the PI and each person as identified in the proposal whether or not they derive support from the proposed budget. Postdoctorals and students do not need to be identified by name.

Historically, proposals that address a single well-focused science objective with a limited set of specific science questions have been more successful at constructing methodologies that are demonstrably feasible and appropriate, as compared with those that propose to address a large number of science questions or that are directed at an overly-broad science topic.

2.4.2 *Step-2 Evaluation Criteria*

Compliant proposals will be evaluated according to the criteria specified in the *ROSES Summary of Solicitation* Section VI(a) and the *NASA Guidebook for Proposers* and they are Relevance, Merit, and Cost. Clarifications and additions specific to this program element are listed below.

The evaluation of scientific and technical merit will include the following:

- Compelling nature and scientific priority of the proposed investigation's science goals and objectives, including the importance of the problem within the broad field of Heliophysics; the unique value of the investigation to make scientific progress in the context of current understanding in the field, and the importance of carrying out the investigation now.
- Appropriateness and feasibility of the methodology, including the appropriateness of the selected data, models, and analysis for completing the investigation and the feasibility of the methodology for ensuring scientific success.

Based on these two science and technical factors, the evaluation will consider the overall potential science impact and probability of success of the investigation.

Each proposal must demonstrate that the investigation is relevant and of high priority.

The evaluation of cost reasonableness includes the amount of work to be accomplished versus the amount of time proposed. Open-ended proposals or those with a large number of science questions to be addressed typically do not fare well in this evaluation. Only necessary Co-Investigators and Collaborators should be included, and their specific tasks and roles in the investigation must be clearly laid out.

3. Available Funds

It is expected that there will be approximately $900K available to support the first year of new Heliophysics PSP-GI investigations selected through this program element. The average yearly budget of an PSP-GI proposal is expected to be $125-150K.

4. Award Types

The PSP-GI program will primarily award funds through three vehicles: (1) grants, (2) interagency transfers, and (3) awards to NASA Centers. The PSP-GI program will not award contracts.

5. Summary of Key Information

Expected program budget for first year of new awards	$900K
Number of new awards pending adequate proposals of merit	6-7
Maximum duration of awards	3 years; shorter-term proposals are allowed
Due date for Step-1 proposal	See Tables 2 and 3 of this ROSES NRA
Due date for full Step-2 proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	6 months after full proposal due date.

Page limit for the central Science-Technical-Management section of full proposal	10 pp; see also Table 1 of ROSES and Section 3.7 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the Heliophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section 3 of the *NASA Guidebook for Proposers* and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of Step 1 and Step 2 proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of Step 1 and Step-2 proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-PSPGI
Point of contact concerning this program.	Arik Posner Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0727 Email: arik.posner@nasa.gov

B.17 INTERDISCIPLINARY SCIENCE FOR ECLIPSE 2020

NOTICE: Amended April 8, 2020. The successful implementation of this program would require extensive logistics (e.g., aircraft to host experiments, site visits, international agreements) be in place soon, in the face of the ongoing COVID-19 pandemic. Out of concern for the health and safety of the international science community, we are cancelling the Interdisciplinary Science for Eclipse ROSES-2020 program element. NASA intends to support research on eclipses in the future.

1. Scope of the Program

The intention of the Interdisciplinary Science for Eclipse program element was to support research applied to the total solar eclipse visible on from the southern hemisphere and partial eclipse visible from some regions in southern South America, south-west Africa, and Antarctica.

However, the successful implementation of this program would require extensive logistics (aircraft to host experiments, site visits, international agreements) be in place soon, in face of the ongoing COVID-19 pandemic. Out of concern for the health and safety of the international science community, we are cancelling the Interdisciplinary Science for Eclipse ROSES-2020 element. NASA intends to support research on eclipses in the future.

Point of contact concerning this program	Madhulika Guhathakurta Heliophysics Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1992 Email: madhulika.guhathakurta@nasa.gov

APPENDIX C. PLANETARY SCIENCE RESEARCH PROGRAM

C.1 PLANETARY SCIENCE RESEARCH PROGRAM OVERVIEW

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1. Introduction

The Planetary Science Research Program supports investigations to help ascertain the content, origin, and evolution of the Solar System and the potential for life elsewhere, consistent with the strategy for Planetary Science Exploration embodied in the 2014 NASA Science Plan. The Planetary Science Research portfolio contains specific program elements aimed at addressing these strategic objectives.

1.1 Changes from Recent Years

This Planetary Science Research Overview has been substantially revised in recent years. Proposers who have not submitted recently are encouraged to read C.1 in its entirety. Several recent changes to program element C.1 are:

- E.4 Habitable Worlds (HW) Cross-Divisional program will be evaluating proposals using a dual-anonymous peer review process in which, not only are proposers unaware of the identity of the reviewers, but the reviewers are not given the identity of the proposers until after the evaluation of Merit. Proposals to HW must be prepared consistent with special instructions as described in Sections IV(b)i and VI(b) of the ROSES-2020 *Summary of Solicitation* and in the text of E.4 HW.
- Starting in ROSES-2020, when a DMP is required, the sufficiency of the data management plan will be part of Merit and thus may have a bearing on whether or not the proposal is selected, see Section 3.7.
- Section 3.2 includes a revised description regarding the prohibition of duplicate proposals.
- Section 3.7.1 includes updated information regarding Data Management Plans (DMPs). Information pertaining to the following has been added: (1) the inclusion of physical astromaterial and biomaterial samples; (2) software/code; (3) a revised method for DMP submission, as part of the main proposal; and (4) the removal of the Early Career Fellowship Start-up Program for Named Fellows (C.18) and Early Career Award Program (C.19) from the list of programs that do not require DMPs (i.e., these two programs now require DMPs).
- DMP strengths and weakness will be factored into the evaluation of intrinsic merit.

- Program elements supporting the publication of geologic maps have been clarified in Section 3.9.
- Information pertaining to Planetary Major Equipment and Facilities (C.17), Early Career Fellowships and Awards (C.18 and C.19), and Topical Workshops, Symposia, and Conferences (E.2) has been added to program element C.1.
- No contracts will be issued in response to proposals submitted to any program elements in Appendix C, unless otherwise noted in the individual program elements.
- The Habitable Worlds (HW) Cross-Divisional program is run within the Planetary Science Division but with the Heliophysics Division (see program element E.4).

1.2 Program Elements Covered by this Overview

This document pertains to all of the program elements in Appendix C of ROSES, including the cross-divisional research program element E.4, Habitable Worlds, but not E.3, Exoplanet Research Program.

2. Proposal Submission Processes

Program elements covered by C.1, Planetary Overview, use a variety of submission methods: sometimes nothing is requested or required in advance of the full proposal submission, sometimes a notice of intent (NOI) is requested, sometimes an NOI or a Step-1 proposal is required for subsequent proposal submission. See below and sections IV(b)vi-viii of the ROSES *Summary of Solicitation* for more information. The submission method being used will be stated in the text of the program element, but it is also indicated in Tables 2 and 3 (the tables of due dates).

2.1 NOI submission process

An NOI is a brief plain-text summary of what the proposer intends to submit, and may be submitted without endorsement from, or action by, the Authorized Organizational Representative (AOR). For more information see Section IV(b)vi of the ROSES *Summary of Solicitation* and the "Create and Submit NOI" tutorial on the NSPIRES web page at https://nspires.nasaprs.com/tutorials/index.html. As noted above, sometimes the submission of an NOI is mandatory. Note that NOIs cannot be submitted via Grants.gov, even if the proposal will ultimately be submitted via that system.

2.2 Two-step submission process

To facilitate the early recruitment of a conflict-free review panel and ensure that proposals are submitted to the appropriate program, many program elements covered by program element C.1 will use a two-step proposal submission process (see Section IV. (b) vii of the ROSES *Summary of Solicitation*). For program elements using the two-step process, a Step-1 proposal is required and must be submitted electronically by an AOR prior to the separate Step-1 deadline. No budget is required. Only proposers who submit a Step-1 proposal are eligible to submit a full, Step-2 proposal. Such Step-2 proposals must address the same broad scientific goals proposed in the Step-1 proposal. The PI cannot be changed and proposers who want to add funded investigators between the Step-1 and Step-2 proposals must inform the point(s) of contact identified in the summary table of key information and cc sara@nasa.gov at

least two weeks in advance of the Step-2 due date. Additions of funded investigators within two weeks of the Step-2 deadline require permission from the NASA point of contact. Submission of a Step-1 proposal does not obligate the proposer to submit a Step-2 (full) proposal later.

The Scientific/Technical/Management (S/T/M) section of a Step-1 proposal is restricted to the 4000-character text box on the NSPIRES web interface cover pages, unless otherwise noted in the program element (e.g., C.17, PMEF). Unless otherwise stated, PDF attachments will not be accepted through NSPIRES for Step-1 proposals submitted to most program elements covered by program element C.1.

A Step-1 proposal must cover the following topics:

- The goals and objectives of the proposed work;
- The approach and methodology to be used to address the goals and/or objectives; and
- The reasons why the work proposed is within the scope of the program element, and why this program element is the most appropriate for the work proposed.

Following the submission of a Step-1 proposal, most proposers will be notified through NSPIRES that the Step-1 proposal has been designated as "encouraged" or "discouraged," at which point the proposer will be able to create a Step-2 proposal. No evaluation of intrinsic merit will be performed on Step-1 proposals. The perceived relevance of the proposed work to the particular program element will be the main factor in deciding whether submission of a Step-2 proposal will be encouraged. Please note that the Step-2 proposal evaluation is independent of the Step-1 designation i.e, reviewers of a Step-2 proposal do not know whether a proposal was discouraged at Step-1.

In rare cases, for example, when the Step-1 proposal is not compliant with the requirements outlined above, or the proposed work cannot be funded because of NASA, SMD, or Planetary Science Division (PSD) policy, a Step-1 proposal may be declined by the selection official. In such a case, a Step-2 proposal cannot be submitted.

2.3 Direct submission process

As mentioned above, some program elements do not request or accept NOIs or Step-1 proposals. In these cases, AORs simply submit the (full) proposal by the published deadline. See Section 3 for additional requirements for a full proposal.

3. Requirements for Full Proposals

"Full" and "Step-2" proposals are synonymous, meaning the proposal that is peer reviewed, with the term "Step-2" used in program elements that use the two-step submission process.

3.1 Full proposal content and formatting

Table 1 of the ROSES *Summary of Solicitation* provides a checklist of required information to be included in full proposals. For program elements using the 2-step submission process, proposers may also refer to the PDF entitled "How to Create a

Step-2 Proposal" that appears under "Other Documents" on the NSPIRES page for the program of interest.

All proposals submitted to ROSES must strictly conform to the instructions regarding proposal format and content. Non-compliance will be taken into consideration, either before or during the selection process. In particular, any detected violation of these rules determined by the selecting official to give the proposer an advantage over competing proposers is grounds for the proposal to be rejected without review or declined following review.

Note that the order of precedence guidelines, described in Section I(g) of the ROSES *Summary of Solicitation*, *NASA Guidebook*, and ROSES instructions, may be superseded or modified by this document (program element C.1) for all covered program elements, and that each individual program element may have its own rules that supersede all of the above.

In previous years, problems with the following aspects of proposal formatting have been noted. Planetary Science proposals must adhere to the following formatting rules, as outlined in Section IV(b)ii of the ROSES *Summary of Solicitation*:

- Length of the Scientific/Technical/Management section: 15 pages, unless otherwise specified in the program element.
- Margins: 1 inch on all sides, with a page size of 8.5 × 11 inches.
- Font: 12-point or larger. The selected font must meet the requirement of having, on average, no more than 15 characters per inch (e.g., Times New Roman and Arial). Proposers may not adjust the character spacing or otherwise condense a font from its default appearance.
- Line spacing: Font and line spacing settings must produce text that contains no more than 5.5 lines per inch. Proposers may not adjust line spacing settings for a selected font below single spaced.
- Figure captions: Captions must follow the same font and spacing rules as the main text.
- Figures and tables: For text within figures and tables, font and spacing rules listed above do not apply, but all text must be judged to be legible to reviewers without magnification above 100%. Expository text necessary for the proposal may not be located solely in figures or tables.

3.2 Prohibition on Duplicate Proposals

Proposers may not submit full proposals for the same, or essentially the same, work to more than one program element covered by program element C.1 concurrently. This prohibition is active for a particular submitted proposal until the PI is notified through NSPIRES that the proposal was declined or until the proposal is withdrawn. The prohibition on duplicate proposals applies across ROSES years as well (e.g., a duplicate of a pending ROSES-2019 proposal may not be submitted in response to ROSES-2020). If a second proposal is submitted while a duplicate proposal is still pending in another program element, only the first proposal will be evaluated; the duplicate proposal may not be evaluated or considered and may be returned without review.

If a second proposal contains substantive changes in areas that are critical to the intrinsic merit evaluation, such as the goals, objectives, or methodology, then it is not considered to be a duplicate proposal.

Changes to a proposal that would fall outside of the merit evaluation are not considered substantive, and two proposals with only changes in these areas may be considered duplicates. Examples of proposal sections not considered in merit evaluation include:

- Current and pending support section;
- Relevance statement;
- Budget section

In addition, minor changes to aspects of a proposal covered by the merit evaluation (team, concepts, implementation, target, DMP, etc.) may not be considered substantive.

If it is unclear if changes to a proposal are substantial enough for that proposal to not be considered a duplicate proposal, or it is unclear to which program a proposal should be submitted, proposers should contact the point of contact for the program element most likely to be appropriate for the proposal, before the NOI or Step-1 proposal deadline.

3.3 Restriction on Funding for Mission-Related Activities

The Planetary Science R&A programs are not intended to provide additional support for mission scientists to carry out activities within the scope of a mission. They are also not intended to augment mission project budgets with the exception of participating scientist/guest investigator programs. If the proposal team contains individuals associated with a mission team (regardless of their role[s] on the proposal or on the mission), and the proposal contains content that might be construed as mission-related, then it must demonstrate that the proposed work is not being used for the above purposes. This applies during all phases of the mission (A through F), unless otherwise specified in the program element. This demonstration should be included in the S/T/M section.

Regardless of whether any members of the proposal team are affiliated with a relevant mission, proposals may be evaluated for the degree of overlap with mission activities. Proposals for work close in scope to a mission’s activities may be declined for programmatic reasons.

3.4 Award Durations and Types

The typical award duration is three years. Proposals for less than three years are encouraged for projects that can be completed on shorter timescales. For those program elements that permit longer awards, funding for more than three years must be explicitly justified in the proposal, i.e., to allow the completion of individual tasks that require more than three years. In these cases, the proposal must contain a discussion of why it is impractical or impossible to complete such tasks within three years.

Note that no contracts will be issued for awards made under the program elements covered by program element C.1 unless otherwise noted in the individual program element.

3.5 Use of Mission Data

Spacecraft mission data to be used in proposed work must be available in the Planetary Data System (PDS), or an equivalent, publicly accessible, archive, at least 30 days prior to the full proposal due date, unless otherwise specified in the program call. Likewise, higher-order data products to be used in the proposed work must be in the PDS, equivalent archive, or otherwise in the public domain for 30 days prior to the proposal due date. The calendar of record for data released in the PDS can be found at: https://pds.nasa.gov/datasearch/subscription-service/data-release-calendar.shtml.

3.6 Discussion of Relevance

All proposals will be evaluated for relevance to the individual program element to which the proposal has been submitted (see Section VI (a) of the ROSES *Summary of Solicitation*).

Some program elements covered by this overview require that an explicit relevance statement be placed into a mandatory (4000-character) text box on the cover pages via the NSPIRES web interface. For program elements that require the text box, this required relevance statement is outside of the 15-page S/T/M Section. This requirement supersedes the default in the *NASA Guidebook for Proposers* and the ROSES *Summary of Solicitation*. For these calls, the omission of a relevance statement on the cover pages is sufficient reason for a proposal to be returned without review.

3.7 Data Management Plans and Archiving

3.7.1 Data Management Plans

To broaden access to the results of NASA-funded research, proposals submitted to ROSES must include a data management plan (DMP). The guiding philosophy behind this requirement is that all relevant data should be made publicly available (i.e., without fee or restriction of use) at the time of publication, or at the earliest practical time thereafter, in a data repository likely to have stable, long-term support.

New for ROSES-2020: the quality of the DMP will be considered as part of the evaluation of intrinsic merit. It will be treated as part of the overall management plan of the project. In previous years, for most program elements, the DMP evaluation was independent of the evaluation of intrinsic merit.

Individual program elements may provide instructions that supersede and/or amplify the requirements described here. For example, the Planetary Data Archiving, Restoration and Tools (PDART, program element C.4) program element includes the data management discussion in the page-limited S/T/M section of the proposal. The instrument development and Planetary Major Equipment calls (program elements C.12 PICASSO, C.13 MatISSE, C.17 PMEF, C.20 DALI, and C.22 REMBRandT) do not require DMPs. However, even for those programs, if those awards result in datasets and peer-reviewed publications, the requirements (laid out here and in the ROSES *Summary of Solicitation*) regarding public release still apply.

Proposers requiring a DMP are strongly encouraged to use the PSD DMP template, that may be downloaded as a Word document, or a LaTeX template in the form of a .txt file,

from the SARA web page at: https://science.nasa.gov/templates-planetary-science-division-appendix-c-roses-proposals.

DMPs must be placed in a special section of the proposal, entitled "Data Management Plan." All proposals to program elements that require DMPs must contain this section. The DMP may not exceed two pages in length and must immediately follow the references and citations for the S/T/M portion of the proposal. The two-page DMP section does not count against the 15-page limit of the S/T/M section. Formatting requirements for DMPs are the same as for the S/T/M section. When appropriate or required, letters of support from data archives (e.g., Section 3.7.2 of this document) must be included in a Statements of Commitment and Letters of Support, Feasibility and Endorsement section of the proposal (see ROSES *Summary of Solicitation*, Table 1).

The DMP must cover any data needed to validate the scientific conclusions of peer-reviewed publications, particularly data underlying figures, maps, and tables.

The DMP should also cover any physical materials that are planned to be collected, purchased, or produced during the course of the research. These include astromaterials such as meteorites, micrometeorites, and cosmic dust; for astrobiology research, this would include biomaterials produced, analog materials collected or synthesized, or analytical standards developed. The DMP should demonstrate that any such materials with scientific value that are not consumed during the proposed research will be made publicly available. Proposers are also encouraged, but not required, to discuss how other physical materials collected, purchased, or synthesized during the planned research would be made publicly available when it is practical and feasible to do so, and when there is scientific utility in doing so.

For proposals that use non-mission data (e.g., laboratory results, Earth-based observations) that are not publicly available (in the PDS or other archive, in the literature, etc.), the project is expected to make the data available following the Data Management Plan guidelines.

"Data" does not include preliminary and other unpublished data, data in prepublication documents, private communications, or certain other types of information that have been specifically exempted from the DMP requirement.

In the case of a project that would produce no data, as defined above, or only data specifically exempted, the DMP must state that no data preservation or data sharing is needed, but must also explain why. In a case where no appropriate archive exists for a particular data set, the DMP should discuss alternative methods for making the data publicly available.

The DMP must contain the following elements, as appropriate to the project, in adequate detail for review:

- A description of data types, volume, formats, and (where relevant) standards;
- A description of the schedule for data archiving and sharing;
- A description of the intended repositories for archived data, including mechanisms for public access and distribution;
- A discussion of how the plan enables long-term preservation of data;

- A discussion of roles and responsibilities of team members in accomplishing the DMP. (If funds are required for data management activities, these should be covered in the normal budget and budget justification sections of the proposal.)

The DMP should also cover any other data and software that would enable future research or the replication/reproduction of published results. Software, whether a stand-alone program, an enhancement to existing code, or a module that interfaces with existing codes, created as part of a ROSES award should be made publicly available when it is practical and feasible to do so, and when there is scientific utility in doing so. Stand-alone code that is not straightforward to implement, or whose utility is significantly outweighed by the costs to share it, is not expected to be made available. This expectation extends to three types of software, defined as follows:

Short Name	Name	Description	Examples
Libraries	Libraries and toolkits	Generic tools implementing well-known algorithms, providing statistical analysis or visualization, and so on, that are incorporated in other software categories.	Numerical Recipes, NumPy, general FFTs, LAPACK, scikit-learn, AstroPy, GDAL
Analysis software	Analysis, post-processing, or visualization software	Generalized software (not low-level libraries) used to manipulate measurements or model results to visualize or gain understanding.	Stand-alone image processing, topology analysis, vector-field analysis, satellite analysis tools, and so on
Frameworks	Modeling frameworks	Multicomponent software systems that incorporate a variety of models and couple them together in a complex way.	Community Earth System Model (CESM) is a collection of coupled models including atmospheric, oceanographic, sea ice, land surface, and other models

SMD expects that the source code, with associated documentation sufficient to enable use of the code, will be made publicly available via GitHub (https://github.com/NASA-Planetary-Science), the PDS (for mission-specific code, when appropriate), or an appropriate community-recognized depository (for instance, the homepage of the code base for which a module was developed). Archiving software in a public repository does not require the proposer to maintain the code. Awards that derive from proposals that include plans to post code in GitHub will contain a Rights in Data clause reflecting this expectation.

Proposals that do not address each of these items in their DMP, even if determined to be selected or selectable for funding, may not be funded until an adequate DMP is submitted. Funded researchers, research institutions, and NASA centers are responsible for ensuring and demonstrating compliance with the DMPs approved as part of their awards. Awardees who do not fulfill the intent of their DMPs may have

continuing funds withheld and this may be considered in the evaluation of future proposals.

3.7.2 Data Archiving in the Planetary Data System (PDS)

For proposals where derived data products will be deposited in the Planetary Data System, these data products must be in PDS4 format. Guidelines for planning for the submission data in this format to the PDS are available at http://pds.nasa.gov/pds4.

Proposers intending to make use of the PDS should refer to the most recent version of the following documents for information on PDS compliance:

- Proposer's Archive Guide: https://pds.nasa.gov/home/proposers/proposing-programs.shtml
- Standards Reference: https://pds.nasa.gov/datastandards/documents

Proposers should communicate with the PDS Discipline Node responsible for curating similar data (links to the PDS Discipline Nodes are at http://pds.nasa.gov/) to discuss procedures and requirements prior to proposing to a Planetary Science Division ROSES program element. Proposers intending to archive data or products in the PDS must obtain and include confirmation, in the form of a letter of support from the appropriate Discipline Node, that the PDS is willing to accept their submission. This letter must be included in the proposal package and placed in a section for Statements of Commitment and Letters of Support, Feasibility, and Endorsement (see ROSES *Summary of Solicitation*, Table 1).

3.8 Table of Personnel and Work Effort

All proposals must include a Table of Personnel and Work Effort. If the program element allows contracts, and it is anticipated by the proposer that the proposal will result in a contract, this table must be within the budget narrative section. All other proposals should include this table as a separate section before the Budget Justification section, and follow the instructions presented here.

Proposers are strongly encouraged to use the PSD Table of Personnel and Work Effort template, which may be downloaded as a Word document, a LaTeX template, or a pdf from the SARA web page at https://science.nasa.gov/templates-planetary-science-division-appendix-c-roses-proposals.

The Table of Personnel and Work Effort should list the names (if known) and titles of every person who will do work on the proposal, regardless of whether that person would receive money, and regardless of their role on the project. It should cover all personnel, including those covered by any sub-awards, sub-contracts, or who work at any NASA center or federal agency that may receive money separately from the main award. The table must have entries covering each proposed award year (do not provide a separate table divided by federal fiscal years) and must distinguish between the effort to be funded by the submitted proposal and non-funded efforts plus those funded separately. All work efforts listed in the table should be made in fractions of a work-year.

Note that this section may not contain any narrative description of tasks to be performed by proposal personnel; such information should be placed in the 15-page Scientific/Technical/ Management section of the proposal.

3.9 Publication of Geologic Maps

Geologic mapping is an investigative process designed to go beyond standard image analyses to determine the geologic history of a region of interest, whether it is local, regional, or global. Thus, geologic maps are key tools to aid in identification of this geologic history. Below are some guidelines about where to propose geologic mapping investigations.

3.9.1 Program Elements Supporting Geologic Mapping

If a geologic map would be created as part of a hypothesis-driven science investigation (i.e., to address specific scientific objectives or questions about a region of interest, as opposed to PDART, see below), and uses data from planetary missions identified in a Data Analysis Program (DAP), then the proposal should be submitted to the appropriate DAP. For example:

- Pluto and Charon maps: New Frontiers DAP (program element C.7);
- Lunar maps: Lunar DAP (program element C.8);
- Mars maps: Mars DAP (program element C.9);
- Cassini-based Saturnian satellite maps: Cassini DAP (program element C.10);
- Dawn-based Vesta or Ceres maps: Discovery DAP (program element C.11); and
- MESSENGER-based Mercury maps: Discovery DAP (program element C.11).

If a geologic map would be created as part of a hypothesis-driven science investigation using data from missions not covered by a current DAP (e.g., Venus missions), or as part of a comparative planetology science investigation not responsive to a single DAP, then the proposal should be submitted to whichever of the non-DAP research program elements the proposal is most relevant (e.g., Solar System Workings, Emerging Worlds, Habitable Worlds).

If a geologic map would be created without an accompanying hypothesis-driven science investigation, then the mapping proposal should be submitted to PDART (program element C.4).

3.9.2 Maps Published by the U.S. Geological Survey

Proposals that include the publication of a Scientific Investigations Map (SIM) by the U.S. Geological Survey (USGS) should check the relevant box on the proposal cover page and clearly indicate this intention in the Proposal Summary, as well as in the text of the proposal. Investigators who choose to produce a geologic map as a USGS product will be required to follow current guidelines for the production and submission of digital products, including the generation of maps that are compatible with Geographic Information System (GIS) software packages for review, edit, and publication. To support this requirement, the USGS will provide a GIS project that contains the projected, geographically rectified, and scaled mapping base or mosaic, as well as other relevant global- or regional-scale data sets (if available and needed). Investigators selected to publish USGS geologic maps will be expected to (1) provide peer reviews for two geologic maps generated by other planetary mappers during their grant period, and (2) attend the annual Planetary Geologic Mappers Meeting to present their map status to the mapping community and receive updates on current guidelines. Proposers should include travel funding to attend the Planetary Geologic Mappers Meeting,

justifiable because of NASA requirements. Further information pertaining to the production of USGS geologic maps (e.g., map bases, scales, extents, formats, guidelines) is available at http://planetarymapping.wr.usgs.gov/, or by contacting Jim Skinner at the USGS (jskinner@usgs.gov).

Investigators who intend to produce a USGS geologic map are required to include a Confirmation of Technical Specification document, obtained from the USGS Map Coordinator, in their Step-2 (full) proposal. This document should identify the (1) latitude/longitude boundaries of the map region, (2) scale of the proposed map, (3) required base map, (4) projection of the base map, and (5) key supplemental data. This document is only a confirmation and does not fulfill any requirement that the mapping effort be described and justified within the 15-page body of the proposal. Selection of a proposal for funding is contingent upon the inclusion of this document. Investigators are encouraged to contact the USGS early in the proposal preparation process.

3.10 Access to the Antarctic

Some program elements in Appendix C, such as C.3 SSW, allow proposals that would require access to the Antarctic.

Proposals to those elements that allow Antarctic fieldwork must include all costs associated with this fieldwork in their proposal budgets. For Antarctic fieldwork supported by the United States Antarctic Program (USAP), such costs include: physical qualification exams; airfare, lodging, and per diem for travel to Christchurch, New Zealand (departure point for Antarctica; seven days in Christchurch should be included as margin for weather-related delays); any required cargo transportation (origin to Pt. Heuneme, California, and return); and any specialty materials or large quantities of stocked materials required in Antarctica. Proposers must also include costs associated with logistics support provided by the USAP via the National Science Foundation (NSF).

To obtain these costs, proposers must complete an Antarctic Logistics Requirements and Field Plan, and return it to Jessie Crain, Antarctic Research Support Manager (jlcrain@nsf.gov). Requirements for this document, and other guidance for conducting field work in the Antarctic, are may be found at: https://www.nsf.gov/geo/opp/ant/solicitation_resources/prop_prep_info.jsp. Please allow one month for processing to receive the USAP cost estimate. Unless otherwise stated, program elements in Appendix C will not fund work in Antarctica.

3.11 Additional Funding for Relevant Instrumentation Construction or Upgrade

The Planetary Major Equipment and Facilities (PMEF) program element (C.17) allows proposals for upgrading the analytical, computational, telescopic, and other instrumentation required by investigations for certain program elements sponsored by the Planetary Science Division Research and Analysis Program. All new analytical instrumentation requests, as well as requests for upgrades to existing instruments, costing more than $50,000 must be requested according to the PMEF guidelines in C.17. Two types of instrumentation requests are permitted: (1) a PMEF request may be made as a special section that is appended to a new research proposal in an eligible program element; or (2) a stand-alone PMEF proposal may be prepared and submitted to a special PMEF proposal deadline. All requests for facility instruments must now be

of the second type. See C.17 for details on how to prepare both types of PMEF requests. Program elements eligible for PMEF are listed in C.17.

3.12 Planetary Science Division Early Career Fellowship Program

The purpose of the Planetary Science Division (PSD) Early Career programs (described in program elements C.18 and C.19) is to support the research and professional development of outstanding early-career scientists in the areas supported by PSD. Support from these programs allows promising individuals to play an increasing and more meaningful role in the planetary science community.

Those who were already named Early Career Fellows in prior years, and are eligible, may submit proposals for start-up funds in response to program element C.18, Early Career Fellowship (ECF) Start-Up Program for Named Fellows (i.e., the legacy ECF program). Previously named Early Career Fellows who have not applied for their start-up funds, but who are still (or may still become) eligible, should email Shoshana Weider (shoshana.z.weider@nasa.gov) regarding their ECF status. The legacy ECF is no longer active, i.e., new Early Career Fellows will not be named through this program.

Early-career researchers may be eligible to propose to the extant Planetary Science Division Early Career Award Program (C.19). Information on how to apply for this award, and its eligibility criteria, are detailed in the program element C.19.

3.13 Topical Workshops

All proposals for topical conferences, workshops, or symposia related to the Planetary Science Division Research and Analysis Program must be submitted in response to program element E.2, Topical Workshops, Symposia, and Conferences. Proposers to E.2 should specifically identify the PSD research program element to which the conference, workshop, or symposium is most closely related, and refer to the goals and objectives of that program element in demonstrating relevance.

4. Resources Available to Proposers

4.1 Data and Information Resources

4.1.1 The Planetary Data System (PDS)

The Planetary Data System (PDS) archives and distributes scientific data from NASA planetary missions, astronomical observations, and laboratory measurements. The archives can be found through the PDS home page: http://pds.nasa.gov/. PDS is supported by six science discipline nodes (Atmospheres, Geosciences, Imaging, Planetary Plasma Interactions, Rings, and Small Bodies) distributed around the U.S. Each node houses data from NASA's planetary missions, and documentation necessary to use those data. Data searches and requests can be initiated from the PDS home page or at any of the science discipline node pages accessible there. Guides and tools for using data, preparing an archive, and archiving data can be found at http://pds.nasa.gov/tools/. Contact the PDS Operator (pds_operator@jpl.nasa.gov) or the appropriate node's point-of-contact for assistance.

4.1.2 The National Space Science Data Center (NSSDC)

The NSSDC archives digital and other data from historic and completed flight missions, and its archives are complementary to those of the PDS. NSSDC data include lunar and planetary photographs, digital planetary images, tabular and experiment data from numerous flight missions, and cartographic products. Investigators are responsible for acquiring the data needed for their proposal. Modest requests for data are free of charge, although charges will be incurred for large-volume requests. Requests from U.S. investigators for data products and information may be made through the Coordinated Request and User Support Office at the NSSDC (nssdc-request@lists.nasa.gov). For more information, see http://nssdc.gsfc.nasa.gov/nssdc/obtaining_data.html.

4.1.3 The Lunar and Planetary Institute (LPI)

LPI provides one of the most concentrated and easily accessible collections of data and other information in lunar and planetary science, including extensive digital map and imagery collections, computational tools for the lunar community, and a vast collection of educational products and resources. These resources, along with an extensive range of electronic tools to enhance science activities and effective communication within the planetary science community, can be found on the LPI's website: http://www.lpi.usra.edu.

4.1.4 Regional Planetary Image Facilities (RPIFs)

RPIFs contain nearly half a million images of the planets, and their satellites, taken from Earth and from crewed and uncrewed spacecraft. RPIFs also contain topographic and geologic maps produced from these images. The RPIFs, located at institutions worldwide, are intended for use by individuals and groups who use photographic and cartographic materials of the planets and satellites in their research programs. These programs include geologic, photometric, colorimetric, photogrammetric, and atmospheric dynamical studies. Send inquiries to the director of the nearest RPIF. Note that although these centers may be used for onsite study and selection of planetary and satellite images, they are not facilities for the production of photographs for users. Instead, such materials may be obtained from the NSSDC (see above). Additional information, including a list of RPIF locations worldwide, can be found on the RPIF home page: http://www.lpi.usra.edu/library/RPIF.

4.1.5 Planetary Cartography Program

NASA has a long-term agreement with the USGS to provide a variety of cartographic support functions for NASA researchers through its Planetary Cartography Program. This support includes:

- Integrated Software for Imagers and Spectrometers (ISIS, http://isis.astrogeology.usgs.gov/);
- Search capability for raw planetary image data (PILOT, http://pilot.wr.usgs.gov);
- On-demand production of higher-level data products (Map Projection On the Web, http://astrocloud.wr.usgs.gov/;
- Coordination of IAU approval of nomenclature http://planetarynames.wr.usgs.gov/;

- Training in planetary GIS methods (MRCTR GIS Lab, http://astrogeology.usgs.gov/facilities/mrctr);
- Production of digital terrain models (DTMs) from Mars Reconnaissance Orbiter (MRO) High Resolution Imaging Science Experiment (HiRISE) stereo data (see details in C.9).

For cartography support beyond what is provided by the Planetary Cartography Program, the USGS is willing to join proposal teams to produce or assist in the production of specific cartographic tools or products. However, the USGS is required to recoup the full cost of such activities in the proposal budget. Visit http://astrogeology.usgs.gov/ or email jhagerty@usgs.gov for further information.

4.2 Astromaterials

NASA's Astromaterials Acquisition and Curation Office at the NASA Johnson Space Center provides access to all NASA-controlled samples of astromaterials, including those returned by the Apollo program and the Genesis and Stardust missions, a subset of particles returned by the Japan Aerospace Exploration Agency (JAXA) Hayabusa mission, interplanetary dust particles collected by high-altitude aircraft, meteorites collected in Antarctica by U.S. field parties, and a variety of space-flown microparticle impact collectors. Peer review of sample requests are provided by the Curation and Analysis Planning Team for Extraterrestrial Materials (CAPTEM). For information on how to obtain any of the specimens in these collections, see http://curator.jsc.nasa.gov/ or contact:

Office of the Curator
Code KT
Johnson Space Center
National Aeronautics and Space Administration
Houston, TX 77058-3696

4.3 Research Facilities

The following facilities are available to supported investigators. If their use is anticipated, this use must be discussed and justified in the submitted proposals (especially note the provision for such discussion in the proposal section entitled Facilities and Equipment). Also note, per the directions in the *NASA Guidebook for Proposers*, that a letter of support may be required from any facility required for the proposed effort that is not under the direct control of the proposing team.

4.3.1 NASA-provided High-End Computational (HEC) Facilities

Those investigators whose research requires high-performance computing should refer to the *Summary of Solicitation*, Section I(d), "NASA-provided High-End Computing Resources." This section describes the opportunity for successful proposers to ROSES to apply for computing time on either of two NASA computing facilities, i.e., at the NASA Goddard Space Flight Center's (GSFC's) Computational and Information Sciences and Technology Office, or at the NASA Ames Research Center's (ARC's) Advanced Supercomputing Division. Proposers needing access to these facilities should follow the instructions in Section I(d) of the ROSES *Summary of Solicitation*. Further information

on computing capabilities may be found at the NASA High-End Computing website: http://www.hec.nasa.gov/.

4.3.2 Planetary Aeolian Facility (PAL)

The Planetary Aeolian Facility at the NASA Ames Research Center consists of wind tunnels that can be used to simulate atmosphere-surface interactions on Earth, Mars and Titan. For more information, contact David Williams (David.Williams@asu.edu) or consult the PAL Guidebook for Proposers at: https://rpif.asu.edu/documents/PAL_Proposers_Guidebook_2019_v7.pdf.

4.3.3 Reflectance Experiment Laboratory (RELAB)

The RELAB facility at Brown University provides a mechanism for researchers to obtain high-quality laboratory spectra of natural or synthetic materials for use in compositional, geologic, and remote sensing applications. RELAB is partially supported by NASA as a multiuser spectroscopy facility, and researchers are invited, but not required, to visit the laboratory in person during sample measurements. Laboratory time and most sample measurements are made available at no charge to investigators funded by NASA. If a proposal to NASA requires acquisition of new spectra via RELAB in the VIS/NIR or mid-IR, then the scope and justification must be provided in the submitted proposal. Data acquired as part of NASA-funded research are made available to the investigator immediately after measurement and are made publicly available three years after measurement. Additional information about this facility, a RELAB user's manual, sample submittal forms, and access to RELAB spectroscopy data can be found at http://www.planetary.brown.edu/relab/. For further information, contact the Science Manager of RELAB, Ralph Milliken (Ralph_Milliken@brown.edu) or the Operations Manager, Takahiro Hiroi (Takahiro_Hiroi@brown.edu).

4.3.4 NASA Ames Vertical Gun Range (AVGR)

The NASA AVGR is a national facility funded by the NASA Science Mission Directorate to enable investigations of impact phenomena and processes. Exploratory or proof-of-concept programs requiring a limited number of experiments can be accommodated at no cost. More extensive programs are subject to review, to assess feasibility and cost effectiveness. Any need for extensive use of the AVGR should be explicitly described in the proposal. The proposal budget should include an estimate of usage costs. A letter of support from the AVGR is required. For more information, potential users of the AVGR should contact John Karcz (john.s.karcz@nasa.gov).

4.3.5 NASA Venus In-situ Chamber Investigations (VICI)

The NASA Venus In-situ Chamber Investigations (VICI) is a pressure chamber that enables testing of components and small instruments under temperatures and pressures that simulate Venus surface conditions. Lower temperatures and pressures can also be accommodated. Exploratory or proof-of-concept programs requiring a limited number of experiments/tests can be accommodated for minimal cost. Extensive use of the chamber should be described in the proposal and is subject to review by VICI personnel, to assess feasibility and cost effectiveness. Any use of the chamber and its corresponding costs should be included in the proposal budget. A letter of support from

the VICI facility is required. For additional information, please contact Natasha Johnson (natasha.m.johnson@nasa.gov).

4.3.6 NASA Glenn Extreme Environment Rig (GEER)

The Glenn Extreme Environment Rig (GEER) is a simulation rig designed to provide an asset to the scientific and engineering communities to perform laboratory experiments and/or technology developments, or instrument/hardware qualifications, in extreme simulated environments. When fully operational, GEER can accurately simulate the temperatures, pressures, and chemistry of the atmospheres of planetary bodies, including the conditions found on the surface of Venus. The chamber is cylindrical, with an interior diameter and length of three feet and four feet, respectively. The chamber is rated for pressures up to 100 bar at 500°C. Eight individually controllable gas streams are available. Interested parties should contact Tibor Kremic (Tibor.Kremic@nasa.gov) for questions regarding status, availability, and any proposal related intentions. Some additional information on the GEER is available at https://geer.grc.nasa.gov/.

4.3.7 USGS Astrogeology Science Center (ASC) Digital Terrain Models (DTMs)

The USGS Astrogeology Science Center (ASC) produces high-quality digital terrain models (DTMs) for engineering (e.g. landing site characterization) and science. The ASC can supply individual investigators with high-quality DTMs in support of NASA-selected R&A investigations, replacing the "Photogrammetry Guest Facility" currently operated by ASC. Proposers who wish to use these DTMs must solicit a Confirmation of Technical Specifications Letter from the ASC indicating their ability to produce the requested DTMs and to provide them at no cost to the proposer. This approach is directly analogous to that currently used for the Planetary Geologic Mapping Program. For ROSES-2020, DTMs will be generated using only HiRISE stereo data, and will thus be most applicable to proposals submitted to the MDAP program; the total number of DTMs generated will necessarily be limited. It is anticipated that the program will expand to additional data sets in future years. Further information pertaining to DTM generation by the USGS is available by **visiting the USGS Astrogeology Planetary Photogrammetry Lab's DTM page. Proposers may request further information by** contacting Donna Galuszka at the USGS (MDAP_DTM_REQUEST@usgs.gov) with "MDAP_DTM_REQUEST" in the email subject line. **[Updated February 28, 2020]**

C.2 EMERGING WORLDS

NOTICE: Amended March 20, 2020. In order to give organizations more time to adapt to remote activities because of the COVID-19 emergency, the Step-1 proposal due date has been delayed to April 17, 2020.

Amended February 27, 2020. The text in sections 2.2 and 3.1.7 regarding sample-based and experimental studies of the chemical, petrological, and isotopic properties of lunar materials have been changed in parallel with an amendment to C.3 Solar System Workings. New text is in bold and deleted text is struck through. The due dates remain unchanged. ~~Step-1 proposals are due April 3, 2020~~.

This program element continues to use a two-step proposal submission process, described in Section 2 of C.1 The Planetary Science Division Research Program Overview.

1. Introduction

Research in the area of "Emerging Worlds" aims to answer the fundamental science question of how the Solar System formed and evolved. It helps to advance the strategic science goal to "explore and observe the objects in the Solar System to understand how they formed and evolve" through basic research that supports planetary exploration, aids in the development of missions, and provides context for the interpretation of all Solar System observations that are relevant to its formation and evolution. A wide range of investigations will be covered, including, but not limited to, theoretical studies, analytical and numerical modeling, sample-based studies of extraterrestrial materials, laboratory studies, and synthesis of previous work.

2. Scope of Program

The Emerging Worlds program solicits research proposals to conduct scientific investigations related to understanding (2.1) the formation of our Solar System; and/or (2.2) the early evolution of our Solar System.

2.1 Formation of our Solar System

For the purposes of this solicitation, the "formation of our Solar System" is considered to begin with the onset of the collapse of the molecular cloud from which the Solar System formed. Therefore, the following research areas are within scope of Emerging Worlds:

- Studies of the materials present and processes that led to the onset of Solar System formation.
- Studies of all aspects of materials present and processes occurring in and affecting the protoplanetary disk, including those occurring on bodies of any size during this stage of Solar System evolution.
- Studies related to the accretion of Solar System bodies after dissipation of the protoplanetary disk.

Studies of the formation of planetary systems in general fall within the scope of Emerging Worlds, but only if the proposal makes an explicit, clear and cogent case that the specific research proposed will result in increased understanding of the formation of

our own Solar System. Studies of exoplanetary systems that do not have direct consequences for our Solar System are not in scope of Emerging Worlds.

2.2 Early evolution of the Solar System

For the purposes of this solicitation, "early evolution" is defined as follows. The absolute ages of processes that are considered "early" depend on the context. Please note the usage of the phrase "most prominent" in the bullets below: the intent of Emerging Worlds is to focus on processes that were characteristic of an early epoch of the Solar System and played a role in establishing the structure of the Solar System or the bodies within it.

- For studies of the dynamical evolution of the Solar System, Emerging Worlds focuses on processes that happened and were most prominent between the time of Solar System formation and the time that large planetary bodies were in or near their modern configuration.
- For studies of the chemistry and physics of collisions and impacts in the Solar System, Emerging Worlds focuses on those processes that occurred and were most prominent during the dynamical evolution of the Solar System up to the time that large planetary bodies were in or near their modern orbital configuration, and which had significant effect on the structure of the target body or its planetary system.
- For studies of the large planetary bodies themselves, Emerging Worlds focuses on the period of planetary evolution through the end of the major period of accretion or the time of global differentiation (the separation into compositionally distinct layers, including their atmospheres, cryospheres, and hydrospheres), whichever is later. Such studies could be about the process of accretion or differentiation, or other processes that occur on or within large Solar System bodies through this period.
- For studies of processes that occurred on small bodies, the intent is to cover processes that can be reasonably inferred to have occurred and were most prominent up to the time that large planetary bodies were in or near their modern configuration.
- For studies of the Moon, sample-based and experimental studies of the chemical, petrological, and isotopic properties of lunar materials, **may be** ~~are~~ within scope of Emerging Worlds **see Section 3.1.7**. Studies that focus on active, ongoing processes remain out of scope of Emerging Worlds. **[Amended February 27, 2020]**

2.3 Programmatic priorities

Emerging Worlds prioritizes investigations that directly address outstanding problems in the origin and evolution of our Solar System. Proposals should clearly explain the problem(s) to be solved or the hypothesis(es) to be tested and present a work plan that will allow the investigation to solve these problems or test these hypotheses within the funding period.

2.4 Long-term projects

The Emerging Worlds program recognizes that some projects may require more than a single funding period to bring to completion. Proposals that seek to do this are

acceptable: they must clearly explain the problem(s) to be solved or the hypothesis(es) to be tested, and present a complete work plan that will allow the proposing team to ultimately reach the scientific objectives, even if such completion may not be possible within a single award period. The work plan must include detailed milestones to be accomplished during the initial award period, as well as milestones envisaged for future work. Selection of such a proposal does not constitute a guarantee of future funding for the completion of the project, and subsequent peer-reviewed proposals would be required in order to continue the work past the initial award period.

2.5 Demonstration of relevance

As stated in program element C.1, Section 3.6, all proposals, including those submitted to this program element, will be evaluated for relevance to the solicitation. Although, proposals submitted to this program element do not require a separate or explicit statement of relevance, proposers are strongly encouraged to address the question of relevance in the Scientific/Technical/Management portion of the proposal.

To be found relevant to the solicitation, all proposals submitted to this program element must demonstrate how they will advance our understanding of the origin or early evolution of the Solar System, as defined in Sections 2.1 and 2.2.

3. Programmatic Information

3.1 Exclusions

Proposers are advised to read each of the calls referenced below prior to submitting proposals.

3.1.1 *Studies of Exoplanets*

General studies of the formation of planetary systems may be relevant to either the Exoplanet Research Program (XRP, program element E.3) or Emerging Worlds. Those proposals which make an explicit, clear and cogent case that the specific research proposed will result in increased understanding of the formation of our own Solar System may be submitted to Emerging Worlds. Others should refer to the XRP solicitation.

3.1.2 *Studies of habitability*

Research aimed at investigating the habitability of planetary bodies in our Solar System or in other planetary systems should be submitted to the Habitable Worlds program element (program element C.22).

3.1.3 *Earth Science Studies*

Emerging Worlds does not, in general, support Earth science investigations, including research on terrestrial analog samples, unless relevance to the formation and early evolution of other planetary bodies or planetary science in general can be firmly established. Terrestrial research should address: key geochemical processes in early planetary evolution; terrestrial history in terms of general Solar System processes; or the reasons for differences in early evolution among the various planetary bodies; including Earth, the Moon, and parent bodies of meteorites. Proposals to analyze

terrestrial samples should clearly explain the nature of the planetary connection, as this will be a key factor in determining relevance to Emerging Worlds.

3.1.4 *Mission Data Analysis*

NASA solicits proposals that use, analyze, and/or enhance the scientific return of certain planetary missions through its data analysis programs (DAPs). Emerging Worlds does not accept proposals that are eligible for submission to a DAP. The DAP solicitations should be consulted prior to the submission of any proposal that uses planetary mission data.

3.1.5 *Returned Sample Analysis*

Through the Laboratory Analysis of Returned Samples (LARS) program (program element C.16), NASA solicits proposals focused on the analysis of astromaterials returned by planetary missions (e.g., Stardust, Genesis, Hayabusa), and on the development of analytical methods for samples returned from these or future sample-return missions. The Emerging Worlds program element does not accept proposals that are eligible for submission to LARS. (Note that LARS does not support work on samples returned by the Apollo program; relevant work on Apollo samples may be submitted to Emerging Worlds.)

3.1.6 *Observations*

Observational proposals that are within the scope of the Solar System Observations program (which must have new observations within our Solar System as a primary element) are not in scope of Emerging Worlds and should instead be submitted to Solar System Observations (program element C.6). Proposals with an observational component that are not in the scope of Solar System Observations must make an explicit, clear and cogent case that the observational data will be used to understand the formation and early evolution of our Solar System in order to be in scope for Emerging Worlds.

3.1.7 *Solar System Workings* **[Amended February 27, 2020]**

Investigations into processes that do not satisfy the definition of "early evolution" in Section 2.2, above, should be submitted to Solar System Workings (program element C.3). **For studies of the Moon, sample-based and experimental studies of the chemical, petrological, and isotopic properties of lunar materials might be relevant to Solar Systems Workings or Emerging Worlds, but proposals for the same, or essentially the same, work may not be submitted to both program elements (see Section 3.2 of C.1, the Planetary Science Research Program Overview).**

3.1.8 *Planetary Data, Archiving, Restoration, and Tools (PDART)*

Proposals whose primary goals are to generate higher-order data products, archive and restore data sets or products, create or consolidate reference databases, generate new reference information, digitize data, and/or to develop or validate software tools may be in the scope of PDART (program element C.4) rather than Emerging Worlds.

3.1.9 *Studies of the Sun*

Emerging Worlds does not solicit proposals whose primary focus is on the formation or early evolution of the Sun (or protosun).

3.2 Duration and Size of Awards

Typical proposals to Emerging Worlds seek three years of funding or fewer. Please refer to program element C.1, Section 3.4, for instructions on submitting requests for more than three years. Projects to demonstrate or develop a new technique or a new application of an established technique, usually for less than three years duration, may also be proposed.

Awards made in Emerging Worlds in the first five years of its existence (selections made from ROSES-2014 though ROSES-2018) averaged ~$160,000 per year, but with a wide range, depending on the nature of the work proposed. The 2014-2018 Emerging Worlds selections are included in the spreadsheet on the SARA grant stats web page, and abstracts are made available through NSPIRES. Proposers may refer to the Frequently Asked Questions (FAQs) for this program to view a histogram of award sizes for prior years, for information purposes only. Proposers should request what they actually need to conduct the research proposed.

Awards resulting from proposals submitted to this program are expected to be funded in their first year with next year's Fiscal Year (FY) dollars.

3.3 Additional Funding for Relevant Instrumentation Construction or Upgrade

Proposers to Emerging Worlds are eligible to request funds for major equipment under the Planetary Major Equipment and Facilities (PMEF) program. See program element C.17 for information on how to append a PMEF request to a regular Emerging Worlds research proposal or submit a stand-alone PMEF proposal to supplement an existing Emerging Worlds award.

3.4 Topical Workshops

The Emerging Worlds program does not accept proposals for topical conferences, workshops, or symposia; such proposals may be submitted in response to program element E.2 Topical Workshops, Symposia, and Conferences. Proposers should specifically identify the Emerging Worlds program as the relevant SMD program element and refer to the goals and objectives of the Emerging Worlds program in demonstrating relevance.

3.5. Mission data, facilities, and resources

Refer to ROSES program element C.1, Section 4, for a detailed list of the data and astromaterials resources, and facilities available to proposers to this program element, and how to use them.

3.6 Use of mission data

Proposals to this program element must follow the rules for use of mission data given in program element C.1, Section 3.5.

3.7 Data Management Plans (DMPs)

Proposals submitted to this program element must include a Data Management Plan (see program element C.1). This must be placed in a special section, not to exceed two pages in length, immediately following the References and Citations section for the Scientific/Technical/Management portion of the proposal.

3.8 Geologic Maps

Proposers who plan investigations involving geologic mapping should consult program element C.1 for guidance on submission and requirements for publication of U.S. Geological Survey (USGS) maps. The scientific goal of such a geologic map product should be clearly explained and justified.

3.9 Planetary Science Early Career Award

Details of the new Planetary Science Early Career Award (ECA) program are given in program element C.19. The aim of this program is to support research and professional development of outstanding early-career scientists, and to help stimulate research careers in areas supported by the Planetary Sciences Division. This program is an ECA-participating ROSES program element. Proposals from eligible PIs, or Science PIs if applicable, selected from this program this year may become the 'parent award' for future ECA proposals.

4. Proposal Preparation, Submission, and Evaluation

4.1 Two-step proposals

This program element uses a two-step proposal submission process described in program element C.1, Section 2. Proposers are reminded that Step-1 proposals are mandatory and must be submitted by the proposing organization.

4.2 Proposal formatting and content

Proposals must follow all formatting requirements that are described in program element C.1 and Section IV(b)ii of the ROSES Summary of Solicitation. See program element C.1 for a discussion of the consequences of non-compliance.

Although proposals are expected to conform to all of the rules outlined above, proposers should be especially aware of the following ways to avoid common errors:

- Do not add an extra page containing the abstract prior to the main body of the proposal. The abstract is limited to the cover pages generated by NSPIRES.
- Do not add a table of symbols or abbreviations as an extra page beyond the 15-page Science/Technical/Management (STM) section. Such definitions must fit within the 15 pages.
- Do not describe team members' roles and responsibilities in the table of work effort or budget sections. Only list job titles in these sections.
- Do not put information on instrument calibration or performance in the Facilities and Equipment section beyond what is needed simply to describe the instrument. If such information is critical to the work, put it in the STM section.
- Do not include work statements from Co-Is in the budget sections covering sub-awards/subcontracts. These may only appear in the STM section.

- Do not set figure captions in a smaller typeface than the minimum permitted for the body text.

Also, we recommend, but do not require, the following practices for clarity in writing proposals:

- Please do not use numbered callouts to bibliographic references in the STM section. Use the author name(s) and year.
- There is no need to present budgets broken down by federal fiscal years. Budgets should be organized by award years.
- Place clear titles on all subsections of your budget.

4.3 Modular proposals

NASA has the option of funding only part of a proposal, if that part of the proposal receives a significantly better evaluation on intrinsic merit, relevance, or cost, or if only part of the overall project fits within the program budget. In order to be considered for this type of descoping, a proposal must be modular, with clearly identified (numbered), separable "tasks." A descopable task is a self-contained sub-project, which in and of itself is relevant to Emerging Worlds and of high scientific merit. Proposals that do not enumerate modular tasks will not generally be considered for descoped funding. Note that a proposal containing identified tasks does not require presentation of a separate budget for each task.

4.4 Evaluation of proposals

All proposals will be evaluated for Intrinsic Merit, Cost, and Relevance, as specified in Section VI(a) of the ROSES *Summary of Solicitation*.

5. Summary of Key Information

Expected program budget for first year of new awards	~$5M
Number of new awards pending adequate proposals of merit	~30, see Section 3.2
Maximum duration of awards	4 years; shorter-term proposals (1-3 years) are typical; fourth year must be well justified.
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA.
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	~6 months after Step-2 proposal due date
Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of the *ROSES Summary of Solicitation.*
Relevance	This program is relevant to the Planetary Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.

General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See C.1 the Planetary Science Research Program Overview, and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-EW
Point of contact concerning this program	Melissa Morris Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 774-8476 Email: HQ-EMERGINGWORLDS@mail.nasa.gov

C.3 SOLAR SYSTEM WORKINGS

NOTICE: Corrected September 2, 2020. The expected program budget for first year of new awards and number of new awards given in Section 5 have been corrected. New text is in bold and deleted text is struck through. Due dates remain unchanged, the due dates for proposals remain unchanged.

June 22, 2020. Subsection 4.2 has been clarified to remind proposers of the necessity for a letter of support for facilities not under the direct control of the PI or Co-I. New text is in bold and deleted text is struck through.

Amended February 27, 2020. Section 2.1 Exclusions has been changed to indicate that studies of lunar materials need not be restricted to active, ongoing processes to be in scope for this program element.

Proposals to this program element are subject to a relevance requirement in addition to and that supersedes that detailed in the ROSES *Summary of Solicitation*, see Section 2.5 of this program element. Proposals that do not fulfill this requirement may be returned without review.

1. Scope of Program

The Solar System Workings (SSW) program element supports research into atmospheric, climatological, dynamical, geologic, geophysical, and geochemical processes occurring on planetary bodies, satellites, and other minor bodies (including rings) in the Solar System. This call seeks to address the physical and chemical processes that affect the surfaces, interiors, atmospheres, exospheres, and magnetospheres of planetary bodies.

The Solar System Workings program is open to investigations relevant to surfaces and interiors of planetary bodies, planetary atmospheres, rings, orbital dynamics, and exospheres and magnetospheres. The Solar System Workings program values the potential of interdisciplinary efforts to solve key scientific questions. The program also values research in comparative planetology. Research supported by this call may cover a wide range of investigations including theoretical studies, data synthesis relevant to the physical and chemical processes affecting planetary systems, sample-based studies of extraterrestrial materials, laboratory studies that examine physical or chemical properties and processes, studies of sample or analog materials of other Solar System bodies, field studies of terrestrial analogs of planetary environments, and theoretical, analytical, and numerical modeling of physical or chemical processes.

This program seeks to understand processes that occur throughout the Solar System, as well as those specific to individual objects and systems, but inform our understanding of the fundamental processes at work. A non-exhaustive list of areas of research called for in this program element follows. For conciseness in this list, the term ‘planetary’ refers to Solar System objects other than the Sun (ranging in size from small objects,

like comets and asteroids, through natural satellites, and up to planets) and structures (such as atmospheres, ionospheres, and ring systems).

- Surfaces and Interiors
  - *Interior structure*. Determine the internal structure, chemistry, and dynamics of Solar System objects and identify and understand the physical and chemical processes that occur within these structures.
  - *Planetary magnetism*. Determine the configuration of planetary magnetic fields and understand how and why they are formed and vary through time. Catalog remnant magnetic fields in order to probe the history of planetary dynamos, as well as core-mantle structures and dynamics.
  - *Mantle Evolution.* Understand the chemical evolution and physical structure of mantles and how they change over time.
  - *Lithospheres*. Identify objects with evidence of active or ancient tectonics and understand the processes and inputs that cause tectonic activity to start or stop. Understand the role that regional and global stress fields play in the formation of large-scale surface features and how those features inform studies of the global structure and dynamics.
  - *Volcanism.* Identify the physical and chemical variations in volcanic activity throughout the Solar System. Investigate how volcanic activity can provide insight into interior processes. Understand how volcanic activity can modify planetary surfaces and atmospheres.
  - *Evolution and modification of surfaces.* Characterize and understand the chemical, mineralogical, and physical features of planetary surfaces (such as geologic formations and impact craters) and fluid inventories that interact with the surface (including hydrospheres, cryospheres, atmospheres, and other volatile reservoirs). Develop theoretical and experimental bases for understanding these features in the context of the varying conditions through time after formation.
- Planetary atmospheres
  - *Composition and evolution*. Characterize the chemical composition (including isotope and trace species) of planetary atmospheres and of atmospheric structures (such as haze layers). Understand the vertical mixing, convective profiles, and chemical processes that control the stability of, the losses from, and the evolution of planetary atmospheres. Determine where atmospheric composition deviates from that expected from solar-nebula material and understand alternative sources and their implications for atmospheric evolution.
  - *Dynamics and thermal structure*. Identify and investigate varied features of Solar System atmospheres, such as Venus' greenhouse effect and Martian dust storms. Accurately describe wind patterns and cloud features; determine their temporal variability, their role in heat and momentum transfer, and other atmospheric processes. Characterize vertical structure and the transport of mass and heat at all scales, including the effects of coupling with planetary surfaces and with the environment above the atmosphere.
  - *Climate change*. Characterize planetary climates over short and long time scales by reconstructing the history of atmospheric volatile inventories and understanding the chemical processes that affect them. Resolve the role that

atmospheric circulation, dynamics, surface (e.g., volcanic activity) and external (e.g., solar radiation) conditions, and disruptive events play in providing stability for, cyclic modulation of, or perturbations in the global climate. Compare climates and atmospheres among different planetary bodies at present and over time.

- Rings
  - *Composition and structure*. Determine the three-dimensional structure of ring systems and the effects that moons and moonlets have on them. Characterize the chemical and size composition of ring system particles, including transient, diffuse, and dust rings.
  - *Processes and evolution*. Understand the physical and chemical processes active in ring systems and the interactions these systems have with planetary atmospheres, magnetospheres, and planetary bodies. Model the effects these interactions have in order to identify temporal changes of the rings on short and long timescales.
- Orbital dynamics
  - *Orbital characteristics and evolution.* Understand the gravitational interactions among groups of planetary bodies (e.g., satellites of a planet, an asteroid family, planets and other Sun-orbiting objects) and how they affect orbital characteristics and stability. Characterize the non-gravitational forces acting on objects and understand their effect on orbital characteristics. Identify and characterize dust populations from planetary sources, and understand their dynamics within in the Solar System.
  - *Orbital relationships.* Characterize the creation, and understand the evolution, of asteroid families. Understand the effects of orbital relationships (such as orbital resonances between satellites) on planetary interiors, surfaces (including liquids and ices), and atmospheres.
- Plasma environments
  - *Fundamental plasma processes.* Understand the role that localized plasma waves and plasma processes (including reconnection and instabilities) have in regulating large-scale dynamics; characterize the energy that is produced and carried by these phenomena and how they couple distant regions.
  - *Sources and sinks of mass and energy*. Characterize the neutral and plasma sources in planetary magnetospheres (including induced magnetospheres), considering the contribution of internal sources (such as moons or rings), the solar wind, and planetary atmospheres (including cometary outgassing). Understand the relative importance of sources of charged and neutral particle energization. Characterize and understand the mass and energy exchange with other objects or structures (such as the planet, the solar wind, or rings) and the loss from the system.
  - *Magnetospheric processes and dynamics*. Characterize magnetospheric processes and dynamics; determine how they cause mass and energy to flow through the system and couple these processes to the ionosphere and solar wind. Identify similarities and differences in magnetospheric processes and dynamics between the planets. Determine the relative importance of dynamics driven by internal and external energy sources across the magnetospheres, and

understand how the different planetary magnetic field configurations affect these dynamics. Refine and exploit our understanding of electromagnetic radiation (e.g., auroral emissions and planetary radio signals) and particle emissions (e.g., dust streams and energetic charged and neutral particles) in order to remotely study dynamics and processes.

- *Plasma interactions with structures and bodies*. Determine mass and energy exchange with atmospheres and surfaces; understand the physical and chemical processes that this coupling may drive. Describe the interactions between the magnetospheric plasma and planetary objects, dust, and gas populations; characterize the energy flow and chemical processes within these coupled systems. Characterize the processes associated with space weathering and its effects on optical, spectroscopic, physical, and mechanical properties.

Due to the broad nature of this program's mandate, it is open to a wide range of targets of interest and methods of investigation, but only accepts scientific investigations. Each proposal must present a scientific investigation to be conducted, what data and resources will be used, the investigation's methodology, and how the investigation will achieve closure of the proposal's goals. Although this program encourages the utilization of data from planetary missions and studies that produce data products (e.g., cartographic products, calibration data, moments calculations) to inform science investigations, it does not accept proposals eligible for funding by the Data Analysis Programs or the Planetary Data Archiving, Restoration, and Tools Program (see Section 2.1).

2. Programmatic Information **[Amended February 27, 2020]**

2.1 Exclusions

Proposers are advised to read each of the calls listed below prior to submitting proposals and to contact the appropriate Points of Contact with any questions.

Early Solar System studies. Proposals to conduct research to understand the formation and early evolution of the Solar System should be submitted to program element C.2, Emerging Worlds. The scope of Solar System Workings covers processes that occur after this period. For evolved bodies, Solar System Workings focuses on processes occurring after the end of global planetary differentiation; for primitive bodies, the focus is on processes that were not mainly active in the early Solar System. Processes that occur on regional or local scales on planetary bodies (such as impact cratering) are generally covered by Solar System Workings, even if they resulted in localized magmatism and/or differentiation.

Studies of Habitability. Research aimed at investigating the habitability of planetary bodies in our Solar System or in other planetary systems should be submitted to the Habitable Worlds program element (E.4).

Lunar Materials. **For studies of the Moon, sample-based and experimental studies of the chemical, petrological, and isotopic properties of lunar materials might be relevant to Solar Systems Workings (see above) or Emerging Worlds, but proposals for the same, or essentially the same, work may not be submitted to both program elements (see Appendix C.1, Planetary Overview).** ~~For studies of the~~

~~Moon, sample-based and experimental studies of the chemical, petrological, and isotopic properties of lunar materials should be submitted to program element C.2, Emerging Worlds. However, if the study is focused primarily on active, ongoing processes on the Moon, the proposal remains within the scope of SSW.~~

Mission Data Analysis. NASA solicits proposals that use, analyze, and/or enhance the scientific return of certain planetary missions through its Data Analysis Programs (DAPs). Solar System Workings does not accept proposals that are eligible for submission to a DAP. The DAP program elements should be consulted prior to the submission of any proposal that uses planetary mission data. If a proposal is not appropriate for any Data Analysis program element and does fit within the bounds of Solar System Workings, submission to this program element is encouraged.

Studies of Exoplanets. Proposals to understand exoplanetary systems are not supported by this program element. Those with ties to observational studies or future NASA missions (either directly or indirectly) should be submitted to the Exoplanet Research Program (see program element E.3 for further clarification and restrictions).

Earth Science Studies. Investigations that focus primarily on the Earth are not appropriate for the Solar System Workings program element; research opportunities supporting the Earth Science Research Program may be found in Appendix A of this ROSES solicitation. However, comparative studies of planetary bodies that apply investigations such as those listed in Section 1 of this call to Earth and one or more other planets, or investigations that use Earth as an analog to another body in our Solar System, are appropriate for this program element.

Data archiving, restoration, and tools. Proposals to Solar System Workings must include a science investigation. Proposals to produce a higher-order data product that enhances the science return from one or more missions, but does not include a science investigation, should be submitted to program element C.4, Planetary Data Archiving, Restoration, and Tools (PDART).

Observations. Solar System Workings does not fund ground- or space-based surveys, but proposals that include analysis and interpretation of existing observations of Solar System objects may be submitted to this program. Observational proposals that are within the scope of the Solar System Observations program (which must have new observations within our Solar System as a primary element) should be submitted to Solar System Observations (program element C.6).

2.2 Duration of Awards

Typical proposals to Solar System Workings seek three years of funding or fewer. Please refer to program element C.1, Section 3.3, for instructions on submitting requests for more than three years. Pilot studies and projects to demonstrate or develop a new technique or a new application of an established technique, usually for less than three years in duration, may also be proposed.

2.3 Additional Funding for Relevant Instrumentation Construction or Upgrade

Proposers to Solar System Workings are eligible to request funds for major equipment under the Planetary Major Equipment and Facilities (PMEF) program. See program element C.17 for information on how to append a PMEF request to a regular Solar

System Workings research proposal or submit a stand-alone PMEF proposal to supplement an existing Solar System Workings award.

2.4 Planetary Science Division Early Career Award Program

Details of the new Planetary Science Early Career Award (ECA) program are given in program element C.19. The aim of this program is to support research and professional development of outstanding early-career scientists, and to help stimulate research careers in areas supported by the Planetary Sciences Division. This program is an ECA-participating ROSES program element. Proposals from eligible PIs, or Science PIs if applicable, selected from this program this year may become the 'parent award' for future ECA proposals.

2.5 Relevance Statement Requirement

Proposals to this program must discuss relevance in a (4000-character max) text box on the cover pages via the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) web interface for this program element. This section is outside of the 15-page Scientific/Technical/Management section and the relocation of the relevance discussion does not decrease that 15-page limit. This requirement supersedes the *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation*, and the omission of this section is sufficient reason for a proposal to be returned without review. The relevance of the proposal no longer needs to be discussed within the 15-page Scientific/Technical/Management section.

The relevance discussion must explicitly refer to this program element and the section of the program element to which the proposal is responsive. If the proposed work is close in scope to research covered by any other program element, this discussion must also justify why it is more relevant to this program element than that other program element. This discussion may not be used to address the proposal's intrinsic merit, budget justification, or any other factor that remains in the 15-page main body, or any other section, of the proposal.

3. Proposal Submission Process and Formatting

This program element requests a Notice of Intent (NOI) by the due date given in Tables 2 and 3 of this ROSES NRA. An NOI is not required in order to be eligible to submit a full proposal. Proposals must be submitted by the due date given in Tables 2 and 3 of this NRA.

Proposals must follow all formatting requirements that are described in program element C.1 and Section IV(b)ii of the ROSES Summary of Solicitation. Violation of these rules is sufficient grounds for a proposal to be rejected.

4. Resources: Information, Data, and Facilities

4.1 Limits on Use of Mission Data

Proposals to this program element must follow the rules for use of mission data given in program element C.1, Section 3.4. If the data to be analyzed have issues that might represent an obstacle to analysis, the proposers must demonstrate clearly and satisfactorily how such potential difficulties will be overcome.

4.2 Facilities and Data Sources Available to Proposers **[Clarified June 22, 2020]**

Please refer to ROSES program element C.1, Section 4, for a detailed list of the data and astromaterials resources, and facilities available to proposers to this program element, and how to use them. If their use is anticipated, this should be discussed and justified in the submitted proposals (especially note the provision for such discussion in the proposal section entitled Facilities and Equipment). Also note that, per the directions in **Section 3.17 of** the *NASA Guidebook for Proposers* **and Table 1 of the *ROSES Summary of Solicitation*, any facility or resource not under the direct control of the PI or a Co-I requires a letter of support acknowledging that it is available for the proposed use during the proposed period.** ~~a letter of support may be required from any facility required for the proposed effort.~~

4.3 Data Management Plans (DMPs)

Proposals submitted to this program element must include a Data Management Plan (see program element C.1, Section 3.6). This must be placed in a special section, no longer than two pages in length, that immediately follows the References and Citations section for the Scientific/Technical/Management portion of the proposal.

4.4 Geologic Maps

Proposers who plan investigations involving geologic mapping should consult program element C.1, Section 3.8, for guidance on submission and requirements for publication of U.S. Geological Survey (USGS) maps. The scientific goal of such a geologic map product should be clearly explained and justified.

4.5 Antarctica

The Solar System Workings program is accepting proposals for work in Antarctica.

For projects that require Antarctic fieldwork, proposers must include all costs associated with this fieldwork in their proposal budgets.

For Antarctic fieldwork supported by the United States Antarctic Program (USAP), these costs include those required for physical qualification exams, airfare, lodging, and per diem for travel to Christchurch, New Zealand (departure point for Antarctica, include seven days in Christchurch as margin for weather-related delays), any required cargo transportation (origin to Pt. Heuneme, California, and return), and any specialty materials or large quantities of stocked materials required in Antarctica. Proposers must also include costs associated with logistics support provided by the USAP via the National Science Foundation (NSF).

To obtain these costs, complete an Antarctic Logistics Requirements and Field Plan, and return to Jessie Crain, Antarctic Research Support Manager jlcrain@nsf.gov. Requirements for this document, and other guidance for conducting field work in the Antarctic, are may be found at: https://www.nsf.gov/geo/opp/ant/solicitation_resources/prop_prep_info.jsp. Please allow one month for processing to receive the USAP cost estimate. Projects receiving U.S. Antarctic Program support for fieldwork in the Antarctic shall include the following acknowledgement in publications resulting from the project: "Logistical support for this

project in Antarctica was provided by the U.S. National Science Foundation through the U.S. Antarctic Program".

5. Summary of Key Information

Expected program budget for first year of new awards	~~$9-10M~~ **$7.5M [Corrected September 2, 2020]**
Number of new awards pending adequate proposals of merit	~~50-70~~ ~**45 [Corrected September 2, 2020]**
Maximum duration of awards	4 years; shorter-term proposals (1-3 years) are typical; fourth year must be explicitly and well justified.
Due date for NOIs	See Tables 2 and 3 of this ROSES NRA.
Due date for proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	~6-8 months after proposal due date
Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of the ROSES *Summary of Solicitation*.
Relevance	This program is relevant to the planetary science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA. See Section 2.5 of this program element for special relevance requirements.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See C.1 the Planetary Science Research Program Overview, and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-SSW

Points of contact concerning this program, all of whom share the following email and postal address: hq-ssw@mail.nasa.gov Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001	Email to hq-ssw@mail.nasa.gov is strongly preferred. Delia Santiago-Materese Email: delia.santiago-materese@nasa.gov Adrian Brown Email: adrian.j.brown@nasa.gov Lucas Paganini Email: lucas.paganini@nasa.gov Henry Throop Email: henry.throop@nasa.gov Shoshana Weider Email: shoshana.weider@nasa.gov

C.4 PLANETARY DATA ARCHIVING, RESTORATION, AND TOOLS

NOTICE: June 22, 2020. Subsection 4.2 has been clarified to remind proposers of the necessity for a letter of support for facilities not under the direct control of the PI or Co-I. New text is in bold and deleted text is struck through.

Amended June 4, 2020. This amendment delays the Step-2 proposal due date for this program element. The due date for Step-2 proposals is now July 24, 2020.

Updated, April 21, 2020. The Point of Contact for this program element has been updated. Please send all email regarding this program element to HQ-PDART@mail.nasa.gov.

This program element continues to use a two-step proposal submission process described in Section 2 of C.1 The Planetary Science Division Research Program Overview.

Data Management Plans will not be collected via the NSPIRES web pages for this element. Instead they an integral part of the proposal and evaluated as part of the merit, see Section 2.6.

Proposals to this program element are subject to a relevance requirement in addition to and that supersedes that detailed in the ROSES *Summary of Solicitation*, see Section 2.1 of this program element. Proposals that do not fulfill this requirement may be returned without review.

1. Scope of Program

1.1 Programmatic Overview

The Planetary Data Archiving, Restoration, and Tools (PDART) program solicits proposals to generate higher-order data products, archive and restore data sets or products, create or consolidate reference databases, generate new reference information, digitize data, and develop or validate software tools.

The objective of this program element is to increase the amount and quality of digital information and data products available for planetary science research and exploration, and to produce tools that would enable or enhance future scientific investigations. Although it is expected that a small amount of data analysis, interpretation, or modeling may be performed to validate any generated products, this program element does not accept proposals in which the main focus is hypothesis-based planetary science.

For all types of proposals, the products of selected proposals must be made available to the scientific community. Data products must be archived in the NASA Planetary Data System (PDS) or an equivalent archive (see Section 2.2 for a definition of an equivalent archive). All proposals will be evaluated on the perceived impact of the new products, datasets, or tools on future planetary science research and exploration.

Proposers to this program element will not provide a data management plan via the NSPIRES cover pages or as a two-page addendum. Instead, that is superseded by

instructions in the sections below that place more detailed descriptions into the body of the Scientific/Technical/Management section of proposals.

1.2 Data Product Generation

Proposals to generate new high-order data products or to improve or expand current high-order data products are encouraged. Source data may be derived from NASA or other spaceflight missions, astronomical observations, sample analyses, or other sources. These new data products may include, but are not limited to, cartographic products and calibrated or corrected datasets.

1.3 Data Set Restoration and Archiving

Proposals to archive complete datasets and/or to restore and archive incomplete datasets (e.g., to reextract, rereduce, and/or recalibrate data to fill in fragmentary datasets) will be considered. Such proposals must include: 1) an archiving plan (see Section 4.3); 2) a description of how the data will be obtained; 3) a detailed plan for how the data will be restored, if relevant; and 4) a description of documentation, calibration data, and related software necessary to read and interpret the original and new datasets.

1.4 Reference Database Creation

Proposals that create and/or consolidate reference databases useful for planetary science research will be considered. These databases may include, but are not limited to, spectral libraries, chemical and physical properties of materials, and photographic catalogs. The burden is on the proposal to demonstrate the demand for a proposed database and its likelihood of advancing the current state of knowledge or resolving a significant planetary question or problem.

1.5 Generation of New Reference Information

Proposals to make laboratory measurements, conduct experiments, or otherwise generate new reference information that is intended for general use in planetary science will be considered. Examples may include, but are by no means limited to, spectral data, phase diagrams and equations of state, physical laws, optical constants, partition coefficients, and thermodynamic properties of materials. Where the main product of the proposal is a reference dataset, the proposal must include a plan to deposit the data in the NASA PDS or an equivalent archive. The burden is on the proposal to demonstrate the demand for a proposed reference product and its likelihood of advancing the current state of knowledge or resolving a significant planetary question or problem.

1.6 Data Digitization

Proposals to recover datasets that currently are available only on media not readable by modern computing equipment, or to digitize data that are only available in analog form (e.g., printed matter, photographs, and manuscripts) will be considered. PDART will consider proposals that include the rental of specialty equipment and/or the hiring of independent expertise to accomplish those tasks. Regardless of the method, the proposal must demonstrate the capability and provide a plan to recover or digitize the data. The burden is on the proposal to demonstrate the demand for the digitized product

and its likelihood of advancing the current state of knowledge or resolving a significant planetary question or problem.

1.7 Software Tool Development and Validation

Proposals to develop and disseminate software tools that facilitate the use of existing datasets or that would enable or enhance future science investigations of interest to the Planetary Science Division will be considered. PDART does not support extensive application of these tools, but it is expected that the validity of the tools will be demonstrated during the course of the proposed work. Proposals are expected to include a plan to disseminate the tools for use by the planetary community. In addition to any other dissemination mechanisms, investigators developing software tools are required to archive the source code, and all relevant documentation, at NASA's PSD Github site (https://github.com/NASA-Planetary-Science). It is expected that user interfaces and/or executables will be made publicly available at no cost. Accordingly, awards made under this program element will contain a "Rights in Data" clause reflecting this expectation.

This program element will also accept proposals to fund the development or enhancement of numerical models, with the expectation that the funded model will be made publicly available. In these instances, the proposal will be judged on 1) how the enhancement would result in an improvement in the results previously produced by this or similar models, and 2) how the enhancement would enable scientific investigations not currently possible with, or improve investigations relative to, models currently in use.

2. Programmatic Information

2.1 Relevance Statement Requirement

Step-2 proposals to this program element must discuss relevance in a (4000-character maximum) text box on the cover pages via the NSPIRES web interface for this program element. This section is outside of the 15-page Scientific/Technical/Management Section and the relocation of the relevance discussion does not decrease that 15-page limit. This requirement supersedes the *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation*, and the omission of this discussion is sufficient reason for a proposal to be returned without review.

The relevance discussion must explicitly refer to the objectives of this program element and the section of this appendix to which the proposal is responsive. If the proposed work is close in scope to research covered by any other program element, this discussion must also justify why it is more relevant to this program element than that other program element. This discussion may not be used to address the proposal's intrinsic merit, budget justification, or any other factor that remains in the 15-page main body, or any other section, of the proposal.

2.2 Merit Evaluation Criterion

As PDART's goals differ from other programs, the review of proposals submitted to this program element will include merit factors not listed in the *NASA Guidebook for Proposers*. In addition to the *Guidebook* criteria, all submitted proposals will be evaluated on the following PDART-specific merit factors:

1. The perceived impact of the new products, datasets, or tools on future planetary science research and exploration. This factor includes an evaluation of the proposal's end products against the state-of-the-art and the demand for the proposed product.
2. The uniqueness and/or time criticality of the proposed new products, datasets, or tools. For this factor, historical significance may also be considered but cannot be the sole justification for the effort.
3. The credibility of the proposed plan for dissemination and archiving. This factor includes both the format that the data products/tools would be in and how they would be made available for the scientific community. For those proposals that would use an archive other than NASA's PDS or Github sites, this factor includes an evaluation of whether the repository is a PDS-equivalent archive (Section 2.3).
4. Any applicable factors described in Sections 1.2-1.7.

2.3 Definition of a PDS-equivalent archive

Equivalence of an archive to the NASA PDS is defined by a number of factors that cover accessibility, reliability, usability, and other qualities.

Proposed archives are required to have the following features:

1. The Archive shall be managed by someone other than the major data provider. (Independence)
2. The Archive shall be managed for the long-term (25 years at least). (Sustainability)
3. The Archive shall be accessible to the public (lay and scientific) without preapproval. (Open Accessibility)
4. The Archive shall ensure that data are searchable. (Searchability)
5. The Archive shall ensure that data are citable. (Citability)
6. The Archive shall be considered by its user community as the "standard" archive for the subfield. (Preeminence)
7. The Archive shall require that data products be submitted in standardized formats and file types. (Standardization)

Proposed archives are preferred (but not required) to have the following features:

1. The Archive should conduct independent peer reviews of data to assess usability and completeness of data packages. (Peer Review)
2. The Archive should include documentation for its holdings such as user guides, calibration descriptions, etc. (Documentation).

The following are some examples of PDS-equivalent archives: The HIgh-resolution TRANsmission molecular absorption database (HITRAN), Infrared Processing and Analysis Center (IPAC) Infrared Science Archive (IRSA), NASA Space Science Data Coordinated Archive (NSSDCA), Coordinated Data Analysis Web (CDAWeb), Minor Planet Center (MPC). In addition, the PDS imaging node annex (PDS IMG annex) is considered by PDART to be PDS-equivalent for certain geospatial products which cannot be ingested into the PDS. If a proposed work effort would deliver data products to an archive other than PDS or one of those listed here, the proposal must demonstrate that it meets the requirements above.

2.4 Exclusions

PDART does not support scientific investigations whose primary emphasis is data analysis, fundamental planetary research, or instrument development. Proposers are encouraged to consult C.1 Planetary Science Research Program Overview for the appropriate program element to which they should submit.

Proposals whose primary focus is on data to be used in investigations solicited by the Astrophysics, Heliophysics, or Earth Science Divisions are encouraged to consult Appendices D, B, and A respectively for information on the appropriate program elements to which they should be submitted.

The PDART element does not fund proposals primarily to acquire new ground- or space-based observations or surveys; such proposals should be submitted to the Solar System Observations program (see program element C.6).

Investigators funded by spaceflight missions who wish to apply to this program element must clearly demonstrate in their proposal how the proposed research does not overlap and is not redundant with duties or responsibilities already funded by their respective mission(s). See C.1, The Planetary Science Division Research Program Overview, for more information.

Proposals for topical conferences, workshops, or symposia related to this program element may not be proposed through this program element. Proposers are encouraged to pursue such submissions through ROSES E.2 Topical Workshops, Symposia, and Conferences.

2.5 Duration and Size of Awards

The maximum funded duration of awards from C.4 is three years. Proposals for funding of less than three years are highly encouraged for projects that can be completed on shorter timescales. The appropriateness of the proposed funding period will be reviewed, and adjustments may be requested.

The 2019 PDART selections are posted to the spreadsheet on the SARA grant stats web page. The average year-one award size in PDART is ~$130K, but the award sizes for this program span a wider-than-typical range, depending on the nature of the work. Proposers are encouraged to request what is actually needed to conduct the proposed work. As always, the number of new awards will also depend on the available budget.

2.6 Data Management Plans (DMPs)

Because data archiving is an integral part of PDART and evaluated as part of the merit, a data management plan should be integrated as part of the Science/Technical/Management portion of the proposal, no additional DMP section is required for this program element.

2.7 Additional Funding for Relevant Instrumentation Construction or Upgrade

Proposers to PDART are eligible to request funds for major equipment under the Planetary Major Equipment and Facilities (PMEF) program. See program element C.17 for information on how to append a PMEF request to a regular PDART proposal or submit a stand-alone PMEF proposal to supplement an existing PDART award.

2.8 Planetary Science Early Career Award

Details of the new Planetary Science Early Career Award (ECA) program are given in program element C.19. The aim of this program is to support research and professional development of outstanding early-career scientists, and to help stimulate research careers in areas supported by the Planetary Sciences Division. This program is an ECA-participating ROSES program element. Proposals from eligible PIs, or Science PIs if applicable, selected from this program this year may become the 'parent award' for future ECA proposals.

3. Proposal Submission Process

This program element uses a two-step proposal submission process described in C.1, Section 2.

Proposers are reminded that Step-1 proposals are mandatory and must be submitted by the proposing organization.

Proposals must follow all formatting requirements that are described in program element C.1 and Section IV(b)ii of the ROSES Summary of Solicitation. Violation of these rules is sufficient grounds for a proposal to be rejected.

4. Resources: Information, Data, and Facilities

4.1 Limits on Use of Data

For proposals that generate higher-order data products from NASA mission or NASA instrument data or otherwise use such data in the development or testing of software, the data to be used in proposed investigations must be available in the Planetary Data System (PDS) or equivalent publicly accessible archive at least 30 days prior to the proposal submission date. Spacecraft data that have not been obtained yet (i.e., future mission data) or those that have not been accepted for distribution in approved archives are not eligible for use in investigations. Regardless of the archive(s) used, if the data to be analyzed have issues that might represent an obstacle to analysis, the proposers must demonstrate clearly and satisfactorily how such potential difficulties will be overcome. This 30-day rule does not apply to unarchived data from missions prior to the creation of the PDS if the dataset in question will be archived to PDS through the proposed project.

Proposals to digitize and/or archive data not currently available in a public archive must demonstrate that the data to be used are available (such as a letter of support, if they are owned by a private entity, or a detailed plan to locate and obtain the data from a known repository), in a format suitable for the proposed work, and of sufficient quality to achieve the goals set forth in the proposal. The proposal should further demonstrate a familiarity with the data and an understanding of the work required to prepare the data for future analysis and/or delivery to an appropriate public archive.

4.2 Facilities and Data Sources Available to Proposers **[Clarified June 22, 2020]**

Proposers are strongly advised to read C.1 The Planetary Science Division Research Program Overview, for information on facilities and data sources that are available to supported investigators. If their use is anticipated, this should be discussed and justified

in the submitted proposals (especially note the provision for such discussion in the proposal section entitled Facilities and Equipment). Also note that, per the directions in **Section 3.17 of** the *NASA Guidebook for Proposers* **and Table 1 of the *ROSES Summary of Solicitation*, any facility or resource not under the direct control of the PI or a Co-I requires a letter of support acknowledging that it is available for the proposed use during the proposed period.** ~~a letter of support may be required from any facility required for the proposed effort~~.

4.3 Data Archiving and Map Publication

Selected investigations are expected to result in data products or tools that are of broad use to the science community, including maps, data with improved calibrations, *etc*. PDART requires that data produced by selected investigations be archived in the Planetary Data System (http://pds.nasa.gov/), or a PDS-equivalent archive, by the end of the award period. Proposers should communicate with the PDS Discipline Node responsible for curating similar data (links to the PDS Discipline Nodes are at http://pds.nasa.gov/) to discuss procedures and requirements prior to proposing and to help with discerning the most efficient way to archive the proposed data products. Proposers intending to archive data or products in the PDS must obtain and include a letter of confirmation from the appropriate Discipline Node that the PDS is willing to accept their submission. It is the proposer's responsibility to conform to PDS standards. All PDS submissions are required to be in PDS4 format; if an exception is needed, please contact the lead discipline scientist before submission to discuss.

Proposed investigations of any planetary or satellite surface that are intended to result in the publication of a Scientific Investigations Map (SIM) by the U.S. Geological Survey (USGS) should check the relevant box on the proposal Cover Page and clearly indicate this intention in the Proposal Summary, as well as in the text of the proposal. Investigators that intend to produce a USGS geologic map are required to include in their Step-2 (full) proposal a confirmation of technical specification document obtained from the USGS Map Coordinator. Proposers are advised to read C.1, The Planetary Science Division Research Program Overview, for the USGS's information on and requirements for map production and publication.

5. Summary of Key Information

Expected program budget for first year of new awards	~$2.4-2.8M
Number of new awards pending adequate proposals of merit	See Section 2.5
Maximum duration of awards	3 years
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA.
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	~8 months after proposal due date.
Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of the ROSES *Summary of Solicitation.*

Relevance	This program is relevant to the Planetary Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA. See Section 2.1
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See C.1 the Planetary Science Research Program Overview, and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-PDART
Point of contact concerning this program element **[Changed April 21, 2020]**	**Please send all email to: HQ-PDART@mail.nasa.gov** K.C. Hansen Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1077 Email: kenneth.hansen@nasa.gov

C.5 EXOBIOLOGY

NOTICE: Corrected February 20, 2020. Sections 1 and 2.2 have been edited to indicate that proposals on the formation of complex organic molecules in space and their delivery to planetary surfaces are allowed. Deleted text is struck through.

This program element requests a Notice of Intent (NOI) in place of a Step-1 proposal. These NOIs will not be evaluated and, therefore, no response will be provided to a submission of an NOI. NOI and proposal due dates are given in Tables 2 and 3 of ROSES.

PIs of awards from this program element may become members of the newly established Astrobiology Program Research Coordination Networks that are relevant to their selected research. For more information, see Section 2.12 of this program element.

New in ROSES-20: Topics regarding formation of organics and their delivery to planetary surfaces are within scope of Exobiology, provided that the research is focused on the origin of life, as described in Section 1 below. Topics regarding formation of organics that do not focus on origins of life may be more appropriate for Emerging Worlds (C.4 see Section 2.2). As detailed in C.1 Planetary Overview, Section 3.2, there is a prohibition on duplicate proposals, so proposers who are not sure about which program is appropriate for their proposal are encouraged to consult the relevant Program Officers.

Proposals to this program element are subject to a relevance requirement in addition to and that supersedes those detailed in the ROSES *Summary of Solicitation*, see Section 2.6 of this program element. Proposals that do not fulfill these requirements may be returned without review.

1. Scope of Program

The goal of NASA's Exobiology is to understand the origin, evolution, distribution, and future of life in the Universe. Research is centered on the origin and early evolution of life, the potential of life to adapt to different environments, and the implications for life elsewhere. This research is conducted in the context of NASA's ongoing exploration of our stellar neighborhood and the identification of biosignatures for *in situ* and remote sensing applications. For further information on the science scope of Astrobiology, within which exobiology is located, please refer to the Astrobiology Strategy which can be found on the Astrobiology web page https://astrobiology.nasa.gov/research/astrobiology-at-nasa/astrobiology-strategy/.

The areas of research emphases in this solicitation are as follows:

- Prebiotic Evolution

Research in the area of prebiotic evolution seeks to delineate the galactic and planetary conditions conducive to the origin of life. Topics of interest include the formation of complex organic molecules in space and their delivery to planetary surfaces, the forms in which prebiotic organic matter has been preserved in planetary materials, and

determining what chemical systems could have served as precursors of metabolic and replicating systems on Earth and elsewhere, including alternatives to the current DNA-RNA-protein basis for life. This would also include models of early environments on the Earth in which organic chemical synthesis could occur. Laboratory and theoretical, as well as related data-analysis, studies will be considered.

Topics not included are the formation and stability of habitable planets, ~~the formation of complex organic molecules in space and their delivery to planetary surfaces~~ **[corrected 02/20/2020]**. Proposals on these topics should be submitted to C.2 Emerging Worlds.

- Early Evolution of Life and the Biosphere

The goal of research into the early evolution of life and the biosphere is to determine the nature of the most primitive organisms and the environment in which they evolved. The opportunity is taken to investigate two natural repositories of evolutionary history available on Earth: the molecular record in living organisms and the geological record. These paired records are used to: (i) determine when and in what setting life first appeared and the characteristics of the first successful living organisms; (ii) understand the phylogeny and physiology of microorganisms, including extremophiles, whose characteristics may reflect the nature of primitive environments; (iii) determine the original nature of biological energy transduction, membrane function, and information processing, including the construction of artificial chemical systems to test hypotheses regarding the original nature of key biological processes; iv) investigate the development of key biological processes and their environmental impact; v) investigate the evolution of genes, pathways, and microbial species subject to long-term environmental change relevant to the origin of life on Earth and the search for life elsewhere; and vi) study the coevolution of microbial communities, and the interactions within such communities, that drive major geochemical cycles, including the processes through which new species are added to extant communities.

- Evolution of Advanced Life

Research associated with the study of the evolution of advanced life seeks to determine the biological and environmental factors leading to the origin of eukaryotes and the development of multicellularity on Earth and the potential distribution of complex life in the Universe. This research includes studies of the processes associated with endosymbiosis and the origin and early evolution of those biological factors that are essential to multicellular life, such as developmental programs, intercellular signaling, programmed cell death, the cytoskeleton, cellular adhesion control and differentiation, in the context of the origin of advanced life.

Proposals aimed at investigation into evolution of individual taxa or properties specifically of advanced multicellular life (e.g. neural systems, bipedalism, intelligence) are not solicited at this time.

- Large scale environmental change and Macro-evolution

Research associated with the study of the macro-evolution of life on Earth includes an evaluation of environmental factors such as the influence of latitudinal differences or extraterrestrial (e.g., bolide impacts, orbital and solar variations, gamma-ray bursts, etc.) and planetary processes ("Snowball Earth" events, rapid climate change, etc.) on the large-scale evolution of life on Earth. Of particular interest are mass extinction events.

- Biosignatures and Life Elsewhere

Research in this area focuses on relating what is known about the origin of life on Earth to the potential for the origin and establishment of life under conditions prevailing on other planetary bodies and basic research on the formation and retention of biosignatures under non-Earth conditions (e.g., Mars, Europa). This includes studies that constrain or extend concepts of possible chemical evolution relevant to the origin, evolution, and distribution of life. As part of the focus on biosignatures, this area includes research on the forms in which prebiotic organic matter formed on planetary surfaces has been preserved and the range of planetary environments amenable to life. Additionally, research focused on defining, understanding or characterizing "technosignatures" as specific types of biosignatures indicative of intelligent life are included in this area. However, since the Exobiology Program does not solicit proposals to apply biosignatures to particular environments, proposals to search for technosignatures are not included.

Biosignature studies of samples from Earth sites thought to be analogues of other planetary environments that might potentially harbor life will be considered as part of NASA's broader interest in the search for life in the Universe.

2. Programmatic Information

2.1 General Information

Proposals are sought for new projects within the scope of the Exobiology program. Proposals submitted in response to this program element should be for new work that is not currently supported by the program or for investigations that would extend to their next logical phase those tasks that have been funded in the Exobiology program, but whose periods of performance expired in the last year or are expiring in the first half of this year.

Although there is a place in the program for exploration of novel and relevant environments, selection preference will be given to hypothesis-driven research projects.

2.2 Program Exclusions

Research aimed at investigating the habitability of planetary bodies in our Solar System other than Earth or in other planetary systems should be submitted to the Habitable Worlds program (C.22).

Proposals focused on the formation and stability of habitable planets ~~and the formation of complex organic molecules in space and their delivery to planetary surfaces~~ should be submitted to the Emerging Worlds program (C.2) **[corrected 02/20/2020]**.

Proposals aimed at the identification and characterization of radio signals from extrasolar planets that may harbor intelligent life are not solicited at this time.

2.3 Pilot Studies

Proposals for one to two-year pilot studies to demonstrate or develop a new technique or a new application of an established technique are encouraged. Such proposals may also include the demonstration of a technique new to the proposer, but not new to the field in general.

2.4 Additional Funding for Relevant Instrumentation Construction or Upgrade

Proposers to Exobiology are eligible to request funds for major equipment under the Planetary Major Equipment and Facilities (PMEF) program. See program element C.17 for information on how to append a PMEF request to a regular Exobiology research proposal or submit a stand-alone PMEF proposal to supplement an existing Exobiology award.

2.5 Development of Astrobiology Instruments

This solicitation does not request proposals for the development of advanced instrument concepts and technologies as precursors to astrobiology flight instruments. Such proposals should be submitted to the Planetary Instrument Concepts for the Advancement of Solar System Observations (PICASSO; see program element C.12) Program (for technology readiness levels [TRLs] 1-3+) or the Maturation of Instruments for Solar System Exploration (MatISSE; see program element C.13) Program (for TRLs 4-6). Proposals for science-driven field campaigns that are expected to produce new science results, as well as new operational or technological capabilities, should be submitted to the Planetary Science and Technology from Analog Research (PSTAR) program (see program element C.14).

2.6 Relevance Statement Requirement

Proposals must discuss relevance to this program element in a (4000-character max) text box on the cover pages via the NSPIRES web interface for this program element. This section is outside of the 15-page Scientific/Technical/Management Section and the relocation of the relevance discussion does not decrease that 15-page limit. This requirement supersedes the *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation*, and the omission of this section is sufficient reason for a proposal to be returned without review.

The relevance discussion must explicitly refer to this program element and the section of the solicitation to which the proposal is responsive. If the proposed work is close in scope to research covered by any other program element, this discussion must also justify why it is more relevant to this program element than that other program element. This discussion may not be used to address the proposal's intrinsic merit, budget justification, or any other factor that remains in the 15-page main body, or any other section, of the proposal.

2.7 Duration of Awards

Typical proposals to Exobiology seek three years of funding or fewer. Please refer to Section 3.4 of C.1, the Planetary Science Research Program Overview, for instructions on submitting requests for more than three years. The appropriateness of the proposed funding period will be reviewed, and adjustments may be requested. Programmatic balance may limit the opportunities for funding in some areas.

2.8 Topical Workshops, Symposia, and Conferences

The Exobiology program does not accept proposals for topical conferences, workshops, or symposia; such proposals may be submitted in response to program element E.2 Topical Workshops, Symposia, and Conferences. Proposers should specifically identify

the Exobiology program as the relevant SMD program element and refer to the goals and objectives of the Exobiology program in demonstrating relevance.

2.9 Planetary Science Division Early Career Fellowship Program

See program element C.21 for the application process for the New Early Career Fellowship Program in the Planetary Science Division. Early Career Fellowship applications will now be submitted as stand-alone proposals rather than tied to the submission of a parent science proposal.

2.10 NASA Postdoctoral Program Fellows

Grantees in the program are eligible to serve as mentors to NASA Postdoctoral Program (NPP) Fellows. The tenure of a Fellow must begin before the end of the Exobiology award – with at least two years of funding remaining on the parent award - but may extend beyond it. Proposals from potential Fellows must be submitted through the standard NPP process. The Astrobiology Program expects to select no more than three Fellows associated with Exobiology research this year. More information about the NASA Postdoctoral Program may be found at http://npp.usra.edu/.

2.11 Antarctica

The Exobiology Program is not accepting proposals for work in Antarctica.

2.12 Research Coordination Networks (RCNs)

PIs of proposals selected for funding from this program element that cover a research topic related to the newly established Research Coordination Networks are eligible to elect to become members of the Steering Committees of these RCNs (For more information, see: https://astrobiology.nasa.gov/news/astrobiology-program-faqs/). Relevance to an RCN is not an evaluation criterion for proposals to this program element, and eligibility for participation in an RCN does not indicate that additional research funding will be provided. RCNs bring together scientists from many disciplines with different objectives. The goals of the currently active RCNs are:

- NExSS: to investigate the diversity of exoplanets and to learn how their history, geology, and climate interact to create the conditions for life. (For more information see https://nexss.info/.)
- NfoLD: to investigate life detection research, including biosignature creation and preservation, as well as related technology development. (For more information see https://nfold.org.)
- PCE_3: to investigate the delivery, synthesis, and fate of small molecules under the conditions of the Early Earth, and the subsequent formation of proto-biological molecules and pathways that lead to systems harboring the potential for life. (For more information see http://prebioticchem.info/)
- NOW: to advance comparative studies to characterize Earth and other ocean worlds across their interiors, oceans, and cryospheres; to investigate their habitability; to search for biosignatures; and to understand life—in relevant ocean world analogues and beyond. (For more information see: https://oceanworlds.space)

Information about the additional RCNs that are being established can be found here: https://astrobiology.nasa.gov/news/how-many-astrobiology-research-coordination-networks-will-be-established/

3. Resources: Information, Data, and Facilities

3.1 Limits on Use of Mission Data

Proposals to this program element must follow the rules for use of mission data given in section 3.4 of C.1, the Planetary Science Research Program Overview. If the data to be analyzed have issues that might represent an obstacle to analysis, the proposers must demonstrate clearly and satisfactorily how such potential difficulties will be overcome.

3.2 Facilities and Data Sources Available to Proposers

Refer to Section 4 of C.1, the Planetary Science Research Program Overview, for a detailed list of the data and astromaterials resources, and facilities available to proposers to this program element, and how to use them. If their use is anticipated, this should be discussed and justified in the submitted proposals (especially note the provision for such discussion in the proposal section entitled Facilities and Equipment). Also note that, per the directions in the *NASA Guidebook for Proposers* a letter of support may be required from any facility required for the proposed effort.

3.3 Data Management Plans (DMPs)

Proposals submitted to this program element must include a Data Management Plan (see C.1, Section 3.7), and since samples are an important component of Exobiology Research, please discuss both data and sample management as part of the Data Management Plan. This must be placed in a special section, not to exceed two pages in length, immediately following the References and Citations section for the Scientific/Technical/Management portion of the proposal.

3.4 Geologic Maps

Proposers who plan investigations involving geologic mapping should consult C.1, Section 3.9, for guidance on submission and requirements for publication of U.S. Geological Survey (USGS) maps. The scientific goal of such a geologic map product should be clearly explained and justified.

4. Proposal Submission Process

This program element requests a Notice of Intent (NOI) by the due date given in Tables 2 and 3 of this NRA. An NOI is not required to submit a full proposal and is submitted by the PI, not the Authorized Organizational Representative (AOR). Proposals submitted by the AOR are due by the date given in Tables 2 and 3 of this NRA.

Proposals must follow all formatting requirements that are described in program element C.1 and Section IV(b)ii of the ROSES Summary of Solicitation. Violation of these rules is sufficient grounds for a proposal to be rejected.

5. Summary of Key Information

Expected program budget for first year of new awards	~$3M
Number of new awards pending adequate proposals of merit	~20
Maximum duration of awards	4 years; shorter term proposals (1-3 years) are typical; fourth year must be explicitly and scientifically justified.
Due date for NOIs	See Tables 2 and 3 of this ROSES NRA.
Due date for proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of ROSES and the *NASA Guidebook for Proposers*.
Relevance	This program is relevant to the Planetary Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See C.1 the Planetary Science Research Program Overview, and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of NOIs and proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of NOIs and proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-EXO

Point of contact concerning this program element	Lindsay Hays Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: 650-604-3668 Email: lindsay.hays@nasa.gov Caucus email: HQ-EXO@mail.nasa.gov

C.6 SOLAR SYSTEM OBSERVATIONS

NOTICE: Amended June 4, 2020. This amendment delays the Step-2 proposal due date for this program element. The due date for Step-2 proposals is now June 17, 2020.

Updated March 12, 2020. The following changes have been made to this program element: 1) What was formerly Section 2.2 "Proposals Utilizing Goldstone Planetary Radar" has been removed. 2) A new Section 2.2, entitled Exclusions, has been added and 3) The point of contact for this program element (see Section 5) has changed. The due dates remain unchanged: ~~Step-1 proposals are due April 8, 2020~~ and Step-2 proposals are due June 10, 2020. New text is in bold and deleted text is struck through.

This program element continues to use a two-step proposal submission process described in Section 2 of C.1 The Planetary Science Division Research Program Overview.

The Near-Earth Object Observations (NEOO) sub-element is now a separate ROSES program element entitled Yearly Opportunities for Research in Planetary Defense.

1. Scope of Program

Solar System Observations (SSO) supports primarily ground-based and limited airborne- and space-based astronomical observations of bodies in our Solar System. Proposals are solicited for observations over the entire range of wavelengths, from the ultraviolet to radio, that contribute to the understanding of the nature and evolution of the Solar System and its individual constituents.

Full PI-led suborbital missions involving balloons, sounding rockets, or aircraft are not being solicited until further notice. Hosted payloads on already-funded suborbital platforms will be considered.

Investigations involving near-Earth objects (NEOs) should be proposed to C.24 the Yearly Opportunities for Research in Planetary Defense (YORPD) program element.

Proposals to this program element must contain as a primary focus new observation of Solar System objects (excluding Earth and Sun) during the proposed period of performance. Considered proposals must also include detailed scientific analysis and publication plans for the proposed observations.

Proposals must also address NASA's planetary science objectives that are not attained nor planned by current spacecraft missions, either in development or in operation. Those objectives are discussed in more detail in the 2018 NASA Science Plan available at https://science.nasa.gov/about-us/science-strategy/.

Observations over any range of wavelengths that enhance, complement, or otherwise expand on the science of NASA missions returning significant amounts of data within the proposed period of performance are especially encouraged. Observations that are required by a spacecraft mission flight project to meet Level 1 requirements or mission success criteria are not in the scope of this program, but of the flight project itself.

Proposals may include observations that utilize any currently operating facility, public or private, including those supported by NASA. All proposed observations must be scientifically and budgetarily justified, including the use of facilities that are not open-access and require fees, as well as facilities that provide a funded observer program.

Proposals to utilize data to be obtained from large surveys, or other sources where the data are obtained in a continuous routine manner for general use, must include a member of the data collection team as a Co-Investigator (Co-I) or as a Collaborator and must utilize data acquired during the award period of performance in order to meet the requirement for a primary focus of new observation.

2. Programmatic Considerations

2.1 Additional Funding for Relevant Instrumentation Construction or Upgrade

Proposers to Solar System Observations are eligible to request funds for major equipment under the Planetary Major Equipment and Facilities (PMEF) program. See program element C.17 for information on how to append a PMEF request to a regular Solar System Observations research proposal or submit a stand-alone PMEF proposal to supplement an existing Solar System Observations award.

~~2.2 Proposals Utilizing Goldstone Planetary Radar~~ **[Deleted March 12, 2020]**

~~Proposals intending to use the planetary radar capabilities of the Deep Space Network Goldstone complex must contact the JPL Goldstone Solar System Radar (GSSR) Task Manager listed below for information on costs associated with use of the Goldstone radar by the proposed investigation. These costs are incurred by NASA and are not part of the proposed budget but must be noted in the budget justification section.~~

~~GSSR Task Manager:~~
~~Martin Slade~~
~~M/S 238-420~~
~~Jet Propulsion Laboratory~~
~~4800 Oak Grove Drive~~
~~Pasadena, CA 91109~~
~~Telephone: (818) 354-2765~~
~~Email: Martin.A.Slade@jpl.nasa.gov~~

2.2 Exclusions [Added March 12, 2020]

Proposals to this program element must include a science investigation. Proposals to produce a higher-order data product that enhances the science return from one or more missions, but without a larger science investigation, must be submitted to the C.4 Planetary Data Archiving, Restoration, and Tools (PDART) program.

3. Resources: Information, Data, and Facilities

3.1 Limits on Use of Mission Data

Proposals to this program element must follow the rules for use of mission data given in program element C.1, Section 3.**5** ~~4~~. If the data to be analyzed have issues that might

represent an obstacle to analysis, the proposers must demonstrate clearly and satisfactorily how such potential difficulties will be overcome.

3.2 Facilities and Data Sources Available to Proposers

Please refer to ROSES program element C.1, Section 4, for a detailed list of the data and astromaterials resources, and facilities available to proposers to this program element, and how to use them. If their use is anticipated, this should be discussed and justified in the submitted proposals (especially note the provision for such discussion in the proposal section entitled Facilities and Equipment). Also note that, per the directions in the *NASA Guidebook for Proposers* a letter of support may be required from any facility required for the proposed effort.

3.3 Data Management Plans (DMPs)

Proposals submitted to this program element must include a Data Management Plan (see program element C.1, Section 3.**7** ~~6~~). This must be placed in a special section, not to exceed two pages in length, immediately following the References and Citations section for the Scientific/Technical/Management portion of the proposal.

3.4 Geologic Maps

Proposers who plan investigations involving geologic mapping should consult program element C.1, Section 3.**9** ~~8~~, for guidance on submission and requirements for publication of U.S. Geological Survey (USGS) maps. The scientific goal of such a geologic map product should be clearly explained and justified.

4. Proposal Submission Process

This program element uses a two-step proposal submission process described in program element C.1, Section 2.

Proposers are reminded that Step-1 proposals are mandatory and must be submitted by the proposing organization.

Proposals must follow all formatting requirements that are described in program element C.1 and Section IV(b)ii of the ROSES Summary of Solicitation. Violation of these rules is sufficient grounds for a proposal to be rejected.

5. Summary of Key Information

Expected program budget for first year of new awards	~$1M
Number of new awards pending adequate proposals of merit	~8-10
Maximum duration of awards	Typical awards are 3 years. Up to 4 years permitted.
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA.
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	~7 months after Step-2 proposal due date.

Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of the *ROSES Summary of Solicitation*.
Relevance	This program is relevant to the Planetary Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See C.1 the Planetary Science Research Program Overview, and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of Step-1 and Step-2 proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of Step-1 and Step-2 proposals via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-SSO
Point~~s~~ of contact concerning this program: Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001	**Lucas Paganini [Changed March 12, 2020]** **Phone: (202) 358-3911** **Email: lucas.paganini@nasa.gov** ~~Doris Daou~~ ~~Email: doris.daou@nasa.gov~~ ~~Phone: (202) 358-1686~~ ~~Kelly Fast~~ ~~Email: kelly.e.fast@nasa.gov~~ ~~Phone: (202) 358-0768~~

C.7 NEW FRONTIERS DATA ANALYSIS PROGRAM

NOTICE: June 22, 2020. Subsection 3.2 has been clarified to remind proposers of the necessity for a letter of support for facilities not under the direct control of the PI or Co-I. New text is in bold and deleted text is struck through.

Amended June 16, 2020. This Amendment delays the proposal due date for this program element. Step-1 proposals are now due September 3, 2020 and Step-2 proposals are now due November 5, 2020

For 2020, this program changes to use a two-step proposal submission process described in Section 2 of C.1 The Planetary Science Division Research Program Overview.

1. Scope of Program

1.1 Programmatic Overview

The objective of the New Frontiers Data Analysis Program (NFDAP) is to enhance the scientific return from New Frontiers missions by broadening scientific participation in the analysis and interpretation of data returned by these missions. Other mission and non-mission data sets may be used to supplement these data in a supporting role, but all proposals must require the use of data from at least one New Frontiers mission: New Horizons, Juno, and OSIRIS-REx.

This program solicits research proposals to conduct scientific investigations using or enhancing the utilization of data obtained by the New Frontiers missions. For the purposes of this solicitation, "data" is understood to include both uncalibrated and calibrated data as well as higher-order data products produced from the mission data. Mission data used in NFDAP investigations must be available in the Planetary Data System (PDS; http://pds.nasa.gov), or an equivalent publicly accessible archive, at least 30 days prior to the Step-2 due date. Spacecraft data that have not been placed in such archives may not be proposed for use.

All proposals to NFDAP must identify and address a clear scientific objective. Proposals responsive to this call must include New Frontiers mission data analysis tasks and may also include non-data-analysis tasks that are necessary to analyze or interpret the data, or to enhance the use of mission data. These tasks may incorporate theory, modeling, laboratory studies, correlative analyses, and/or other research. Proposals that include non-data-analysis tasks must incorporate the results of such tasks in the proposed data analysis tasks.

Each research proposal must constitute a stand-alone scientific investigation, with stated lines of inquiry, and result in one or more peer-reviewed publications.

1.1.1 *Mission Team Member Requirements*

Members of current mission or instrument teams must demonstrate that their proposed investigation will use only released and publicly available data. Such team members must comply with the 30-days-prior-to-submission rule (above). Proposals including

current mission team members must demonstrate how the proposed research does not overlap work already funded by their mission team.

1.2 Mission Data and Produced Data Products

Higher-order data products produced as part of funded research must be made publicly available, following the guidelines described in Section 3.7 of C.1, Planetary Science Overview ("Data Management Plans and Archiving"). New data products, including maps, improved calibrations, etc., must be submitted to the PDS, the USGS, or another appropriate archive, by the end of the funded research period, unless the investigator explicitly makes a case in the proposal for a later date. Proposed data products for delivery to the PDS must be clearly described, appropriate time and effort for delivery and ingestion must be budgeted, and the proposal must include a letter from the manager of the appropriate PDS data node. For additional information, refer to the PDS Proposer's Archiving guide at https://pds.nasa.gov/home/proposers/proposing-programs.shtml.

2. Programmatic Information

2.1 Exclusions

Proposals to produce a higher-order data product that enhances the science return from one or more missions, but without a larger science investigation, should be submitted to the Planetary Data Archiving, Restoration, and Tools (PDART) Program, C.4.

3. Data, Facilities, and Archiving

3.1 Use of Mission Data

Proposals to this program element must follow the rules for use of mission data given in program element C.1, The Planetary Science Division Research Program Overview, Section 3.5.

- Mission information can be accessed via the NASA websites.
  - Juno: https://www.nasa.gov/mission_pages/juno/main/index.html
  - New Horizons: https://www.nasa.gov/mission_pages/newhorizons/main/index.html
  - OSIRIS-REx: https://www.nasa.gov/mission_pages/osiris-rex/index.html

- Mission data information can be accessed via the PDS webpages.
  - Juno: https://pds-atmospheres.nmsu.edu/data_and_services/atmospheres_data/JUNO/juno.html
  - New Horizons: http://pds-smallbodies.astro.umd.edu/data_sb/missions/newhorizons/index.shtml
  - OSIRIS-REx: https://pds-smallbodies.astro.umd.edu/data_sb/missions/orex/index.shtml

3.2 Facilities and Data Sources Available to Proposers **[Clarified June 22, 2020]**

Proposers are advised to read Section 4 of program element C.1 for information on facilities and data sources that are available to supported investigators. If their use is

anticipated, this should be discussed and justified in the submitted proposals (especially note the provision for such discussion in the proposal section entitled Facilities and Equipment). As described in **Section 3.17 of** the *NASA Guidebook for Proposers* **and Table 1 of the *ROSES Summary of Solicitation*, any facility or resource not under the direct control of the PI or a Co-I requires a letter of support acknowledging that it is available for the proposed use during the proposed period.** ~~a letter of support may be required from any facility required for the proposed effort.~~

3.3 Data Archiving and Map Publication

Proposals submitted to this program element must include a Data Management Plan (see program element C.1, Section 3.7).

Proposers who plan investigations involving geologic mapping should consult program element C.1 for guidance on submission and requirements for publication of U.S. Geological Survey (USGS) maps. The scientific goal of such a geologic map product should be clearly explained and justified.

4. The Two-Step Submission Process

This program element uses a two-step proposal submission process described in C.1, Section 2. Step-1 proposals are mandatory and must be submitted by the proposing organization.

Proposals must follow all formatting requirements that are described in C.1 and Section IV(b)ii of the ROSES Summary of Solicitation. Violation of these rules is sufficient grounds for a proposal to be rejected.

5. Planetary Science Early Career Award

Details of the Planetary Science Early Career Award (ECA) program are given in program element C.19. The aim of this program is to support research and professional development of outstanding early-career scientists, and to help stimulate research careers in areas supported by the Planetary Sciences Division. This program is an ECA-participating ROSES program element. Proposals from eligible PIs, or Science PIs if applicable, selected from this program this year may become the 'parent award' for future ECA proposals.

6. Summary of Key Information

Expected program budget for first year of new awards	~ $2.0 M/Year
Number of new awards pending adequate proposals of merit	~ 12-18 total
Maximum duration of awards	3 years
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA.
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	~6 months after the Step-2 proposal due date.

Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Table 1 of the ROSES *Summary of Solicitation*.
Relevance	This program is relevant to the Planetary Science questions, and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See C.1 the Planetary Science Research Program Overview, and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted
Web site for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-NFDAP
Point of contact concerning this program	Henry Throop Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Email: HQ-NFDAP@mail.nasa.gov (preferred) Email: henry.throop@nasa.gov Telephone: (202) 358-3709

C.8 LUNAR DATA ANALYSIS PROGRAM

NOTICE: June 22, 2020. Subsection 4.2 has been clarified to remind proposers of the necessity for a letter of support for facilities not under the direct control of the PI or Co-I. New text is in bold and deleted text is struck through.

This program element continues to solicit proposals via a two-step proposal submission process described in Section 2 of C.1 The Planetary Science Division Research Program Overview.

1. Scope of Program

The Lunar Data Analysis Program (LDAP) funds research on the analysis of data from lunar missions. The overall objectives of LDAP are to: enhance the scientific return of lunar missions; broaden scientific participation in the analysis of lunar mission data sets; and fund high-priority areas of research that support planning for future lunar missions.

1.1 Sources of Mission Data

LDAP supports scientific investigations of the Moon using publicly available (released) data from missions/instruments that include:

- Lunar Crater Observation and Sensing Satellite (LCROSS);
- Moon Mineralogy Mapper (M^3);
- Lunar Reconnaissance Orbiter (LRO);
- Gravity Recovery and Interior Laboratory (GRAIL);
- Acceleration, Reconnection, Turbulence, and Electrodynamics of the Moon's Interaction with the Sun (Time History of Events and Macroscale Interactions during Substorms), ARTEMIS (THEMIS);
- Lunar Atmosphere and Dust Environment Explorer (LADEE);
- Lunar Prospector;
- Deep Impact Lunar Flyby;
- Clementine;
- Apollo missions; and
- Non-U.S. missions: Kaguya, Chang'e 1, Chang'e 2, Chang'e 3, Chang'e 4, Chandrayaan-1, Chandrayaan-2

Proposals must incorporate the analysis of data from at least one of these lunar missions. Such studies may include (but are not limited to) scientific, landing site science, cartographic, topographic, or geodetic research, and may incorporate the analysis of data from more than one mission.

Additional information about NASA and other lunar missions can be found at NASA's National Space Science Data Center (NSSDC) at: http://nssdc.gsfc.nasa.gov/planetary/planets/moonpage.html.

Lunar mission data used in LDAP investigations must be available in the Planetary Data System (PDS; http://pds.nasa.gov), or an equivalent publicly accessible archive, at least 30 days prior to the Step-2 due date for LDAP proposals. Spacecraft data that have not been placed in such archives may not be proposed for use in LDAP investigations. (Once a proposal has been awarded, investigators are free to augment the proposed

dataset under analysis with data deposited in the PDS, or an equivalent publicly available archive, subsequent to 30 days prior to the LDAP submission date.)

In all cases, it is the responsibility of the LDAP investigator to acquire any necessary data. Investigators are encouraged to contact the archive for assistance in identifying specifics of available datasets. Proposers must demonstrate in their proposal that the necessary data are available. In addition, the obligation is on the proposer to clearly demonstrate that any potential difficulties, which might represent an obstacle to analysis, can be overcome.

1.1.1 Mission Team Member Requirements

Members of current mission or instrument teams who wish to apply to LDAP must clearly demonstrate that their proposed investigation will use only released and publicly available data. Such team members must scrupulously comply with the 30-days-prior-to-submission rule (above). Additionally, proposals from current flight team members must rigorously demonstrate how the proposed LDAP research does not overlap—and is not redundant with—data analysis duties/responsibilities already funded by their respective mission. This requirement applies to all members of the proposal team.

1.2 Analysis of Data

Proposals to LDAP must include a science investigation. Proposals with the principal objective of producing a higher-order data product that enhances the science return from one or more missions, but does not include a science investigation, should be submitted to the C.4 Planetary Data Archiving, Restoration, and Tools (PDART) program element.

Proposed work responsive to LDAP may include: (1) data analysis tasks; (2) tasks that are not data analysis (non-data-analysis tasks), but that require the use of lunar mission data; and (3) non-data-analysis tasks that significantly enhance the use, or facilitate the interpretation, of lunar mission data. These tasks may incorporate theory, modeling, laboratory or field studies, correlative analyses, or other research. Non-data-analysis tasks that are responsive to this call are defined as tasks that are necessary to analyze (or help analyze) the lunar mission data. Proposals that include non-data-analysis tasks that do not incorporate the results of such tasks in the analysis of lunar mission data will not be deemed responsive to this call.

LDAP will consider requests for support of new ground-based observations of the Moon, provided that such requests are clearly described and that the observations are essential to the success of the work proposed. Requests to support such tasks are only allowable in the context of enhancing the analysis and understanding of the data from the missions listed above.

Proposals for investigations that mostly involve theoretical, modeling, laboratory, or field studies, and that do not directly use spacecraft data are not appropriate for LDAP, but may be suitable for submission to the C.2 Emerging Worlds or C.3 Solar System Workings programs.

A description of science research priorities for lunar exploration can be found in the documents: *The Scientific Context for Exploration of the Moon (2007),* obtained at http://books.nap.edu/catalog.php?record_id=11954, and *Vision and Voyages for*

Planetary Science in the Decade 2013-2022 (2011), obtained at http://www.nap.edu/catalog.php?record_id=13117. Both documents are published by the Space Studies Board of the National Research Council. A more-recent description of priorities can be found in the Lunar Exploration Analysis Group Special Action Team report *Advancing Science of the Moon* (2018), which can be obtained at https://www.lpi.usra.edu/leag/reports/ASM-SAT-Report-final.pdf.

2. The Two-Step Submission Process

This program element uses a two-step proposal submission process described in program element C.1, Section 2. Proposers are reminded that Step-1 proposals are mandatory and must be submitted by the proposing organization.

Proposals must follow all formatting requirements that are described in program element C.1 and Section IV(b)ii of the ROSES Summary of Solicitation. Violation of these rules is sufficient grounds for a proposal to be rejected.

3. Programmatic Information

3.1 Program-Specific Evaluation Criteria

As part of the evaluation of Intrinsic Merit, the following evaluation factors will be taken into account (not to the exclusion of other standard factors described in the *Proposers Guidebook*): (a) The extent to which datasets to be used in the proposed work are clearly and specifically identified in the proposal; (b) the extent to which the proposal demonstrates clearly that the public data are of sufficient quantity and quality to achieve the project's science goals; (c) the extent to which the proposal demonstrates familiarity with the data and an understanding of the work required to refine the data for the purposes of the analysis; and (d) the extent to which the proposal demonstrates that any known issues with the data, presenting obstacles to analysis, will be overcome.

3.2. Data Management and Archiving

Proposals submitted to this program element must include a Data Management Plan (DMP; see program element C.1, Section 3.6). This must be placed in a special section, not to exceed two pages in length, immediately following the References and Citations section for the Scientific/Technical/Management portion of the proposal.

Data products produced by funded LDAP investigations must be made publicly available, following the guidelines described in Section 3.6 of C.1 Planetary Science Overview ("Data Management Plans and Archiving"). Proposed data products for delivery to the PDS must be clearly described, appropriate time and effort for delivery and ingestion must be budgeted, and the proposal must include a letter from the manager of the appropriate PDS data node. For additional information, refer to the PDS Proposer's Archiving guide at https://pds.nasa.gov/home/proposers/proposing-programs.shtml. Data products, including maps, improved calibrations, etc., must be submitted to the PDS or the U.S. Geological Survey (USGS), as appropriate, by the end of the funded research period, unless the investigator explicitly makes a case in the proposal for a later date.

3.3 Progress Reports

An Annual Progress Report will be due no later than 60 days in advance of the anniversary date of the award. Awards to NASA Centers, including the Jet Propulsion Laboratory (JPL), always have an anniversary date of the start of the Federal fiscal year, October 1.

3.4 Duration of Awards

Typical proposals to this program seek three years of funding or fewer. Please refer to program element C.1, Section 3.3, for instructions on submitting requests for more than three years. Proposals for less than three years of funding are highly encouraged for projects that can be completed on shorter timescales.

3.5 Planetary Science Early Career Award

Details of the Planetary Science Early Career Award (ECA) program are given in program element C.19. The aim of the ECA program is to support research and professional development of outstanding early-career scientists, and to help stimulate research careers in areas supported by the Planetary Sciences Division. LDAP is an ECA-participating ROSES program element. Proposals from eligible PIs, or Science PIs if applicable, selected from LDAP this year may become the 'parent award' for future ECA proposals.

4. Resources: Information, Data, and Facilities

4.1 Limits on Use of Mission Data

Proposals to this program element must follow the rules for use of mission data given in program element C.1, Section 3.4 and further clarified in Section 1.1.1 above.

4.2 Facilities and Data Sources Available to Proposers **[Clarified June 22, 2020]**

Proposers are advised to read C.1 (Section 4), The Planetary Science Division Research Program Overview, for information on facilities and data sources that are available to supported investigators. If their use is anticipated, this should be discussed and justified in the submitted proposals (especially note the provision for such discussion in the proposal section entitled Facilities and Equipment). Also note that, per the directions in **Section 3.17 of** the *NASA Guidebook for Proposers* **and Table 1 of the *ROSES Summary of Solicitation*, any facility or resource not under the direct control of the PI or a Co-I requires a letter of support acknowledging that it is available for the proposed use during the proposed period.** ~~a letter of support may be required from any facility required for the proposed effort.~~

4.3 Geologic Maps

Proposers who plan investigations involving geologic mapping should consult program element C.1. Section 3.8, for guidance on submission and requirements for publication

of U.S. Geological Survey (USGS) maps. The scientific goal of such a geologic map product should be clearly explained and justified in the proposal.

5. Summary of Key Information

Expected program budget for first year of new awards	~$1.3M
Number of new awards pending adequate proposals of merit	~10
Maximum duration of awards	Four years; shorter-term proposals (one to three years) are typical; fourth year must be explicitly and scientifically justified.
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA.
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	6 months after the Step-2 proposal due date
Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of the ROSES *Summary of Solicitation*.
Relevance	This program is relevant to the Planetary Science questions, and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See C.1 the Planetary Science Research Program Overview, and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of the *ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-LDAP

Points of contact concerning this program, both of whom share this mailing address: Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001	Shoshana Weider (Caucus lead) Telephone: (202) 358-1667 Email: shoshana.z.weider@nasa.gov Sarah Noble Telephone: (202) 358-2492 Email: sarah.noble-1@nasa.gov

C.9 MARS DATA ANALYSIS

NOTICE: June 22, 2020. Subsection 3.2 has been clarified to remind proposers of the necessity for a letter of support for facilities not under the direct control of the PI or Co-I. New text is in bold and deleted text is struck through.

Proposals to this program element are subject to a relevance requirement in addition to and that supersedes those detailed in the ROSES *Summary of Solicitation*, see Section 2.2 of this program element. Proposals that do not fulfill this requirement may be returned without review.

1. Scope of Program

The objective of the Mars Data Analysis Program (MDAP) is to enhance the scientific return from missions to Mars conducted by NASA and other space agencies. These include, but are not limited to, the following missions: Insight, Mars Pathfinder (MPF), Mars Global Surveyor (MGS), Mars Odyssey (MO), Mars Exploration Rovers (MER), Mars Express (MEX), Mars Reconnaissance Orbiter (MRO), Phoenix (PHX), Mars Science Laboratory (MSL), Mars Atmosphere and Volatile EvolutioN (MAVEN), and ExoMars Trace Gas Orbiter (TGO). Any proposal may incorporate the investigation of data from more than one mission. Additional information about these missions, as well as references containing preliminary science results, can be found on the Mars Exploration Program (MEP) homepage at: http://mars.nasa.gov.

MDAP broadens scientific participation in the analysis of mission data sets and funds high-priority areas of research that support planning for future Mars missions. Investigations that use data derived from other sources (e.g., ground-based radar, Hubble) will also be considered. MDAP supports scientific investigations of Mars using publicly available (released) data.

Investigations submitted to this program must demonstrate how the research to be undertaken will directly improve our understanding of open science questions at Mars relevant to current hypotheses. Tasks responsive to this call include 1) data analysis tasks, 2) non-data-analysis tasks that are necessary to analyze or interpret the data, and 3) non-data-analysis tasks that significantly enhance the use or facilitate the interpretation of mission data. These tasks may incorporate theory, modeling, laboratory studies, correlative analyses, and/or other research, as long as the primary focus and majority of the work are data analysis. All proposals must include a complete science investigation. Proposals that include nondata-analysis tasks to enhance the use or facilitate the interpretation of mission data must incorporate the results of such tasks in the analysis or interpretation of mission data to be responsive to this call. MDAP does not support field studies or the acquisition of new astronomical observations or collection of new data from spacecraft at Mars.

An investigator may also propose in the following areas of Mars research that support planning for future Mars missions, provided that the investigation makes use of publicly-available Mars mission data:

- Improved atmospheric models that further the understanding and forecasting of Mars atmospheric conditions that affect the orbital trajectories of spacecraft and/or the safe passage of spacecraft through the atmosphere, including aerobraking and aerocapture.
- Characterization of potential landing sites for future Mars exploration missions (e.g., geomorphology, distribution and size of rocks, pits, sand dunes, regional and local slopes, surface composition, and texture variability).
- Analysis and comparison of Mars orbital and surface data to increase the predictive accuracy of surface characteristics of Mars from orbit.

Members of active mission or instrument teams who wish to apply to MDAP must clearly demonstrate that their proposed investigation will use only released and publicly available data. Flight team members must scrupulously comply with the 30-days-prior-to-due date rule (See Section 3.1 below). Additionally, team members must clearly demonstrate how the proposed MDAP research does not overlap and is not redundant with activities already funded by their respective missions.

For more information about the type of research supported by the MDAP, please refer to the abstracts of currently funded investigations that are available online at: http://nspires.nasaprs.com/.

2. Programmatic Information

2.1 Program Exclusions

Investigators proposing studies that do not focus on the tasks listed in Section 1 are advised that such studies are not appropriate for MDAP, but may be suitable for submission to the other programs in Planetary Science.

Proposals to conduct comparative studies between Mars and other Solar System objects are not responsive to this call and are directed to the most appropriate core program in Planetary Science.

Proposals whose principle objective is the production of data products (e.g., cartographic products, such as geologic, topographic, or mineral maps, and/or calibration data) that are not part of a larger science investigation are directed to program element C.4 Planetary Data Archiving, Restoration and Tools (PDART).

MDAP also does not support:

- Proposals for organizing and/or hosting scientific meetings (which should be submitted to Topical Workshops, Symposia, and Conferences, E.2);
- Proposals for detector, instrumentation, or technology development; or
- Investigations whose primary emphasis is fundamental theory, the development of numerical models, or laboratory measurements (unless there is a direct and explicitly presented connection to and use of Mars mission data; in these cases, the primary focus of the proposed work must be data analysis and not simply using data for model or measurement validation).

2.2 Relevance Statement Requirement

Step-2 proposals to this program element must discuss relevance in a (4000-character maximum) text box on the cover pages via the NSPIRES web interface for this program element. This section is outside of the 15-page Scientific/Technical/Management Section and the relocation of the relevance discussion does not decrease that 15-page limit. This requirement supersedes the *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation*, and the omission of this section is sufficient reason for a proposal to be returned without review.

The relevance discussion must explicitly refer to this program element and the section of the solicitation to which the proposal is responsive. If the proposed work is close in scope to research covered by any other program element, this discussion must also justify why it is more relevant to this program element than that other program element. This discussion may not be used to address the proposal's intrinsic merit, budget justification, or any other factor that remains in the 15-page main body, or any other section, of the proposal.

2.3 Planetary Science Early Career Award

Details of the new Planetary Science Early Career Award (ECA) program are given in program element C.19. The aim of this program is to support research and professional development of outstanding early-career scientists, and to help stimulate research careers in areas supported by the Planetary Sciences Division. This program is an ECA-participating ROSES program element. Proposals from eligible PIs, or Science PIs if applicable, selected from this program this year may become the 'parent award' for future ECA proposals.

2.4 Data Management Plans (DMPs)

Program element C.1, Section 3.7, discusses the requirements for DMPs in proposals to this program element. Please note that DMPs are mandatory for this program element, and must be placed in a special section not to exceed two pages in length, immediately following the References and Citations section of the Scientific/Technical/Management portion of the proposal.

2.5 Duration and Size of Awards

NASA anticipates that most proposals will seek three years of funding. Proposals for less than three years are encouraged for projects that can be completed on shorter timescales. In rare cases, funding for a proposed fourth year may be provided, if the need for the longer duration is sufficiently well justified. The appropriateness of the proposed funding period will be reviewed, and adjustments may be requested. Programmatic balance may limit the opportunities for funding in some areas. Proposers are encouraged to request the resources they actually need to conduct the research proposed.

2.6 Planetary Major Equipment and Facilities (PMEF) and development of instruments

Proposers to the Mars Data Analysis Program are not eligible to request funds for Planetary Major Equipment (PMEF; program element C.17).

This solicitation does not request proposals for the development of advanced instrument concepts and technologies as precursors to flight instruments. Such proposals may be submitted to program element C.12 Planetary Instrument Concepts for the Advancement of Solar System Observations (PICASSO), for technology readiness levels (TRLs) 1-3 or program element C.13 Maturation of Instruments for Solar System Exploration (MatISSE) for TRLs 4-6.

3. Resources: Information, Data, and Facilities

3.1 Limits on Use of Mission Data

For proposals that contain mission data analysis, planetary spacecraft mission data to be used in proposed investigations must be available in the Planetary Data System (PDS) or equivalent publicly accessible archive at least 30 days prior to the Step-2 proposal due date. Spacecraft data that have not been placed in the public domain may not be proposed for use in MDAP investigations. (Once a proposal has been awarded, investigators are free to augment the proposed dataset under analysis with data deposited in the PDS (or an equivalent publicly available archive) subsequent to 30 days prior to the MDAP Step-2 due date.) Spacecraft data that have not been obtained yet (i.e., future mission data) or those that have not been accepted for distribution in approved archives are not eligible for use in investigations. Note: For this program element, existing derived data products (e.g. data retrievals that required manipulation of the original spacecraft data set), if necessary to address the scientific questions, must also be publicly available in the literature or in a publicly accessible archive at least 30 days prior to the Step-2 due date for proposals.

Regardless of the archive(s) used, if the data to be analyzed have issues that might represent an obstacle to analysis, the proposers must demonstrate clearly and satisfactorily how such potential difficulties will be overcome. Investigators funded by spacecraft missions who wish to apply, must demonstrate clearly how the proposed research does not overlap and is not redundant with data analysis, duties, or responsibilities already funded by their respective mission(s). Please see C.1 The Planetary Science Division Research Program Overview, for more information.

3.2 Facilities and Data Sources Available to Proposers **[Clarified June 22, 2020]**

Refer to ROSES program element C.1, Section 4, for a detailed list of the data and astromaterials resources, and facilities available to proposers to this program element, and how to use them. If their use is anticipated, this should be discussed and justified in the submitted proposal (especially note the provision for such discussion in the proposal section entitled Facilities and Equipment). Also note that, per the directions in **Section 3.17 of** the *NASA Guidebook for Proposers* **and Table 1 of the *ROSES Summary of Solicitation*, any facility or resource not under the direct control of the PI or a Co-I requires a letter of support acknowledging that it is available for the proposed use during the proposed period.** ~~a letter of support may be required from any facility required for the proposed effort.~~

Documents that describe the research priorities for Mars exploration include:

- Mars Exploration Program Analysis Group (MEPAG) reports (http://mepag.jpl.nasa.gov/) including *Mars Scientific Goals, Objectives, Investigations, and Priorities* [2010 and subsequent updates];
- The recommendations of the Committee on the Planetary Science Decadal Survey of the National Research Council as described in the Space Studies Board report, *Visions and Voyages for Planetary Science in the Decade 2013-2022* [2011], available at http://www.nap.edu/catalog.php?record_id=13117; and
- *An Astrobiology Strategy for the Exploration of Mars* [2007], by the Space Studies Board of the National Research Council (http://www.nap.edu/catalog.php?record_id=11937).

Additional information is available on the MEP web site at: http://mars.nasa.gov/.

3.3 Geologic Maps

Proposers who plan investigations involving geologic mapping should consult program element C.1, Section 3.9, for guidance on submission and requirements for publication of U.S. Geological Survey (USGS) maps.

4. The Proposal Submission Process

This program element uses a two-step proposal submission process described in Section 2 of program element C.1.

Proposers are reminded that Step-1 proposals are mandatory and must be submitted by the proposing organization.

Proposals must follow all formatting requirements that are described in program element C.1 and Section IV(b)ii of the ROSES Summary of Solicitation. Violation of these rules is sufficient grounds for a proposal to be rejected.

5. Summary of Key Information

Expected program budget for first year of new awards	~ $3.0M
Number of new awards pending adequate proposals of merit	~ 20
Maximum duration of awards	4 years
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA.
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	9 months after proposal due date.
Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of the *ROSES Summary of Solicitation*.
Relevance	This program is relevant to the Planetary Science questions, and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA. See Section 2.2.

General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See C.1 the Planetary Science Research Program Overview, and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of the *ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of Step-1 and Step-2 proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of Step-1 and Step-2 proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-MDAP
Points of contact concerning this program both of whom share the following postal address: Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001	Mitch Schulte Telephone: (202) 358-2127 Email: mitchell.d.schulte@nasa.gov Adrian Brown Washington, DC 20546-0001 Email: adrian.j.brown@nasa.gov

C.10 CASSINI DATA ANALYSIS PROGRAM

NOTICE: June 22, 2020. Subsection 3.2 has been clarified to remind proposers of the necessity for a letter of support for facilities not under the direct control of the PI or Co-I. New text is in bold and deleted text is struck through.

1. Scope of Program

1.1 Programmatic Overview

The objective of the Cassini Data Analysis Program (CDAP) is to enhance the scientific return of the Cassini mission by broadening the scientific participation in the analysis and interpretation of data returned by this mission. Other mission and non-mission data sets may be used with these data, but all proposals must require the use of data from the Cassini mission.

This program solicits research proposals to conduct scientific investigations using or enhancing the utilization of data obtained by the Cassini mission. For the purposes of this solicitation, "data" is understood to include both uncalibrated and calibrated data as well as higher-order data products produced from the mission data. Mission data used in CDAP investigations must be available in the Planetary Data System (PDS; http://pds.nasa.gov), or an equivalent publicly accessible archive, at least 30 days prior to the Step-2 due date. Spacecraft data that have not been placed in such archives may not be proposed for use.

All proposals to CDAP must identify and address a clear scientific objective. Proposals responsive to this call must include Cassini mission data analysis tasks and may also include non-data-analysis tasks that are necessary to analyze or interpret the data, or to enhance the use of mission data. These tasks may incorporate theory, modeling, laboratory studies, correlative analyses, and/or other research. Proposals that include non-data-analysis tasks must incorporate the results of such tasks in the proposed data analysis tasks.

Each research proposal must constitute a stand-alone scientific investigation, with stated lines of inquiry, and result in one or more peer-reviewed publications.

1.2 Mission Data and Produced Data Products

Higher-order mission data products produced as part of funded research must be made publicly available, following the guidelines described in Section 3.7 of C.1 Planetary Science Overview ("Data Management Plans and Archiving"). New data products, including maps, improved calibrations, etc., must be submitted to the PDS, the USGS, or another appropriate archive, by the end of the funded research period, unless the investigator explicitly makes a case in the proposal for a later date. Proposed data products for delivery to the PDS must be clearly described, appropriate time and effort for delivery and ingestion must be budgeted, and the proposal must include a letter from the manager of the appropriate PDS data node. For additional information, refer to the PDS Proposer's Archiving guide at https://pds.nasa.gov/home/proposers/proposing-programs.shtml.

2. Programmatic Information

2.1 Exclusions

Proposals to this program element must include a science investigation. Proposals to produce a higher-order data product that enhances the science return from one or more missions, but without a larger science investigation, must be submitted to the C.4 Planetary Data Archiving, Restoration, and Tools (PDART) program.

3. Data, Facilities, and Archiving

3.1 Use of Mission Data

Proposals to this program element must follow the rules for use of mission data given in C.1 The Planetary Science Division Research Program Overview, Section 3.5.

- Mission information can be accessed via the NASA website.
  - http://saturn.jpl.nasa.gov/
- Mission data information can be accessed via PDS webpages.
  - http://pds-atmospheres.nmsu.edu/data_and_services/atmospheres_data/Cassini/Cassini.html
  - http://pds-rings.seti.org/cassini/
  - http://pds-rings.seti.org/cassini/data.html

3.2 Facilities and Data Sources Available to Proposers **[Clarified June 22, 2020]**

Proposers are advised to read Section 4 of C.1 for information on facilities and data sources that are available to supported investigators. If their use is anticipated, this should be discussed and justified in the submitted proposals (especially note the provision for such discussion in the proposal section entitled Facilities and Equipment). As described in **Section 3.17 of** the *NASA Guidebook for Proposers* **and Table 1 of the *ROSES Summary of Solicitation*, any facility or resource not under the direct control of the PI or a Co-I requires a letter of support acknowledging that it is available for the proposed use during the proposed period.** ~~a letter of support may be required from any facility required for the proposed effort.~~

3.3 Data Archiving and Map Publication

Proposals submitted to this program element must include a Data Management Plan (see program element C.1, Section 3.7).

Proposers who plan investigations involving geologic mapping should consult program element C.1 for guidance on submission and requirements for publication of U.S. Geological Survey (USGS) maps. The scientific goal of such a geologic map product should be clearly explained and justified.

Proposed investigations of any planetary or satellite surface that are intended to result in the publication of a Scientific Investigations Map (SIM) by the U.S. Geological Survey (USGS) should check the relevant box on the proposal Cover Page and clearly indicate this intention in the Proposal Summary, as well as in the text of the proposal. The scientific goal of such a geologic map product should be clearly explained and justified.

Proposers are advised to read C.1, Section 3.9, for the USGS information on and requirements for map production and publication.

4. The Two-Step Submission Process

This program element uses a two-step proposal submission process described in C.1, Section 2. Step-1 proposals are mandatory and must be submitted by the proposing organization.

Proposals must follow all formatting requirements that are described in program element C.1 and Section IV(b)ii of the ROSES Summary of Solicitation. Violation of these rules is sufficient grounds for a proposal to be rejected.

5. Planetary Science Early Career Award

Details of the Planetary Science Early Career Award (ECA) program are given in program element C.19. The aim of this program is to support research and professional development of outstanding early-career scientists, and to help stimulate research careers in areas supported by the Planetary Sciences Division. This program is an ECA-participating ROSES program element. Proposals from eligible PIs, or Science PIs if applicable, selected from this program this year may become the 'parent award' for future ECA proposals.

6. Summary of Key Information

Expected program budget for first year of new awards	~$2.5 M/Year
Number of new awards pending adequate proposals of merit	~12-20 total
Maximum duration of awards	3 years
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA.
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	~6 months after Step-2 proposal due date.
Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of the ROSES Summary of Solicitation.
Relevance	This program is relevant to the Planetary Science questions, and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA. See Section 2.2.
General requirements for content of proposals	See C.1 the Planetary Science Research Program Overview, and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of the *ROSES Summary of Solicitation*.

Detailed instructions for the preparation and submission of proposals	Please see ROSES *Summary of Solicitation* Section I(g) Order of Precedence and the *NASA Guidebook for Proposers*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of Step-1 and Step-2 proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of Step-1 and Step-2 proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-CDAP
Point of contact concerning this program:	Henry Throop Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Email: HQ-CDAP@mail.nasa.gov (preferred) Email: henry.throop@nasa.gov Telephone: (202) 358-3709

C.11 DISCOVERY DATA ANALYSIS

NOTICE: June 18, 2020. The point of contact for this program element has changed, see Section 5. New text is in bold.

This program element continues to solicit proposals via a two-step proposal submission process described in Section 2 of C.1 The Planetary Science Division Research Program Overview.

1. Scope of Program

The objective of the Discovery Data Analysis Program (DDAP) is to enhance the scientific return of Discovery Program missions and broaden the scientific participation in the analysis of data, both recent and archived, collected by Discovery missions.

1.1. Sources and Analysis of Mission Data

In the ROSES-2020 cycle, the scope of DDAP is limited to projects making use of data from the following missions:

- NEAR
- Stardust
- Stardust-NExT
- Genesis
- Deep Impact
- EPOXI
- MESSENGER
- Dawn
- Kepler/K2 (Solar System targets only)
- Rosetta

Despite Rosetta not having been a Discovery mission, Rosetta data analysis is supported by the Discovery program. Projects not making use of data from at least one of these missions are not in scope and are not responsive to the DDAP program element.

Spacecraft data used in DDAP investigations must be available in the Planetary Data System (PDS; https://pds.nasa.gov/), or equivalent publicly accessible archive(s), at least 30 days prior to the Step-2 due date for DDAP proposals. Spacecraft data that have not been placed in such archives are not eligible for use in DDAP investigations. In all cases, it is the responsibility of the DDAP investigator to acquire any necessary data. Investigators are encouraged to contact the archive for assistance in identifying specifics of available datasets.

Spacecraft data that have not yet been obtained (i.e., future mission data), or those that have not been made publicly available in approved archives, as indicated above, may not be proposed for use in DDAP investigations.

Members of mission or instrument teams who wish to apply to DDAP must clearly demonstrate that their proposed investigation will use only released and publicly available data. Flight team members must scrupulously comply with the 30-days-prior-to-due date rule (above). Additionally, team members must clearly demonstrate how the

proposed DDAP research does not overlap and is not redundant with activities already funded by their respective mission.

Proposals to DDAP must include a science investigation. Proposals to produce a higher order data product that enhances the science return from one or more missions, but does not include a science investigation, should be submitted to the C.4 Planetary Data Archiving, Restoration, and Tools (PDART) program element.

Proposed work responsive to this call may include (1) data analysis tasks, 2) tasks that are not data analysis but are necessary to analyze or interpret the data, and 3) tasks that are not data analysis but that significantly enhance the use or facilitate the interpretation of Discovery mission data. These tasks may incorporate theory, modeling, laboratory studies, correlative analyses, and/or other research; however, proposals that include tasks that are not data analysis must also incorporate the results of these tasks into the analysis or interpretation of Discovery mission data in order to be responsive to this call.

1.2 Program Exclusions

The Discovery Data Analysis Program is not intended to overlap other active program elements. Therefore, DDAP does not support the analysis of:

- Lunar data (see LDAP, program element C.8);
- Mars data from Mars missions (see MDAP, C.9);
- Data from Cassini (see CDAP, C.10);
- Data from New Frontiers missions (see NFDAP C.7);
- Data from Kepler/K2 on objects outside the Solar System (see ADAP, D.2);
- Data from past Discovery missions not listed in Section 1.1 above.

DDAP also does not support:

- Proposals for organizing and/or hosting scientific meetings (which should be submitted to Topical Workshops, Symposia, and Conferences, E.2);
- Proposals for detector, instrumentation, or technology development; or
- Investigations whose primary emphasis is fundamental theory, the development of numerical models, or laboratory measurements (unless there is a direct and explicitly presented connection to Discovery mission data).

The Planetary Science Division solicits proposals whose work efforts are primarily analysis of planetary mission data through this and other Data Analysis Programs. If a proposal would analyze data within the scope of more than one of the data analysis programs in order to perform comparative studies across the Solar System, but is not appropriate to any one data analysis program, then submission to a Core Research Program (e.g., Solar System Workings, Emerging Worlds, Solar System Observations) is encouraged. If a proposal is not appropriate for one of the Data Analysis programs, but does fit within the bounds of a Core Research Program, it should be submitted to that Core Program.

2. The Two-Step Submission Process

This program element uses a two-step proposal submission process described in program element C.1, Section 2.

Proposers are reminded that Step-1 proposals are mandatory and must be submitted by the proposing organization.

Proposals must follow all formatting requirements that are described in program element C.1 and in the *NASA Guidebook for Proposers*. Violation of these rules is sufficient grounds for a proposal to be rejected.

3. Programmatic Information

3.1 Program-Specific Evaluation Criteria

As part of the evaluation of Intrinsic Merit, the following evaluation factors will be taken into account (not to the exclusion of other standard factors described in the *Proposers Guidebook*): (a) The extent to which datasets to be used in the proposed work are clearly and specifically identified in the proposal; (b) the extent to which the proposal demonstrates clearly that the public data are of sufficient quantity and quality to achieve the project's science goals; (c) the extent to which the proposal demonstrates familiarity with the data and an understanding of the work required to refine the data for the purposes of the analysis; and (d) the extent to which the proposal demonstrates that any known issues with the data, presenting obstacles to analysis, will be overcome.

3.2. Data Management and Archiving

Proposals submitted to this program element must include a Data Management Plan (DMP; see program element C.1, Section 3.7). This must be placed in a special section, not to exceed two pages in length, immediately following the References and Citations section for the Scientific/Technical/Management portion of the proposal.

Data products produced by funded DDAP investigations must be made publicly available, following the guidelines described in Section 3.7 of C.1 Planetary Science Overview ("Data Management Plans and Archiving"). Proposed data products for delivery to the PDS must be clearly described, appropriate time and effort for delivery and ingestion must be budgeted, and the proposal must include a letter from the manager of the appropriate PDS data node. For additional information, refer to the PDS Proposer's Archiving guide at https://pds.nasa.gov/home/proposers/proposing-programs.shtml. Data products, including maps, improved calibrations, etc., must be submitted to the PDS or the U.S. Geological Survey (USGS), as appropriate, by the end of the funded research period, unless the investigator explicitly makes a case in the proposal for a later date.

3.3 Progress Reports

An Annual Progress Report will be due no later than 60 days in advance of the anniversary date of the award. Awards to NASA Centers, including the Jet Propulsion Laboratory (JPL), always have an anniversary date of the start of the Federal fiscal year, October 1.

3.4 Duration of Awards

Typical proposals to this program seek three years of funding or fewer. Please refer to program element C.1, Section 3.4, for instructions on submitting requests for more than three years.

3.5 Planetary Science Early Career Award

Details of the Planetary Science Early Career Award (ECA) program are given in program element C.19. The aim of this program is to support research and professional development of outstanding early-career scientists, and to help stimulate research careers in areas supported by the Planetary Sciences Division. This program is an ECA-participating ROSES program element. Proposals from eligible PIs, or Science PIs if applicable, selected from this program this year may become the 'parent award' for future ECA proposals.

4. Resources: Information, Data, and Facilities

4.1 Limits on Use of Mission Data

Proposals to this program element must follow the rules for use of mission data given in C.1 Planetary Science Research Program Overview, Section 3.5 and further clarified in Section 1.1 above.

4.2 Facilities and Data Sources Available to Proposers

Proposers are advised to read C.1 the Planetary Science Research Program Overview, for information on facilities and data sources that are available to supported investigators. If their use is anticipated, this should be discussed and justified in the submitted proposal (especially note the provision for such discussion in the proposal section entitled Facilities and Equipment). Also note that, per the directions in Table 1 of the ROSES Summary of Solicitation, a letter of support acknowledging that the facility or resource is available for the proposed use during the proposed period may be required from any facility or resource that is required for the proposed effort but not under the direct control of the PI or a Co-I.

4.3 Geologic Maps

Proposers who plan investigations involving geologic mapping should consult program element C.1. Section 3.9, for guidance on submission and requirements for publication of U.S. Geological Survey (USGS) maps. The scientific goal of such a geologic map product should be clearly explained and justified.

5. Summary of Key Information

Expected program budget for first year of new awards	~$2.5
Number of new awards pending adequate proposals of merit	~10-16
Maximum duration of awards	4 years; shorter-term proposals (1-3 years) are typical; fourth year must be explicitly and scientifically justified.
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA.
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	~Six months after Step-2 proposal due date.

Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of the ROSES *Summary of Solicitation* and the *NASA Guidebook for Proposers*.
Relevance	This program is relevant to the Planetary Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See C.1 the Planetary Science Research Program Overview, and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-DDAP
Point of contact concerning this program	**Thomas Wagner [Changed June 18, 2020]** Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Email: **thomas.wagner@nasa.gov** Telephone: 202-358-**4682**

C.12 PLANETARY INSTRUMENT CONCEPTS FOR THE ADVANCEMENT OF SOLAR SYSTEM OBSERVATIONS

NOTICE: Corrected September 2, 2020. The expected program budget for first year of new awards and number of new awards given in Section 5 have been corrected. New text is in bold and deleted text is struck through. Due dates remain unchanged, the due dates for proposals remain unchanged.

July 16, 2020. The main point of contact for this program element has changed. The new point of contact is Catherine Walker. The due dates remain unchanged. New text is in bold.

June 22, 2020. Subsection 3.1 has been clarified to remind proposers of the necessity for a letter of support for facilities not under the direct control of the PI or Co-I. New text is in bold and deleted text is struck through.

Proposals to this program continue to be taken by a two-step process in which the Notice of Intent is replaced by a required Step-1 proposal submitted by an Authorized Organizational Representative. See Section 2, of C.1 Planetary Science Research Program Overview for the most recent guidance on how to submit a Step-1 and Step-2 proposal.

Proposals must include an entry Summary Chart submitted as a separately uploaded appendix along with the Step-2 proposal, see Section 2.1 for more details. Progress reports are due Semi-Annually. See Section 2.4 for more detail.

Data Management Plans are not required for this program element.

1. Scope of Program

The goal of the Planetary Instrument Concepts for the Advancement of Solar System Observations (PICASSO) program is to support the development of spacecraft-based instrument components and systems that would enhance or enable the scientific return from future planetary missions that support the Science Mission Directorate's (SMD) Planetary Science Division (PSD). Therefore, the proposed instrument component or system must address specific scientific objectives of likely future planetary science missions.

The PICASSO program seeks proposals to develop new proof-of-concept instruments or instrument components, including sampling technologies, that enable new science by significantly improving instrument measurement capabilities for planetary science missions (such as SIMPLEx, Discovery, New Frontiers, Mars Exploration, and other planetary programs, including those flown on commercial spacecraft). The objective of the program is to develop instruments or instrument technologies with low Technology Readiness Level (TRL 1-3) for use in planetary science missions to the point where they may be proposed in response to the Maturation of Instruments for Solar System Exploration (MatISSE) Program, C.13 of ROSES or the Development and Advancement of Lunar Instruments (DALI) Program, C.20. In most cases that will mean demonstrating

that meeting key performance targets is feasible. It is the responsibility of the proposer(s) to demonstrate how their proposed technology addresses significant scientific questions relevant to stated NASA goals. Prospective proposers are encouraged to review the most recent Decadal Survey "Visions and Voyages for Planetary Science in the Decade 2013-2022" available at http://solarsystem.nasa.gov/2013decadal/, the goals of the Planetary Science Division as described in the 2014 Science Mission Directorate Science Plan available at http://science.nasa.gov/about-us/science-strategy/, and the astrobiology strategy at

https://nai.nasa.gov/media/medialibrary/2016/04/NASA_Astrobiology_Strategy_2015_FINAL_041216.pdf. Proposed investigations may target any Solar System body except the Earth and Sun in order to advance the objectives outlined in the Science Plan.

PICASSO is an instrument hardware development program and as such does not support mission operation and system software or platform technologies such as materials and structures, power generation or conditioning, communications, small satellites, landers, rovers, or any spacecraft technology that does not directly address planetary science instrumentation. Integrating multiple existing instrument systems does not generally demonstrate the proof-of-concept of a new instrument element. In addition, PICASSO does not support proposals that seek to develop ground-based laboratory instruments, or instruments for astronomical or astrophysical observations. Instrument systems that have already demonstrated key performance targets (i.e. achieved TRL 4+) can be proposed to the MatISSE program (C.13) or DALI program (C.20) to be matured for fit, form and function, and testing in relevant use environments.

The nature of specific efforts selected for funding will vary, with emphasis given to innovative technologies that substantially improve instrument measurement capabilities. Explicit comparisons to the current state-of-the-art must quantitatively demonstrate the expected improvements and what new science such improvements would enable. It is anticipated that the science payloads on most future planetary science spacecraft will be limited to small, low-mass, and low power consumption instruments.

2. Programmatic Considerations

2.1 Special Requirements for Proposals

Proposals are solicited under this program element for instrument development only for the mission focus areas described in the Decadal Survey or the Science Plan. All proposals submitted to this program element must specify:

- The mission focus area for which the proposed instrument or component technology is applicable. Instruments that are applicable to more than one mission focus area are encouraged.
- The science objectives of the proposed instrument or component technology. The relationship between the science objectives and the instrument capabilities must be clearly demonstrated. For those instruments applicable to more than one mission, focus area, or capable of meeting multiple science objectives, examples of science objectives for the proposed mission or missions must be given.
- A quantitative explanation of the key performance metric that is proposed to be advanced, with a quantitative comparison to the state-of-the-art. The state-of-the-art

should be a comparison to a similar flight instrument if possible, otherwise a clear definition of the state-of-the-art should be described.

- A detailed description and justification for the entry TRL and a detailed plan for raising the instrument system to the proposed exit TRL. The plan must include a description of milestones, as well as discussions of how the proposed research will advance the TRL of the instrument by a minimum of one TRL. A full description of Technology Readiness Levels (TRLs) 1- 9 appears in Appendix E of NASA Procedural Requirement 7123.1B and is available on the web at http://nodis3.gsfc.nasa.gov/displayDir.cfm?Internal_ID=N_PR_7123_001B_&page_name=AppendixE.
- How the proposed instrument system or component technology would address planetary protection requirements, as described in the NASA Procedural Requirements document, NPR 8020.12, Version D. Restrictions on operation and hardware cleanliness apply to all instrument systems that are intended to operate in environments where Earth life could proliferate – currently that is considered to be Mars, Europa, Enceladus, and anywhere in the Solar System where warm ice or liquid water is possible and includes instrument systems or component technology associated with detection of signs of life or biosignatures. To address this requirement the proposal shall, at a level appropriate to the exit TRL:
  - Establish whether the instrument will require planetary protection protocols.
  - If the instrument requires planetary protection protocols, describe which specific components could pose a challenge.
  - Describe possible mitigation strategies to meet planetary protection requirements.

  The instrument developer is encouraged to communicate informally with the Office of Planetary Protection regarding planetary protection categorization and associated requirements with a future mission interest as they relate to instrument design and development. For additional information, proposers may contact the NASA Planetary Protection Officer, Dr. Lisa Pratt at lisa.m.pratt@nasa.gov and cc Stephen.A.Rinehart@nasa.gov.

- An entry level Summary Chart, not counted in the page limit, shall be submitted as a separately uploaded appendix PDF file to the Step-2 Proposal. A template is available from the SARA web page at https://science.nasa.gov/researchers/templates-planetary-science-division-appendix-c-roses-proposals. The Summary Chart shall contain the following information:
  - Title, Principal Investigator Name and Institution
  - Target (Mars subsurface, airless body surface, planetary body flyby or orbit, etc.)
  - Bulleted list of science that will be enabled by new instrument
  - Bulleted list of major objectives of proposed work
  - Co-Investigators (Co-Is)/Institutions
  - A figure illustrating and clarifying the proposed concept
  - Top level Milestones
  - Entry and exit TRLs

2.2 Additional Selection Considerations

In addition to the criteria specified in the *NASA Guidebook for Proposers,* the following will also be considered when formulating PICASSO selection recommendations:

- The extent to which the instrument system or subsystem addresses a priority science goal of the mission or missions for which it would be a candidate for flight;
- The extent to which the proposed instrument system or subsystem is applicable to multiple Planetary Science missions;
- The Planetary Science Division strongly encourages proposers to investigate current and recent Small Business Innovative Research (SBIR) awards (http://sbir.gsfc.nasa.gov/abstract_archives) for possible teaming and leveraging of emerging technologies. Collaborations leveraging SBIR funded technologies will be given preference. In addition, selectable proposals that leverage funding from NASA technology development offices and programs such as those in the Space Technology Mission Directorate, will be given additional consideration.

2.3 Award Duration and Types

The typical award duration is three years. Proposals for less than three years are encouraged for projects that can be completed on shorter timescales. All awards will be in the form of grants to non-governmental institutions, intra-agency awards to NASA labs including JPL, and interagency funds transfers for other Federal organizations. Proposed efforts should have start dates no earlier than July 1, 2021.

2.4 Technical Reporting Requirements

Once awarded, all Progress Reporting deliverables applicable to this PICASSO solicitation shall be submitted to the web-based Planetary Electronic Reporting System (ERS). A user account on ERS will be provided to the PI upon award. Due to NASA IT security requirements, all PIs must register with the Identity Management and Account Exchange (IdMAX) system before a user account on ERS will be established. To create an IdMAX account, some personal information will be required. All submissions shall be made in PDF format.

The following deliverables shall be required of institutions that win awards. In cases where subawards exist, consolidated project reports are the responsibility of the PI. The proposed budget should provide for these reporting requirements. In this context, "Annual" refers to a twelve-month task effort that commences at award.

2.4.1 *Semi-Annual Progress Report Deliverable*

The PI shall provide a written Semi-Annual Progress Report. These reports are phased such that end-of-year reports are aligned with required reporting for the NSSC.
The Semi-Annual Report must:

1. Describe the primary findings, technology development results, and technical status, e.g., status of design, construction of prototype implementations, results of tests and/or proof-of-concept demonstrations, etc.;
2. Describe the work planned for the remainder of the project and critical issues that need to be resolved to successfully complete the remaining planned work;

3. Quantitatively summarize the cost and schedule status of the project, including any schedule slippage/acceleration;
4. Include an updated Summary Chart noting changes in team membership, milestones, schedule, and updates to the TRL;
5. A TRL assessment sheet that describes the current TRL level of the effort and plans for maturing the technology to the anticipated final TRL of the effort;
6. Report any educational and outreach components of the project, e.g., graduate degrees, educational activities; technology infusion or patents applied for or granted; journal or conference publications; presentations at professional conferences, seminars, and symposia; demonstrations; media exposure; and, other activities that contributed to the overall success of the research project.

The release of the PI's annual budget allocation is contingent on the timely submission of the written Semi-Annual Progress Report deliverable.

2.4.2 *Final Report*

The PI shall provide a written Final Report at the completion of the activity. The Final Report is similar to the Semi-Annual Report and includes all of the products required in the Semi-Annual Report, with the following exceptions:

- The Final Review must provide conclusions of the work performed and make recommendations for follow-on activities that should be pursued;
- As this is the Final Report, there is no need to present future work plans or a cost profile.

The written Final Report shall include the following:

1. Background of the project, including the science rationale for conducting this technology development;
2. Results of all analyses, element, subsystem, or system designs and/or prototyping implementations and designs;
3. Performance analysis results of tests and/or demonstrations; estimation of reduction(s) in size, mass, power, volume, and/or cost; improved performance; description of newly enabled capability; and documentation of technology dependencies;
4. Tables, graphs, diagrams, curves, sketches, photographs, and drawings in sufficient detail to comprehensively explain the results achieved;
5. An updated TRL assessment;
6. At the end of the period of performance, the PI shall provide a final Accomplishments Chart which contains the following information:
   - Title, PI Name and Institution
   - Target (Mars subsurface, airless body surface, planetary body flyby or orbit, etc.)
   - Bulleted list of science that will be enabled by new instrument
   - Bulleted list of instrument development accomplishments
   - Co-Is/Institutions
   - A figure illustrating and clarifying the proposed concept
   - Exit TRL

The written Final Report, Accomplishments Chart, and updated TRL assessment shall be uploaded to the ERS system on or before the designated anniversary date. Links to the templates for all of these documents can be found within the ERS system.

2.5 Planetary Science Early Career Award

Details of the new Planetary Science Early Career Award (ECA) program are given in program element C.19. The aim of this program is to support research and professional development of outstanding early-career scientists, and to help stimulate research careers in areas supported by the Planetary Sciences Division. This program is an ECA-participating ROSES program element. Proposals from eligible PIs, or Science PIs if applicable, selected from this program this year may become the 'parent award' for future ECA proposals.

3. Resources: Information, Data, and Facilities

Proposers to this program are not required to provide a Data Management Plan. However, dissemination of the findings of the effort via conference presentations and journal articles is expected, and the plan for dissemination should be briefly described. Archiving conference presentations and journal articles in ERS is highly encouraged.

3.1 Facilities Available to Proposers **[Clarified June 22, 2020]**

Proposers are advised to read Section 4 of program element C.1, The Planetary Science Division Research Program Overview, for information on facilities that are available to supported investigators. If their use is anticipated, this should be discussed and justified in the submitted proposals (especially note the provision for such discussion in the proposal section entitled Facilities and Equipment). Also note that, per the directions in **Section 3.17 of** the *NASA Guidebook for Proposers* **and Table 1 of the ROSES Summary of Solicitation, any facility or resource not under the direct control of the PI or a Co-I requires a letter of support acknowledging that it is available for the proposed use during the proposed period.** ~~a letter of support may be required from any facility required for the proposed effort.~~

4. Proposal Submission Process

This program element uses a two-step proposal submission process described in program element C.1, Section 2.

Proposers are reminded that Step-1 proposals are mandatory and must be submitted by the proposing organization.

Proposals must follow all formatting requirements that are described in program element C.1 and Section IV(b)ii of the ROSES Summary of Solicitation. Violation of these rules is sufficient grounds for a proposal to be rejected.

An entry level Quad Chart, not counted in the page limit, shall be submitted as an appendix to the Step-2 Proposal as a separate PDF document uploaded to NSPIRES as document type "Appendix". See Section 2.1 for more details regarding the Quad Chart.

5. Summary of Key Information

Expected program budget for first year of new awards	~$3.~~5~~M **[Corrected September 2, 2020]**
Number of new awards pending adequate proposals of merit	~~~~12~~ **10** awards **[Corrected September 2, 2020]**
Maximum duration of awards	3 Years
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA.
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	No earlier than July 1, 2021
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Table 1 of the *ROSES Summary of Solicitation*.
Relevance	This program is relevant to the Planetary Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See *the ROSES Summary of Solicitation*.
General requirements for content of proposals	See C.1 the Planetary Science Research Program Overview, and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of the *ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of Step-1 and Step-2 proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of Step-1 and Step-2 proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-PICASSO

Main point of contact concerning this program:	**Catherine Walker [updated July 16, 2020]** Planetary Science Division Science Mission Directorate National Aeronautics and Space Administration Washington DC 20526-0001 Telephone: (202) 358-**5118** Email: **catherine.c.walker@nasa.gov**
Other points of contact related to this program all of whom share the following postal address: Planetary Science Division National Aeronautics and Space Administration Washington DC 20526-001	Questions concerning Discovery or Astrobiology Program may be addressed to: Mary A. Voytek Senior Scientist for Astrobiology Telephone: 202-358-1577 Email: mary.voytek-1@nasa.gov Questions concerning Lunar scientific objectives may be addressed to: Sarah Noble Telephone: 202-358-2492 Email: sarah.noble-1@nasa.gov Questions concerning New Frontiers Program may be addressed to: Curt Niebur New Frontiers Program Discipline Scientist Telephone: 202-358-0390 Email: curt.neibur@nasa.gov Questions concerning Mars Exploration Program may be addressed to: Michael A. Meyer Lead Scientist Mars Exploration Program Telephone: 202-358-0307 Email: michael.a.meyer@nasa.gov

C.13 MATURATION OF INSTRUMENTS FOR SOLAR SYSTEM EXPLORATION

NOTICE: June 22, 2020. Subsection 3.2 has been clarified to remind proposers of the necessity for a letter of support for facilities not under the direct control of the PI or Co-I. New text is in bold and deleted text is struck through.

Amended June 4, 2020. This amendment delays the Step-2 proposal due date for this program element. The due date for Step-2 proposals is now July 17, 2020.

This program element continues to use a two-step proposal submission process described in Section 2 of Appendix C.1. The entry level Technology Readiness Level for this program has been raised to TRL 4 in order to more clearly differentiate this program from the PICASSO program. Planetary protection requirements are imposed on instruments intended to operate in an environment where Earth life could proliferate, see Section 2.1 for more details. Proposals must include an entry Summary Chart submitted as a separately uploaded appendix along with the Step-2 proposal, see Section 2.1 for more details. Progress reports are due Quarterly, see Section 2.4. No data management plan is requested for this program element.

1. Scope of Program

The Maturation of Instruments for Solar System Exploration (MatISSE) Program supports the advanced development of spacecraft-based instruments that show promise for use in future planetary missions. The goal of the program is to develop and demonstrate planetary science instruments to the point where they may be proposed in response to future announcements of flight opportunity without additional extensive technology development (approximately technology readiness level [TRL] 6). The proposed instrument must address specific scientific objectives of likely future planetary science missions.

The MatISSE Program seeks proposals for development activities leading to instrument systems in support of the Science Mission Directorate's (SMD) Planetary Science Division. The objectives of the program are to develop new technologies that significantly improve instrument measurement capabilities for planetary science missions (such as SIMPLEx, Discovery, New Frontiers, Mars Exploration, and other planetary programs, including those flown on commercial spacecraft). It is the responsibility of the proposer to demonstrate how their proposed technology addresses significant scientific questions relevant to stated NASA goals and not for NASA to attempt to infer this.

Only proposals relevant to Planetary Science Division's strategic goals and objectives will be considered for this program element. The MatISSE Program is intended to enable technology infusion into NASA planetary science missions to take place in a timely and efficient manner. As such, the technology readiness level (TRL) that MatISSE supports is TRL 4-6.

It is the responsibility of the proposer to justify the entry and exit level TRL of the proposed technology. Instrument development activities must be planned and initiated so that major technological risk is retired prior to a science solicitation via an Announcement of Opportunity (AO) or Request for Proposal (RFP). This program will permit appropriate funding to be applied at each stage of readiness associated with the development and demonstration of key and enabling technologies, such as breadboarding, brassboarding, and testing of critical components and complete instruments in a relevant environment.

A full description of technology readiness levels (TRLs) 1- 9 appears in Appendix E of NASA Procedural Requirement 7123.1B and is available on the web at *http://nodis3.gsfc.nasa.gov/displayDir.cfm?Internal_ID=N_PR_7123_001B_&page_name=AppendixE*.

Prospective proposers are encouraged to review "Visions and Voyages for Planetary Science in the Decade 2013-2022" (https://solarsystem.nasa.gov/docs/Vision_and_Voyages-FINAL.pdf) for the most recent Decadal Survey) and the 2014 Science Plan for NASA's Science Mission Directorate (available at http://science.nasa.gov/about-us/science-strategy/) to learn more about relevant missions.

Proposals not appropriate for MatISSE are feasibility studies, concept formulation, and proof of concept or advanced component development. Proposals for low-TRL instrument technologies should be submitted to the C.12 Planetary Instrument Concepts for the Advancement of Solar System Observations (PICASSO) Program in ROSES.

Proposals that focus on high-TRL development of instrumentation specific to lunar operations should be submitted to C.20 Development and Advancement of Lunar Instrumentation (DALI) call. In addition, MatISSE does not support proposals that seek to develop ground-based laboratory instruments; astronomical or astrophysics space observations; auxiliary instrumentation, such as spectrometers for ground-based telescopes, mission operation and system software; or any spacecraft technology that does not directly address planetary science instrumentation.

The nature of specific efforts selected for funding will vary, with emphasis given to innovative technologies that improve instrument measurement capabilities. It is anticipated that the science payloads on most future planetary science spacecraft will be limited to small, low mass, and low power consumption instruments.

The Planetary Science Division strongly encourages proposers to investigate current and recent Small Business Innovative Research awards (http://sbir.gsfc.nasa.gov/abstract_archives) as well as NASA programs such as Planetary Instrument Concepts for the Advancement of Solar System Observations (PICASSO), the retired NASA programs Planetary Instrument Definition and Development Program (PIDDP) and Astrobiology Science and Technology for Instrument Development (ASTID), and Science Technology Mission Directorate (STMD) programs such as Game Changing Technologies for possible teaming and leveraging of emerging technologies.

2. Programmatic Considerations

2.1 Special Requirements for Proposals

Proposals are solicited under this program element for instrument development only for the mission focus areas described in Decadal Survey or the current (2014) version of the SMD Science Plan (which may be found here). All Step-2 proposals submitted to this program element must specify:

- The mission focus area for which the proposed instrument is applicable. Instruments that are applicable to more than one mission are encouraged.
- The relationship between the science objectives and the instrumental capabilities must be clearly demonstrated. For those instruments that are applicable to more than one mission or capable of meeting multiple science objectives, examples of science objectives for the proposed mission or missions must be given.
- A detailed description and justification for the entry technology readiness level and a detailed plan for raising the instrument to the proposed exit technology readiness level. The plan must include descriptions of planned tests or demonstrations and milestones, as well as discussions of how those tests or demonstrations will advance the technology readiness level of the instrument.
- Technological advances are to be pursued as an inherent element of achieving the science objectives. Such advances may be suitable for technology transfer beyond PSD, either within NASA or beyond – including to commercial entities. Investigations with such potential are encouraged but must also describe possible mechanisms for such transfer.
- The technical, schedule, and cost risks to the proposed project and risk mitigation strategies shall be addressed in the proposal work plan.
- How the proposed instrument system would address planetary protection requirements, as described in the NASA Procedural Requirements document, NPR 8020.12, Version D. Restrictions on operation and hardware cleanliness apply to all instrument systems that are intended to operate in environments where Earth life could proliferate – currently that is considered to be Mars, Europa, Enceladus, and anywhere in the Solar System where warm ice or liquid water is possible and includes instrument systems or component technology associated with detection of signs of life or biosignatures. Applicable proposals must discuss, at a level appropriate to the exit TRL, how the instrument design and material choices are compatible with 1) surface bioburden reduction techniques, 2) reduction of contamination by organic compounds, 3) recontamination prevention, and 4) the reduction of encapsulated bioburden. The instrument developer is encouraged to communicate informally with the Office of Planetary Protection regarding planetary protection categorization and associated requirements with a future mission interest as they relate to instrument design and development. For additional information, proposers may contact the NASA Planetary Protection Officer, Dr. Lisa Pratt at lisa.m.pratt@nasa.gov and cc the point of contact below.
- Because of the anticipated greater degree of complexity, the Scientific/Technical/Management section of proposals for these investigations may be 25 pages long, instead of the default 15 pages specified in the *NASA Guidebook for Proposers*

- An entry level Summary Chart, not counted in the page limit, shall be submitted as a separately uploaded appendix PDF file to the Step-2 Proposal. A template for the entry level Summary Chart is available from the SARA web page at https://science.nasa.gov/researchers/templates-planetary-science-division-appendix-c-roses-proposals. The Summary Chart shall contain the following information:
  a. Title, Principal Investigator (PI) Name and Institution
  b. Target (Mars subsurface, airless body surface, planetary body flyby or orbit, etc.)
  c. Bulleted list of science that will be enabled by a new instrument
  d. Bulleted list of major objectives of proposed work
  e. Co-Investigators (Co-Is) Names and Institutions
  f. A figure illustrating and clarifying the proposed concept
  g. Top level Milestones
  h. Entry and exit technology readiness levels (TRLs)
- An optional TRL Assessment spreadsheet is available from the SARA web page may be included in the Step-2 Proposal to help justify the TRL case. This optional spreadsheet does not count against the page limit and is to be placed immediately following the References and Citations section for the Scientific/Technical/ Management portion of the proposal.

2.2 Additional Evaluation Considerations

In addition to the criteria specified in Section VI. (a) *ROSES Summary of Solicitation* and (by reference) the *NASA Guidebook for Proposers,* the assessment of Merit includes the extent to which the instrument addresses a priority science goal of the mission or missions for which it would be a candidate for flight, if applicable.

2.3 Award Duration and Types

It is expected that most proposals will request awards with durations of three years, but proposals may be submitted for projects of duration from one to four years. For proposals that request an award of four years in duration, a detailed justification is required and will be used in determining the duration of any award, should the proposal be selected. Awards to non-governmental organizations will be in the form of grants (or cooperative agreements if appropriate).

2.4 Technical Reporting Requirements

Once awarded, all Progress Reporting deliverables applicable to this MatISSE solicitation shall be submitted to the web-based Planetary Electronic Reporting System (ERS). A user account on ERS will be provided to the PI upon award. Due to NASA IT security requirements, all Principal Investigators (PIs) must register with the Identity Management and Account Exchange (IdMAX) system before a user account on ERS will be established. To create an IdMAX account, some personal information will be required. All submissions shall be made in PDF, except the Quad-Chart which shall be in Microsoft PowerPoint.

The following deliverables shall be required of institutions that win awards. In cases where subcontract arrangements exist, consolidated project reports are the responsibility of the Principal Investigator (PI). The proposed budget should provide for

these reporting requirements. In this context, "Annual" refers to a twelve-month task effort that commences at award.

2.4.1 *Initial Plans and Reports*

If a proposal was "descoped" (i.e., only part of the scope of the project will be supported by NASA), the PI should contact the NASA Program Officer after receipt of the Award notification Letter to discuss a revised budget and work plan. No funding will be awarded until an updated project plan and budget have been received and approved by the NASA Program Officer. NASA may direct that the project plan and budget be emailed to the cognizant NASA Program Officer or uploaded via NSPIRES.

2.4.2 *Quarterly Technical Reports*

The quarterly technical report shall focus on the preceding three month's efforts. Each report shall address:

1. Technical status: The PI shall summarize accomplishments for the preceding three months, including technical accomplishments (trade study results, requirements analysis, design, etc.), technology development results, and results of tests and/or demonstrations.
2. Schedule status: The PI shall quantitatively address the status of major tasks and the variance from planned versus actual schedule, including tasks completed, tasks in process, tasks expected to complete later than planned, and tasks that are delayed in starting, with rationale for each and recovery plans, as appropriate.

Quarterly Technical Reports shall be uploaded to the ERS system starting on the third-month anniversary date of the signing of the award vehicle. All awardees will receive an ERS username and password after selections have been made.

In months for which the PI is providing an Annual Review, the requirement for a quarterly report is superseded by the review requirements discussed in the next two sections.

Reports shall be submitted in PDF, except the Quad-Chart which shall be in Microsoft PowerPoint compatible file formats by the required due date, or by close of business of the first workday following the due date, if the due date falls on a weekend or a holiday. A teleconference or brief meeting may be conducted between the NASA Program Officer and the PI to review and discuss each report.

2.4.3 *Annual Progress Report Deliverable*

The PI shall provide an Annual Review at the end of the first twelve-month calendar period commencing from the date of award and at twelve-month intervals thereafter. The PI must conduct an oral presentation summarizing the work accomplished and results leading up to this Annual Review and must:

1. Describe the primary findings, technology development results, and technical status, e.g., status of design, construction of breadboards or prototype implementations, results of tests and/or proof-of-concept demonstrations, etc.;
2. Describe the work planned for the remainder of the project and critical issues that need to be resolved to successfully complete the remaining planned work;

3. Summarize the cost and schedule status of the project, including any schedule slippage/acceleration. A schedule milestone chart of all major task activities shall be created and maintained and shown at all reviews. A cost data sheet shall be created and maintained, showing total project costs committed, obligated, and costed, along with a graphical representation of the project cost profile to completion;
4. Provide a summary of accomplishments and anticipated results at the end of the task;
5. Report any educational and outreach components of the project, e.g., graduate degrees, educational activities; technology infusion or patents applied for or granted; journal or conference publications; presentations at professional conferences, seminars, and symposia; demonstrations; media exposure; and, other activities that contributed to the overall success of the research project;
6. The Annual Review should be comprehensive and should include a discussion of the planned content of the written report.

The NASA Program Officer will conduct the Annual Review at the PI's facility or via teleconference. If the review is conducted at the PI's facility, or a mutually agreed to location, the PI may also provide a laboratory demonstration, if appropriate, to show technical results and status. The presentation slides (Power Point) shall be uploaded to the ERS system at least two working days prior to the review.

Following the review, the presentation shall be updated in accordance with comments and discussion resulting from the review; this will constitute the Annual Review. The presentation, updated in accordance with comments and discussion resulting from the review, together with the separate written Annual Report, shall constitute the Annual Progress Report deliverable. A copy of each report shall be uploaded to the ERS system and, for grants, emailed to the NASA Shared Services Center (NSSC) at NSSC-Grant-Report@mail.nasa.gov. For grants, the Annual Review may be scheduled as early as 60-days before the anniversary start date. The release of the annual budget allocation is contingent on the timely submission of the Annual Progress Report deliverables.

2.4.4 *Final Review and Final Report*

The PI shall provide a comprehensive Final Review at the completion of the activity. The Final Review is similar to the Annual Reviews and includes all of the products required at an Annual Review with the following exceptions:

1. The Final Review must provide conclusions of the work performed and make recommendations for follow-on activities that should be pursued, with estimates of the cost and schedule to achieve TRL 7.
2. As this is the Final Review, there is no need to present future work plans or a cost profile.

The written Final Report shall include the following:

1. Background of the project, including the science rationale for conducting this technology development;

2. Results of all analyses, element, subsystem, or system designs, breadboards, and/or prototyping implementations and designs;
3. Performance analysis results of tests and/or demonstrations; estimation of reduction(s) in size, mass, power, volume, and/or cost; improved performance; description of newly enabled capability; and documentation of technology dependencies;
4. Tables, graphs, diagrams, curves, sketches, photographs, and drawings in sufficient detail to comprehensively explain the results achieved;
5. An updated TRL assessment, including a rough order of magnitude cost and a description and estimate of the duration of the follow-on activities necessary to achieve TRL 7;
6. At the end of the period of performance, the PI shall provide a final Accomplishments Chart which contains the following information
   - Upper Left: "Description and Objectives."
   - Middle: "Accomplishments."
   - Upper Right: A visual, graphic, or other pertinent information.
   - Bottom: "Co-Is" (name and affiliation), "Entry TRL," and "Exit TRL."

The written Final Report, Accomplishments Chart, and updated TRL assessment shall be uploaded to the ERS system within ten days of the final review. In addition, for grantees, a copy of the written report shall be emailed to the NSSC.

2.5 Planetary Science Division Early Career Fellowship Program

Details of the new Planetary Science Early Career Award (ECA) program are given in program element C.19. The aim of this program is to support research and professional development of outstanding early-career scientists, and to help stimulate research careers in areas supported by the Planetary Sciences Division. This program is an ECA-participating ROSES program element. Proposals from eligible PIs, or Science PIs if applicable, selected from this program this year may become the 'parent award' for future ECA proposals next year.

3. Resources: Information, Data, and Facilities

3.1 Limits on Use of Mission Data

Proposals to this program element must follow the rules for use of mission data given in Section 3.5 of C.1, The Planetary Science Division Research Program Overview. If the data to be analyzed have issues that might represent an obstacle to analysis, the proposers must demonstrate clearly and satisfactorily how such potential difficulties will be overcome.

3.2 Facilities and Data Sources Available to Proposers **[Clarified June 22, 2020]**

Proposers are advised to read Section 4 of C.1, The Planetary Science Division Research Program Overview, for information on facilities and data sources that are available to supported investigators. If their use is anticipated, this should be discussed and justified in the submitted proposals (especially note the provision for such discussion in the proposal section entitled Facilities and Equipment). Also note that, per the directions in **Section 3.17 of** the *NASA Guidebook for Proposers* **and Table 1 of**

the *ROSES Summary of Solicitation*, any facility or resource not under the direct control of the PI or a Co-I requires a letter of support acknowledging that it is available for the proposed use during the proposed period. ~~a letter of support may be required from any facility required for the proposed effort.~~

4. Proposal Submission Process

This program element uses a two-step proposal submission process described in C.1, Section 2.

Proposers are reminded that Step-1 proposals are mandatory and must be submitted by the proposing organization.

Proposals must follow all formatting requirements that are described in program element C.1 and Section IV(b)ii of the ROSES Summary of Solicitation. Violation of these rules is sufficient grounds for a proposal to be rejected.

5. Summary of Key Information

Expected program budget for first year of new awards	~ $1.0M per year per award
Number of new awards pending adequate proposals of merit,	~ 6
Maximum duration of awards	3-4 Years, (See last bullet in Section 2.3)
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA.
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	Six months after the Step-2 proposal due date
Page limit for the central Science/Technical/Management section of proposal	25 pp; see also Table 1 of the *ROSES Summary of Solicitation.*
Relevance	This program is relevant to the Planetary Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See C.1 the Planetary Science Research Program Overview, and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the* ROSES Summary of Solicitation.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.

Web site for submission of Step-1 and Step-2 proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of Step-1 and Step-2 proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-MATISSE
Main Point of contact concerning this program	Haris Riris Planetary Science Division Science Mission Directorate National Aeronautics and Space Administration Washington DC 20526-0001 Telephone: (301) 614-6736 Email: haris.riris-1@nasa.gov
Points of contact for related programs, all of whom share this mailing address: Planetary Science Division National Aeronautics and Space Administration Washington DC 20526-0001	Questions concerning Discovery or Astrobiology Program may be addressed to: Mary A. Voytek Senior Scientist for Astrobiology Telephone: 202-358-1577 Email: mary.voytek-1@nasa.gov Questions concerning New Frontiers Program may be addressed to: Curt Niebur New Frontiers Program Scientist Telephone: 202-358-0390 Email: curt.neibur@nasa.gov Questions concerning Lunar scientific objectives may be addressed to: Sarah Noble Telephone: 202-358-2492 Email: sarah.noble-1@nasa.gov Questions concerning Mars Exploration Program may be addressed to: Michael A. Meyer Lead Scientist Mars Exploration Program Telephone: 202-358-0307 Email: michael.a.meyer@nasa.gov

C.14 PLANETARY SCIENCE AND TECHNOLOGY THROUGH ANALOG RESEARCH

NOTICE: Amended July 6, 2020. This program element is converting to a biennial program: it will not be solicited as part of ROSES-20 but will be solicited in ROSES-21 and every other year thereafter.

June 22, 2020. Subsection 2.1 has been clarified to remind proposers of the necessity for a letter of support for facilities not under the direct control of the PI or Co-I. New text is in bold.

This program element continues to use a two-step proposal submission process described in Section 2 of C.1 The Planetary Science Division Research Program Overview.

1. Scope of Program

NASA analog missions research addresses the need for integrated interdisciplinary field experiments as an integral part of preparation for future human and robotic missions. Future planetary research associated with Solar System exploration requires the development of relevant, miniaturized instrumentation capable of extensive operations on lunar, asteroid, and planetary surfaces throughout the Solar System. To this end, and in collaboration with other Directorates at NASA and other agencies, this Planetary Science and Technology Through Analog Research (PSTAR) program solicits proposals for investigations focused on exploring the relevant environments on Earth in order to develop a sound technical and scientific basis to conduct planetary research on other Solar System bodies. The PSTAR program is a science-driven exploration program that is expected to result in new science and operational/technological capabilities to enable the next generation of planetary exploration. Proposals must demonstrate fidelity to at least two of the following three objectives:

1) Science: PSTAR seeks science investigations designed to further planetary research in terrestrial extreme environments that may be analogous to those found on other planets, past or present. Of particular interest are investigations that increase our understanding of the limits of and constraints (or lack thereof) on life in extreme environments and lead to a better understanding of how to seek, identify, and characterize life and life-related chemistry that may exist or have existed on other Solar System bodies. Proposals which claim science fidelity are expected to result in publishable-quality planetary or Earth science results.

2) Science Operations: PSTAR seeks systems-level terrestrial field campaigns that are conducted with complete systems and in a manner that approximates operations during an actual planetary mission, providing an opportunity to understand the performance, capabilities, and efficiencies associated with the tested systems, while enabling human participants to gain operational experience with those systems in the field. Fidelity in this area means that the constraints placed on the execution of science tasks in the field are functionally similar to those of an actual mission, enabling the development, testing, and validation of new concepts of operations that may impact the design of surface infrastructure or ground support. Some examples of science operations elements include:
    a. Decision-making protocols;
    b. Traverse planning;

c. Sample acquisition, storage, documentation, and high-grading protocols;
d. Communications and data flow protocols to support science;
e. Navigation unique to science support;
f. Crew scheduling for Intra- and Extravehicular activities; and
g. Science backroom design and support for surface science activities.

Proposals which claim science operations fidelity are expected to describe investigations that rigorously test and evaluate science operations elements, not simply utilize them.

3) Technology: PSTAR seeks the testing and application of technologies that support science investigations, particularly those that enable remote searches for, and identification of, life and life-related chemistry in extreme environments (including lunar and planetary surfaces). These technologies include, but are not limited to:
    a. sample acquisition and handling techniques;
    b. sample manipulation;
    c. the use of mobile science platforms (including planetary rovers and astronauts);
    d. techniques for autonomous operations;
    e. self-contained deployment systems;
    f. intelligent systems and human/robotic interfaces;
    g. communication and navigation systems; and
    h. instrument packages.

PSTAR is not an instrument development program. Science instrument technology proposals should be submitted to C.12 The Planetary Instrument Concepts for the Advancement of Solar System Observations (PICASSO), C.13 The Maturation of Instruments for Solar System Exploration (MatISSE) Program, or C.20 Development and Advancement of Lunar Instrumentation (DALI) Program.. Hardware development to ruggedize instruments or otherwise prepare for field trials is acceptable, but is expected to be a minor part of the overall proposed effort.

In summary, PSTAR is expected to lower the risks of planetary exploration through instrument/technology development aimed at or coupled with systems-level field tests in relevant environments that will obtain scientific data and/or develop operational capability.

The high-visibility field campaigns to the Earth's extreme environments that are expected to be supported through this program element should also provide significant opportunities for student involvement in exploration, thereby inspiring a technologically competent next generation of scientists, engineers, explorers, and citizens. Therefore, proposals to PSTAR that provide for graduate or undergraduate science training are encouraged.

In addition, because field activities, particularly those with a high degree of technology fidelity, tend to attract the attention of the public and the media, proposers must include a plan for engaging with the public and media during their field deployment (see section 2.10).

2. Programmatic Information

2.1 General Information

Proposals submitted in response to this call should be for new work that is not currently supported by the Planetary Sciences research and analysis program or for investigations that would extend to their next logical phase those tasks that have been funded, but whose periods of performance expired in this past year or are expiring in the first half of this coming year.

Proposers are strongly advised to read C.1 The Planetary Science Division Research Program Overview, for information on mandatory data management plans.

Proposers are reminded that, per the directions in Section 3.17 of the *NASA Guidebook for Proposers* and Table 1 of the ROSES Summary of Solicitation, any facility or resource not under the direct control of the PI or a Co-I requires a letter of support acknowledging that it is available for the proposed use during the proposed period. [Clarified June 22, 2020]

2.2 Special Requirements for Proposals

Proposals should follow the guidelines set for all ROSES proposals, as given in the *NASA Guidebook for Proposers*.

Proposals should also specify:

- Area(s) of fidelity (Science, Science Operations, and/or Technology, as described in Section 1) that are addressed by the project.
- Specific field activity, site(s), and dates being targeted for their investigation(s), as well as a clear schedule for field preparations, training, and deployment strategy.

Justification for field site selection (see Section 2.4 for restriction on Antarctica).

- If proposed investigation(s) are to be conducted in conjunction with established field campaign(s), proposers must provide evidence of coordination with field campaign leaders.
- Field resource requirements:
    - Duration, timing, and scheduling of investigations
    - Power requirements
    - Communications requirements (bandwidth, type of communications, etc.)
    - Logistics Support Requirements
    - Permits and/or land access/use requirements
- The science objectives and expected science return of the proposed investigation – type and amount of data, validation of science requirements, expected publications, etc.
- Specific deliverables at the conclusion of the field activity.
- Source, type, and amount of external funding already received or expected, if any, for the hardware, software, or operational concepts being tested.
- Risks to the investigation, including weather scrubs, hardware failures, power failures, etc., and a mitigation plan.

- Clear budget, including field deployment costs, logistics support, direct labor, overhead, subcontracts, special equipment, travel, Education and Public Outreach, other costs, General and Administrative Expenses, fees, etc.
- A plan for engaging the public and media during field deployment (see sec 2.10 below).

2.3 Development of Flight Instruments

This solicitation does not request proposals for the development of advanced instrument concepts and technologies as precursors to flight instruments. Such proposals should be submitted to C.12 Planetary Instrument Concepts for the Advancement of Solar System Observations (PICASSO), C.13 The Maturation of Instruments for Solar System Exploration (MatISSE) Program or C.20 Development and Advancement of Lunar Instrumentation (DALI) Program.

2.4 Antarctica

The PSTAR program does not accept proposals for work in Antarctica.

2.5 Instrumentation: Construction or Upgrade

Proposers to PSTAR are eligible to request funds for major equipment under the Planetary Major Equipment and Facilities (PMEF) program. See program element C.17 for information on how to append a PMEF request to a regular PSTAR research proposal or submit a stand-alone PMEF proposal to supplement an existing PSTAR award.

2.6 Topical Workshops

The PSTAR program does not accept proposals for topical conferences, workshops, or symposia; such proposals may be submitted in response to program element E.2, "Topical Workshops, Symposia, and Conferences." Proposers should specifically identify the PSTAR program as the relevant SMD program element and refer to the goals and objectives of the PSTAR program in demonstrating relevance.

2.7 Planetary Science Early Career Award

Details of the new Planetary Science Early Career Award (ECA) program are given in program element C.19. The aim of this program is to support research and professional development of outstanding early-career scientists, and to help stimulate research careers in areas supported by the Planetary Sciences Division. This program is an ECA-participating ROSES program element. Proposals from eligible PIs, or Science PIs if applicable, selected from this program may become the 'parent award' for future ECA proposals.

2.8 NASA Postdoctoral Program Fellows

Grantees of astrobiology-relevant awards in the program are eligible to serve as mentors to Astrobiology NASA Postdoctoral Program (NPP) Fellows. The tenure of a Fellow must begin before the end of the PSTAR award but may extend beyond it. Proposals from potential Fellows must be submitted through the standard NPP process. The Astrobiology Program expects to select no more than two Fellows associated with

PSTAR research in 2020. More information about the NASA Postdoctoral Program may be found at http://npp.usra.edu/.

2.9 Data Management Plans (DMPs)

Appendix C.1, Section 3.7, discusses the requirements for DMPs in proposals to this program element. Please note that DMPs are mandatory for this program element and must be placed in a special section no longer than two pages in length, immediately following the References and Citations section for the Scientific/Technical/Management portion of the proposal.

2.10 Plan to engage the Media and Public

Because field activities tend to attract the attention of the public and the media, it is important for teams to be prepared to engage and take advantage of these unique experiences. The description of the plan should be no more than one page and included as an addendum to the 15-page technical proposal immediately following the DMP. Proposals that incorporate public engagement activities, through telepresence capabilities and involvement of professional educators and students nationwide in the fun and challenges of science and technology are particularly encouraged. Proposers should also state in their proposals whether they are willing to host an outside public engagement activity arranged by NASA. Resources budgeted for engagement activities may constitute only a minor component of the proposal.

2.11 Proposal Submission Process

This program element uses a two-step proposal submission process described in Section 2 of Appendix C.1.

Proposers are reminded that Step-1 proposals are mandatory and must be submitted by the proposing organization.

Proposals must follow all formatting requirements that are described in program element C.1 and Section IV(b)ii of the ROSES Summary of Solicitation. Violation of these rules is sufficient grounds for a proposal to be rejected.

2.12 Duration and Size of Awards

The standard award duration is three years. NASA anticipates that most proposals will seek three years of funding. However, proposals for less than three years are highly encouraged for projects that can be completed on shorter timescales. On rare occasions, four-year projects can be considered, but appropriate justification must be provided. The appropriateness of the proposed funding period will be reviewed, and adjustments may be requested. Programmatic balance may limit the opportunities for funding in some areas.

A wide range of award sizes is expected, depending on the nature and scope of the work proposed. We anticipate funding several larger-scope awards (typically $500K-1M per year) and several smaller-scope awards (typically $40-100K per year).

3. Summary of Key Information

Expected program budget for first year of new awards	Not solicited This Year
Number of new awards pending adequate proposals of merit	Not solicited This Year
Maximum duration of awards	4 years (see Section 2.12)
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA.
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	8 months after Step-2 proposal due date.
Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of the ROSES *Summary of Solicitation*.
Relevance	This program is relevant to the Planetary Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See C.1 the Planetary Science Research Program Overview, and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the NASA Guidebook for Proposers and Section IV(b) of the *ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of Step-1 and Step-2 proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of Step-1 and Step-2 proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-PSTAR

Points of contact concerning this program both of whom share this postal address: Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001	Sarah Noble Telephone: (202) 358-2492 Email: sarah.noble-1@nasa.gov Mary Voytek Telephone: (202) 358-1588 Email: mary.voytek-1@nasa.gov

C.15 PLANETARY PROTECTION RESEARCH

NOTICE: NASA does not intend to solicit proposals for this program element in ROSES this year. There was a large increase (2-4x) in proposals received for ROSES-2018, which was solicited in early in 2019. It is anticipated that it will be solicited next in ROSES-2021.

1. Scope of Program

Planetary Protection is the practice of protecting solar system bodies from contamination by Earth life and protecting Earth from possible life forms that may be returned from other solar system bodies. Numerous areas of research in astrobiology/exobiology are improving our understanding of the potential for survival of Earth microbes in extraterrestrial environments, relevant to preventing contamination of other bodies by Earth organisms carried on spacecraft. As we continue to bring extraterrestrial samples back to the Earth system for advanced research and analysis, there is an urgent need to understand and prevent biological contamination of the terrestrial environment. Mission-enabling and capability-driven research is required to improve NASA's understanding of the potential for both forward and backward contamination; and improve methods and technologies for accurate, efficient, and effective minimization of biological contamination for outbound spacecraft and return samples. The Planetary Protection Research (PPR) program solicits research in the following areas (in order of programmatic priority):

- Identify and provide proof-of-concept on new or improved methods, designs, technologies, techniques, and procedures to support planetary protection requirements for outbound and return sample missions. Of particular interest are improvements to spacecraft cleaning and sterilization that remain compatible with spacecraft materials and assemblies, prevention of re-contamination and cross-contamination throughout the spacecraft lifecycle, and expansion of materials and commercial-off-the-shelf (COTS) hardware with compatibility to current cleaning and sterilization techniques.
- Develop or adapt modern molecular analytical methods to rapidly detect, classify, and/or enumerate Earth microbes carried by spacecraft (on surfaces and/or in bulk materials, especially at low densities) before, during, and after assembly and launch processing. Of particular interest are methods capable of identifying and verifying the functionality of microbes with high potential for surviving spacecraft flight or planetary environmental conditions (e.g., anaerobes, psychrophiles, radiation-resistant organisms), methods that can validate and support biological modeling as it relates to biological contamination of spacecraft, and comparison to current NASA planetary protection standard assay techniques.
- Model to understand and predict biological and organic contamination sourcing, transport, survival, and burden level of spacecraft. Of particular interest are mission-enabling models that support mission designers, project managers, and life-detecting science teams in the early stages of the mission lifecycle.
- Model space environmental conditions and spacecraft designs that could permit a decrease in biological contamination of spacecraft during the journey to the target destination with emphasis on reduction of organisms currently surviving under

cleanroom conditions. Of particular interest is the radiation environment of deep space and the combined effects of multiple simultaneous stressors, such as a combination of space vacuum and radiation stressors.

- Model planetary environmental conditions and transport processes that could permit mobilization of spacecraft-associated contaminants to locations in which Earth organisms might thrive. Of particular interest are the subsurface environments of icy bodies, such as Europa and Enceladus, and Mars Special Regions.
- Characterize the limits of life in laboratory simulations of relevant planetary environments or in appropriate Earth analogs. Of particular interest are studies on the potential and dynamics of organism survival and reproduction in conditions present on the surface or subsurface of Mars (e.g., gullies and ice-rich environments), or on Europa and other icy satellites – potentially in the presence of a heat source brought from Earth.

It should be noted that the evolving planetary protection requirements of NASA's programs may affect the priorities for funding among these areas.

2. Summary of Key Information

Point of contact concerning this program	Becky McCauley Rench Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0530 Email: HQ-PPR@mail.nasa.gov

C.16 LABORATORY ANALYSIS OF RETURNED SAMPLES

NOTICE: June 22, 2020. Subsection 3.4 has been clarified to remind proposers of the necessity for a letter of support for facilities not under the direct control of the PI or Co-I. New text is in bold.

Amended April 9, 2020. The due dates for this program element have been delayed. Step-1 proposals are now due May 15, 2020, and Step-2 proposals are now due July 14, 2020.

1. Scope of Program

The goal of the Laboratory Analysis of Returned Samples (LARS) program is to maximize the science derived from planetary sample-return missions. Activities supported by LARS fall into two categories: (1) development of laboratory instrumentation and/or advanced techniques required for the analysis of returned samples; (2) direct analysis of samples already returned to Earth. Proposals may fall into either category or contain tasks that do both.

All proposed work must be in support of the overarching goals of the Planetary Science Research Program to help ascertain the content, origin, and evolution of the Solar System and the potential for life elsewhere, consistent with the strategy for Planetary Science Exploration embodied in the *2014 NASA Science Plan*.

1.1 Proposals to Develop Laboratory Instrumentation or Advanced Techniques

Proposals are solicited to develop new analytical instrumentation or combinations of analytical instruments, or new components of analytical instruments, leading to significant improvements in the precision, resolution, or sensitivity of measurements compared to the existing state of the art, and to enable new types of measurements. Also solicited are proposals for the development of new analytical techniques for existing instrumentation that will push the limits of current technology, for example, by the elimination of analytical interferences or contamination problems. In all cases, both the development efforts and the clear relevance to NASA sample-return missions must be documented.

Development proposals may seek to develop instrumentation and techniques that will be used by only a small number of investigators at a single institution, or they may seek to develop facilities to be shared by the entire research community. For shared facilities, proposers must include detailed plans for facility management based on the size of the anticipated user base, including facility oversight, the fraction of time that will be made available to outside users, and the mechanism for allotting such time on a regular basis. In all cases, cost-sharing arrangements in the development of new instrumentation or techniques and evidence of a long-term institutional commitment to the analysis of returned samples will be viewed favorably in the selection process. Collaborations among instrument builders and scientists who understand the samples to be analyzed are encouraged. Ongoing laboratory support (e.g., service contracts) will not be supported.

The development proposals solicited by LARS must include significant work effort dedicated to achieving the development goals. LARS is not intended to cover

developments that are essentially equipment purchases, where the new analytical capabilities are available off-the-shelf and the work effort is limited to instrument check-out, minor adaptations for applying the instrument to returned samples, or learning how to use the new instrument.

1.2 Proposals to Analyze Returned Samples

Proposals are solicited to conduct analytical studies of astromaterials already returned by planetary missions (described in Section 2). Samples needed to carry out the work plan do not need to be allocated prior to the submission of a LARS proposal. In such cases, the proposal should address the availability of appropriate samples. Selection and funding of proposals may be contingent upon final allocation of the necessary samples.

1.3 Exclusions

1.3.1 *Lunar samples*

LARS does not support work principally relevant to past lunar sample-return missions:

- Apollo 11, 12, 14, 15, 16, and 17
- Luna 16, 20, and 24

Proposals to work on the above lunar materials are most likely to be within the scope of the Emerging Worlds (EW, program element C.2) or Solar System Workings (SSW, program element C.3) program elements.

1.3.2 *Space exposed hardware*

LARS does not support work to study returned space-flown hardware that has been exposed to micrometeorite impacts, unless associated with one of the missions listed in Section 2.1. For example, work on micrometeorite impacts on the Long Duration Exposure Facility (LDEF) is not supported by LARS. Proposals to work on micrometeorites are most likely to be within the scope of the EW and SSW programs.

1.3.3 *Terrestrial collections*

LARS does not support research on astromaterials collected on Earth (e.g., meteorites, micrometeorites, cosmic dust) unless these analyses are directly in support of the analysis of currently available mission-returned samples or are needed as part of a development effort.

1.3.4 *Spacecraft Instrumentation*

LARS does not support efforts to develop instruments for flight on planetary missions. See the instrument development calls for information on this subject (e.g., program elements C.12 PICASSO and C.13 MatISSE, and C.20 DALI).

2. Sample Return Missions

2.1 Completed sample-return missions

The following completed missions have returned samples, and may be the targets of either Instrument/Method Development or Sample Analysis proposals to LARS:

2.1.1 *Genesis*

This mission was designed to return samples of the solar wind to provide constraints on the chemical and isotopic composition of the primitive solar nebula; it was launched in 2001 and returned samples to Earth in 2004. Further information may be found at http://genesismission.jpl.nasa.gov/. Failure of the parachute system led to a hard landing in the Utah desert, and many of the fragile collectors were shattered on impact and contaminated. Intensive effort is underway to document the chips of collector materials and to measure and remove contamination from the chips. For information on availability of samples, check the Genesis curation website at http://curator.jsc.nasa.gov/genesis/index.cfm.

2.1.2 *Stardust*

This mission returned samples of the coma of comet 81P/Wild (Wild 2); it was launched in 1999, encountered the comet in 2004, and returned samples to Earth in 2006. The dust grains that impacted the silica aerogel collectors during a 6.1 km/sec flyby were all small (<100 µm) and fine-grained. In most cases the particles fragmented on impact and interacted strongly with the aerogel. For example, many particles are coated and sometimes penetrated with compressed or melted aerogel. Many particles impacted on the sample collector frame; work on particle residues in impact craters in the aluminum foils that separated the aerogel cells is also solicited. The aft-facing side of the collector was designed to collect interstellar dust particles, which are expected to be ~0.1 µm in size and to have impacted at more than 20 km/sec. Examination of this interstellar collector is extremely challenging (see http://stardustathome.ssl.berkeley.edu/). In addition to investigations involving direct analysis of Stardust materials, proposals to investigate the details of the capture process are solicited. Further information may be found from the mission homepage at http://stardust.jpl.nasa.gov/ and the Stardust curator's website at http://curator.jsc.nasa.gov/stardust/index.cfm.

2.1.3 *Hayabusa*

This mission, run by the Japan Aerospace Exploration Agency (JAXA), returned samples from the S-type Apollo asteroid, 25143 Itokawa; it was launched in 2003, encountered the asteroid in 2005, and its sample capsule was returned to Earth in 2010. In November 2010, JAXA announced that a large number of small particles, most smaller than 10 micrometers, were present in the capsule, with strong evidence of asteroidal origin for many of them. Most of the particles are curated by JAXA, and a subset that will eventually comprise 10% of the mass is curated at the Astromaterials Curation facility at NASA Johnson Space Center. More information and sample catalogs may be found at http://hayabusaao.isas.jaxa.jp/curation/hayabusa/index.html and http://curator.jsc.nasa.gov/hayabusa/.

2.2 Future sample return missions

LARS supports Method/Instrumentation Development proposals to prepare for future sample-return missions. Such proposals should focus on gaps in current capabilities of ground-based laboratories, and address both the scientific importance of making such analyses on samples to be returned from these missions, and on the timeliness of initiating the development effort during the proposed performance period. Highest

priority will be given to proposals addressing missions already selected for or in flight and to those which can best demonstrate the timeliness of the effort.

2.2.1 *OSIRIS-REx*

This mission launched in September 2016 and encountered 101955 Bennu, a 500-m diameter, B-type Apollo asteroid, in December 2018. It is currently engaged in operations around Bennu. Following observations of the asteroid, a sample of regolith (<2 cm particles) will be collected. The collected sample, which is expected to have a mass between 60 g and 2 kg, will be returned to Earth in September 2023. The samples will be curated in the Astromaterials Curation facility at NASA Johnson Space Center. The first sample catalog is expected to be published in the spring of 2024. See http://science.nasa.gov/missions/osiris-rex/ for more information.

2.2.2 *Hayabusa2*

JAXA launched the Hayabusa2 mission in December 2014, and encountered asteroid 162173 Ryugu, a ~1-km diameter, C-type, Apollo asteroid, in June 2018. Samples of surficial material have been collected from two locations on Ryugu in 2019. Samples are expected to be returned to Earth in December 2020. Samples will be made available for research by JAXA, and a fraction of the returned material will be transferred to NASA for curation at the Astromaterials Curation facility at NASA Johnson Space Center. See http://www.hayabusa2.jaxa.jp/en/ for more information.

2.2.3 *Other missions and potential missions*

Below is a list of some of the missions that may return samples to Earth in the future. Proposals addressing these missions are expected to demonstrate the timeliness of the development effort.

- Mars sample-return missions
- Future New Frontiers comet and lunar sample-return missions
- Future Discovery missions (Discovery >14)
- JAXA's Martian Moons eXploration mission (MMX)
- Emerging lunar sample return opportunities

3. Programmatic information

3.1 Proposals that contain both development efforts and sample analysis

Proposers will be asked during proposal submission in NSPIRES whether the proposal is a development effort, per section 1.1, a sample analysis effort, per section 1.2, or contains elements of both. For proposals that contain both, the development and sample analysis efforts should be clearly delineated and identified, preferably, but not necessarily, as separate tasks.

3.2 Supplemental Funding for Additional Instrumentation

Proposers to LARS are eligible to request funds for Planetary Major Equipment and Facilities (PMEF). See program element C.17 for information on how to append a PMEF request to a regular LARS research proposal or submit a stand-alone PMEF proposal to supplement an existing LARS award.

LARS treats PMEF requests differently from other program elements:

Appended PMEF requests to LARS may only be made for significant off-the-shelf purchases of instrumentation needed to directly perform or enhance the proposed research in an analysis proposal (as described in section 1.2).

Because LARS directly solicits the development of laboratory instruments, proposers to this program element may not use appended PMEF requests for the purpose of acquiring hardware for instrument development (as described in section 1.1). If the main proposal includes a significant effort to enhance or further develop an off-the-shelf instrument, or to develop analytical methods using such an instrument, then a PMEF appendix is not permitted: the instrument purchase must be part of the main proposal and described within the 15-page limit of the Scientific/Technical/Management portion of the proposal. In these cases, specifications and quotations for significant equipment purchases may be included in the detailed proposal budget.

The rules for stand-alone PMEF requests to LARS are the same as for other program elements, as described in C.17.

3.3 Planetary Science Early Career Award

Details of the new Planetary Science Early Career Award (ECA) program are given in program element C.19. The aim of this program is to support research and professional development of outstanding early-career scientists, and to help stimulate research careers in areas supported by the Planetary Sciences Division. This program is an ECA-participating ROSES program element. Proposals from eligible PIs, or Science PIs if applicable, selected from this program in 2019 may become the 'parent award' for future ECA proposals (i.e., in 2020 or later).

3.4 Mission data, facilities, and resources **[Clarified June 22, 2020]**

Please refer to Section 4 of program element C.1, The Planetary Science Research Program Overview, for a detailed list of the data and astromaterials resources and facilities available to proposers to this program element, and how to use them.

Proposers are reminded that, per the directions in Section 3.17 of the *NASA Guidebook for Proposers* and Table 1 of the *ROSES Summary of Solicitation*, any facility or resource not under the direct control of the PI or a Co-I requires a letter of support acknowledging that it is available for the proposed use during the proposed period.

3.5 Use of mission data

Proposals to this program element must follow the rules for use of mission data given in program element C.1, Section 3.5.

3.6 Statement of Relevance

Proposals to this program element do not require a separate or explicit statement of relevance. As stated in program element C.1, Section 3.6, all proposals, including those submitted to this program element, will be evaluated for relevance to the program element. Consequently, proposers are strongly encouraged to address the question of relevance in the Scientific/Technical/Management portion of the proposal.

3.7 Data Management Plans (DMPs)

Program element C.1, Section 3.7, discusses the requirements for DMPs in proposals to this program element. Please note that DMPs are mandatory for this program element and must be placed in a special section no longer than two pages in length, immediately following the References and Citations section for the Scientific/Technical/Management portion of the proposal.

4. Proposal Submission Process

Program element C.1, Section 2, outlines the two-step proposal submission process to be used by this program element.

Step-2 (full) proposals must follow all formatting requirements that are described in program element C.1 and Section IV(b)ii of the ROSES Summary of Solicitation. Proposals that violate the rules may be rejected without review or declined following review if violations are detected during the evaluation process.

5. Summary of Key Information

Expected program budget for first year of new awards	~$2.6M
Number of new awards pending adequate proposals of merit	~ 10
Maximum duration of awards	4 years; shorter-term proposals are encouraged for Development proposals.
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA.
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	~6 months after Step-2 proposal due date
Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of the *ROSES Summary of Solicitation*.
Relevance	This program is relevant to the Planetary Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See C.1 the Planetary Science Research Program Overview, and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of the *ROSES Summary of Solicitation*.

Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of Step-1 and Step-2 proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of Step-1 and Step-2 proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-LARS
Point of contact concerning this program	Jeffrey N. Grossman Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1218 Email (Preferred): HQ-LARS@mail.nasa.gov

C.17 PLANETARY MAJOR EQUIPMENT AND FACILITIES

NOTICE: Amended October 22, 2020. This amendment releases final text and due dates for stand-alone PMEF proposals. The changes are not tracked, the text is replaced in its entirety. The expected annual program budget for new awards has been increased to ~$1.5M. Step-1 proposals are due by December 4, 2020 and Step-2 proposals are due February 5, 2021.

The budget ceiling of $200,000 remains in effect for appended PMEF requests for programs still pending under ROSES-2020 (Habitable Worlds and Solar System Workings). This cap does not apply to stand-alone PMEF proposals. C.24 YORPD is not eligible for stand-alone PMEF proposals (see Table 1).

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1. Overview

1.1 Scope of Program

The Planetary Major Equipment and Facilities (PMEF) program element allows proposals for the purchase or development of new or upgraded non-flight analytical, computational, telescopic, and other instrumentation to be used in investigations in Planetary Science Division (PSD) research programs.

For a proposal to be relevant to PMEF, the instrument must enable or enhance PSD-funded research in at least one of the "Target" program elements listed in Table 1 of this program element directly below. In addition, PMEF proposals are allowed from NASA Centers to support activities conducted under the Internal Scientist Funding Model (ISFM), provided that the activities are demonstrated to be relevant to one of the non-ISFM program elements shown in Table 1 below.

Table 1. Target program elements, eligible for PMEF funding

Program element	Number	Appended[1]	Stand-alone[2]
Emerging Worlds	C.2	Yes	Yes
Exoplanets Research	E.3	No	Yes
Exobiology	C.5	Yes	Yes
Habitable Worlds	E.4	Yes	Yes
ISFM (NASA centers)	—	No	Yes
LARS	C.16	Yes	Yes
PDART	C.4	Yes	Yes
Planetary Protection Res.	C.15	Yes	Yes
PSTAR	C.14	Yes	Yes
Solar System Obs.	C.6	Yes	Yes
Solar System Workings	C.3	Yes	Yes
YORPD	C.24	Yes	No

[1] Eligible to submit Appended PMEF requests
[2] May be used as justification for Stand-alone PMEF proposals

1.2 Instrument Categories

There are two types of PMEF instruments that may be proposed: Investigator Instruments and Facility Instruments.

- An "Investigator Instrument" is acquired or developed by the proposer to support the PI's research, where the PI has full authority for its exclusive use, and where there are no commitments to make the instrument available to other investigators.
- A "Facility Instrument" is acquired or developed to support a wide range of planetary science research. Facility Instrument proposals may identify a portion of the instrument time to be reserved for use by the PI, or by an identified group of PSD-supported investigators, but a significant fraction of instrument time must be made available to other knowledgeable researchers conducting investigations in planetary science. All details of access, announcement of availability, assistance to be provided on its use, and methods of use (whether hands on or by a facility-based

operator), charges, and data rights must be documented and agreed to by NASA and the sponsoring institution before NASA support is provided.

1.3 Submission methods and eligibility

1.3.1 *PMEF requests appended to research proposals*

Investigator Instrument PMEF requests may be appended to a normal, full research proposal submitted to an eligible Target Program. Note that not all program elements in Table 1 of this program element allow this type of proposal (e.g., E.3, Exoplanets Research).

In a change from past Planetary Major Equipment (PME) solicitations, Facility Instruments may NOT be proposed as requests appended to research proposals. See Section 1.3.2 for instructions on how to submit proposals for facility instruments.

An Appended PMEF request may either be integral to the research proposal (i.e., required to perform the research) or it may be presented as an enhancement option to the research proposal (see Section 2 for more information on this topic).

The deadline for submission of an Appended PMEF request is the same as that of the Target Program.

1.3.2 Stand-Alone PMEF proposals

Stand-Alone PMEF requests are self-contained, full proposals submitted to enable future PSD-funded research or enhance PSD-funded research in one or more of the Target Programs. Both Investigator Instruments and Facility Instruments may be requested in Stand-Alone PMEF proposals.

In a change from past PME solicitations, there is a single deadline for all Stand-Alone PMEF requests, regardless of Target Program. The deadlines for submission are given in Tables 2 and 3 of ROSES.

Stand-Alone requests for Investigator Instruments and Facility Instruments both begin with submission of a Step-1 proposal, as described in Section 3.1. However, the instructions for preparing Step-2 Stand-Alone proposals differ for the two types of instruments: these are described in Section 3.2 for Investigator Instruments and Section 3.3 for Facility Instruments.

In order to submit a Stand-Alone PMEF proposal for an Investigator Instrument, the following criteria must be met:

1) The Principal Investigator (PI) or the Co-investigator/Science PI of the stand-alone PMEF proposal must either be the PI or Co-investigator/Science PI of an existing, funded (or selected) "parent" award in a Target program (see Table 1 of this program element, above), or funded under ISFM at a NASA center to perform research relevant to one or more of the Target programs. It is also acceptable to justify the PMEF proposal on the basis of multiple parent awards to the same PI in one or more of the Target programs.
2) The parent award or ISFM project of the stand-alone PMEF proposal must not have entered its last funded task year at the time of the Stand-Alone PMEF proposal deadline.

3) The instrument must only be intended to enhance the research in the PI's or Science PI's funded parent award(s).

In a change from past Planetary Major Equipment (PME) solicitations, there are no restrictions on who may be the PI of a Stand-Alone PMEF proposal for a Facility Instrument. The PI of such a proposal does not need to be a funded investigator in one of the Target programs, nor does the proposal need to be tied to a single funded project in one of the Target programs. However, Stand-Alone Facility Instrument proposals do need to include at least one funded investigator from an eligible program (Table 1, "Stand-alone" column) as either the PI, Science PI, or Co-I.

1.4 Allowable PMEF requests

Instrumentation purchases or upgrades that may be requested through the PMEF program are to be of a substantial nature, with hardware costs over $50,000. A PMEF proposal must be for purchase of a single instrument or system, or components of a single instrument or system. If a PI wishes to purchase multiple, unrelated equipment items each of which costs less than $50,000, these are not considered to be major equipment purchases under this program element, even if the combined cost exceeds $50,000.

Until further notice, appended PMEF proposals may not be used to purchase instrumentation exceeding $200,000 in total cost. There is no cap on stand-alone PMEF proposals, although see the caution in section 3.1 about evaluation of Step-1 proposals and section 5 for an estimate of the total budget expected to be available for the PMEF program.

This program element does not allow for the purchase of personal computers or computer peripherals, unless these are integral parts of an instrumentation package. In addition, it does not support the repair of equipment unless the repair involves significant enhancement of the instrument's basic capabilities. Proposals that seek to design, develop, test, or evaluate new instruments that are intended for commercial sale will be rejected without review.

1.5 Allowable Costs

The PMEF program element allows for either the purchase of instrumentation from a commercial vendor or for the acquisition of components and development of new instrumentation. Funds may also be requested for the installation and check out of instrumentation, either by a vendor or by the investigator(s). No funds may be requested for scientific research, instrument calibration, or development of standards. In addition, no funds may be requested for support contracts, maintenance, or continued operations of any instrument; costs for maintenance and operation beyond the check-out period must be requested in research proposals submitted to appropriate program elements or through ISFM projects. Each relevant cost should be fully explained and substantiated, and a quotation should be provided for any major equipment or components purchased from a commercial vendor. If acquisition or development of an instrument or facility will require more than one year, the proposal should cover the complete project, but make a clear distinction between efforts in each year.

It should be noted that cost sharing between NASA and other federal agencies is encouraged to the extent that NASA's share of the cost will ensure adequate access to the finished instrumentation by NASA investigators; this acquisition/access aspect of any proposed effort involving cost-sharing must be discussed in the proposal. The proposal must document whether any other agency has been approached or has made tentative commitments and provide the name and telephone number of the appropriate officer who can discuss their agency's interest.

It is expected that title to any equipment obtained or developed through this program shall vest with the proposing institution in accordance with the provisions of 2 CFR section 200.313. However, in cases of an equipment upgrade at a facility owned by the U.S. Government, NASA reserves the right to negotiate title of the equipment for the best interests of the user community.

2. Appended PMEF requests for Investigator Instruments

Appended PMEF proposals are always submitted using the process described in ROSES for the eligible Target program element, which may use an NOI followed by a full proposal, or a two-step proposal process. Unless otherwise noted in the Target solicitation, the NOI or Step-1 proposal should mention the anticipated PMEF request, but this is not a requirement: PMEF requests may be appended to proposals in eligible Target program elements regardless of whether the request was mentioned in the Step-1 proposal or NOI.

2.1 Elements of a proposal with a PMEF Appendix

All information about the research to be performed with the equipment associated with an Appended PMEF request should be integrated into the Scientific/Technical/ Management section of the main research proposal. This includes description of any instrument-development efforts associated with the purchase.

In constructing the main research proposal associated with an appended PMEF request, the PI should consider whether and how the main part of the proposal could be executed if the PMEF request were not funded. The Scientific/Technical/ Management section of the main proposal should contain a contingency plan for the non-selection of the PMEF request. This plan might discuss alternative methods of obtaining the required data, the effect that the lack of the instrument would have on the proposed science goals, or tasks that could be removed from the proposal if the instrument were not available. If the contingency plan has budget implications (either positive or negative), the proposal's budget section should either clearly identify the contingent items or include a clearly labeled alternate budget table that takes into account the case of the instrument not being funded. If the proposal could not be executed without the instrument in the appended PMEF request, this should be explicitly stated. If no contingency plan is presented, the PMEF request will be considered as an essential element of the proposal.

The proposal must contain an appendix entitled, "Planetary Major Equipment and Facilities Request," that should be the last item in the proposal (subsequent to all of the required sections in the main research proposal). This appendix, which does not count toward any page limitations in the main proposal, should include, and is limited to:

- A single cover page specifying:
    i. The title of the PMEF request
    ii. The name and institution of the PI (which must be the same as the PI of the main proposal).
    iii. A brief summary/abstract of the PMEF request (which will not be evaluated, and therefore should contain only information covered in the body of the PMEF request)
- A maximum of four (4) pages of description of the instrument request, justifying its purchase. This section should make a convincing case for instrument funding and should address why the instrument is necessary for the PI's or Science PI's research or how it would enable or enhance that research. It should include a description of the technical capabilities of the instrument and how they relate to the requirements of the proposed research, a discussion of how the instrument relates to other existing instruments that might be used to perform the research, and any cost-sharing arrangements. This section must not be used to describe plans for research to be done with the instrument beyond than that which is outlined in the main body of the proposal.
- A page of instrument specifications
- At least one quote for the instrument or major components

The PMEF appendix itself should not contain a budget section. All costs associated with the Appended PMEF request, including instrument purchase and development, belong in the budget of the main research proposal. When filling out the NSPIRES cover page budget for a proposal with an appended PMEF request, the cost of the equipment must be included as a single number per year on configurable line 10 in Section F, Other Direct Costs and labeled as "Cost of Appended PMEF". In most cases, it is expected that the PMEF costs will be contained within a single budget year.

Appended PMEF requests will be funded only if the main science proposal itself is selected for funding. Conversely, if the plan for "descope" (i.e., this part of the project will not be supported by NASA) is not meritorious for the PMEF request, or if the PMEF cannot be descoped, the main science proposal may be declined for funding solely on the basis of the merit of the PMEF request or upon the lack of available funds to select the PMEF request.

2.2. Evaluation of a proposal with a PMEF Appendix

The main science proposal will always be evaluated under the assumption that the equipment proposed in the PMEF request will be selected for funding. However, the proposal may also receive a separate score for intrinsic merit, taking into account any contingency or descope plan that was presented, that would apply if the PMEF request were to be declined. Evaluation criteria for the main proposal will be as described in the program solicitation to which it was submitted.

The appended PMEF request will receive a separate evaluation, with the following factors considered as part of its intrinsic merit:

- The demonstrated value that the equipment will add to the PI's proposed research.

- The demonstrated appropriateness of the instrument for achieving the objectives of the proposed research
- The demonstrated need for the new instrument, given potential alternative methods of achieving the research objectives.

No separate relevance score will be given to appended PMEF proposals. Relevance is determined by the main research proposal.

3. Stand-alone PMEF proposals

Stand-alone proposals submitted to this program element will use a two-step process, beginning with a required Step-1 proposal. Only proposers who are "invited" in response to the Step-1 proposal may submit a full Step-2 proposal.

3.1 Step-1 proposal process for Stand-alone PMEF requests

Step-1 proposals must be submitted electronically by the Step-1 PMEF due date given in Tables 2 and 3 of ROSES. The Step-1 proposal cannot be submitted by the PI alone, it must be submitted by an Authorized Organizational Representative (AOR).

The body of a Step-1 proposal is a single document limited to two pages of text, plus at least one quotation for the instrument or its major components. The text does not need to explain the technical details or specifications of the instrument, and no formal budget information should be submitted. In all cases, the Step-1 proposal must describe the kind of instrument being proposed and how the instrument would be used. If cost sharing is anticipated, the Step-1 proposal should outline how this is being planned, although the plans do not have to be final. For Investigator Instruments, the Step-1 proposal must identify the Parent award or ISFM title, the award number (NASA centers may use the original proposal number), Target program element, and the funded performance period of the award. For Facility Instruments, the Step-1 proposal should explain what parts of the planetary science community, or other communities, would benefit from the instrument and how, as well as which Target programs are expected to benefit from the instrument. Letters of endorsement or other sections beyond the two-page limit plus quotation are not permitted for Step-1 proposals.

Step-1 proposals undergo a programmatic review. The goals of this review are to:

1) confirm that eligibility to submit a stand-alone PMEF proposal was established;
2) enable budget planning to accommodate the cost of anticipated proposals. Proposals that greatly exceed PSD's present or expected budget requirements may be declined at Step-1;
3) for Facility Instruments, determine whether the proposal plausibly demonstrates a need for the facility, and that there exists an appropriate community of planetary science researchers who might benefit from use of the instrument.

The proposal title, category of instrument, and the nature of the instrument to be purchased may not be changed between the Step-1 and Step-2 proposals. Submission of a Step-1 proposal does not obligate the PI to submit a Step-2 (full) proposal. Quotations from instrument vendors may be updated prior to submitting a Step-2 proposal, but increases in instrument costs of >20% will require permission from the Program Officer prior to submitting the Step-2. Failure to obtain such permission may result in a Step-2 proposal being declined without review.

3.2 Elements of Stand-alone Step-2 PMEF proposals for Investigator Instruments

If a Step-1 proposal for a stand-alone Investigator Instrument is invited, then a Step-2 proposal for an Investigator Instrument can be submitted for review by the PMEF program. These are treated as augmentation proposals for a funded project by the PI or Science PI in one of the Target program elements.

The Scientific/Technical/ Management (STM) section must contain the following components, not exceeding seven total (7) pages:

- Page 1 must be a title page specifying:
  i. The title of the PMEF request
  ii. The name and institution of the PI and, if applicable, the Science PI.
  iii. The name, award number, and period of performance of the Parent award in one of the Target program elements.
  iv. A one-paragraph summary of the equipment request (this will not be evaluated and therefore should contain only information covered in the 5-page body of the PMEF request)

- A maximum of five (5) subsequent pages should describe the instrument request, outlining how the instrument would be used, and justifying its purchase. This section should make a convincing case for instrument funding and must address how the instrument would be used to enhance the PI's or Science PI's funded research. No instrument development tasks may be proposed in Stand-Alone requests for Investigator Instruments. This section may also include a description of the technical capabilities of the instrument and how they relate to the requirements of the proposed research enhancements, a discussion of how the instrument relates to other existing instruments that might be used to perform the research, and any cost-sharing arrangements.

  Note that no information about the Parent award will be provided to reviewers beyond what is written in the Scientific/Technical/ Management of the PMEF request itself, nor will reviewers have access to previous peer-review documents.

  The STM section does not require a statement of relevance if the PI has a parent award in one of the Target program elements. However, if the PI is funded under an ISFM award at a center, a brief statement of how the PI's work is relevant to the Target program element must be provided.

- One page of instrument specifications.

No Data Management Plan (DMP) section is required for a Stand-Alone PMEF Investigator Instrument proposal.

The budget section of the stand-alone PMEF proposal must include at least one quote for the instrument or major components.

No letters of endorsement are allowed for Stand-alone Step-2 proposals for Investigator Instruments. However, letters to confirm cost-sharing arrangements are acceptable.

3.3 Elements of Stand-alone Step-2 PMEF proposals for Facility Instruments

If the Step-1 proposal for a stand-alone Facility Instrument is invited, then a Step-2 proposal for a Facility Instrument may be submitted for review by the PMEF program. If selected, these may either result in augmentations to existing awards or they may result in new awards, depending on the circumstances.

The Scientific/Technical/ Management section must contain the following components, not to exceed twelve (12) total pages:

- Page 1 must be a title page specifying:
  - i. The title of the PMEF Facility request
  - ii. The name and institution of the PI and, if applicable, the Science PI.
  - iii. The proposed location of the Facility Instrument
  - iv. The name of the Target program elements to which the request is relevant.
  - v. A one-paragraph summary of the equipment request (which will not be evaluated, and therefore should contain only information covered in the body of the PMEF request)
- A maximum of ten (10) pages may be used for the "main body" of the facility request, as further described below.
- One page of instrument specifications.

No data management plan is required for a Stand-Alone PMEF facility proposal.

Letters of affirmation are permitted from community members who are not on the PMEF Facility proposal team. Note that those providing letters will be considered to have a conflict of interest as potential reviewers of the proposal, in the same way as proposal Co-Investigators.

The budget section must include at least one quote for the instrument or major components.

The main body of the PMEF facility proposal (limited to 10 pages) must describe the instrument request, explain how the instrument would be used, who would use it, how it would be managed, and justify its purchase. If instrument development tasks are proposed, they should be fully described. This section should include:

(a) A description of the technical capabilities of the instrument.

(b) A description of the potential user-community, and how the facility would benefit their research. If the facility is to have an identified portion of time reserved to a particular funded investigator, or group of investigators, their research and the benefits the facility would provide, should be specifically described, as no information about their research awards will be provided to reviewers beyond what is provided here.

(c) A management plan for the instrument that includes, as applicable:
  - i. A statement of the percentage of the instrument's time that would be available to various classes of users (e.g., the PI, a specific group of researchers, PSD-funded researchers, or the broader community).
  - ii. A statement regarding aspects of user access, such as:
    - time of day when access would be granted,

- whether access would be "hands on" or only by an operator or collaborator in the proposer's group,
- any costs to be charged for use,
- how such costing would be handled,
- how user access would be solicited, requested (e.g., by personal communication, formal proposal, or other method), and evaluated.

(d) A description of any cost-sharing arrangements.

(e) A demonstration of relevance of the facility to research currently funded in one or more Target program elements.

3.4 Evaluation of Stand-alone Step-2 PMEF proposals.

3.4.1 *Investigator Instruments*

The review of a stand-alone proposal for an Investigator Instrument does not include a re-evaluation of the research in the Parent award, nor will reviewers have access to the original Parent proposal. The evaluation criteria of the stand-alone proposal will include:

- The scientific merit of the newly proposed research enhancements to be enabled by the purchase of the instrument.
- The technical appropriateness of the instrument for achieving the proposed research enhancements.
- The demonstrated need for the new instrument, given potential alternative methods of achieving the research enhancements.

No relevance score will be given to stand-alone PMEF proposals for Investigator Instruments. Relevance was established by the previous funding of the Parent award.

3.4.2 *Facility Instruments*

The following factors may be considered as part of the intrinsic merit of a stand-alone facility instrument proposal:

- The scientific merit of the newly proposed research enhancements to be enabled by the purchase of the instrument for identified, funded investigators in the Target Programs.
- The technical appropriateness of the instrument for achieving proposed research enhancements for identified, funded investigators in the Target Programs.
- The demonstrated value that the equipment will add to research in Planetary Science in general.
- The demonstrated value that the equipment will add to the broader community.
- The quality of the management plan for the facility instrument.
- The demonstrated need for the new facility instrument, given potential alternative methods of achieving the research objectives.

The relevance of a stand-alone PMEF proposal for a facility instrument is determined by whether the proposal demonstrated the need for the instrument to do research that would itself be relevant to one of the Target programs.

4. Funding for PMEF awards

In general, funding for PMEF awards is drawn from a separate PMEF program budget, as noted in Section 5. Some Target programs may also contribute to PMEF awards from their own program budgets, thereby augmenting the amount of PMEF funds available in a given year.

5. Summary of Key Information

Expected annual program budget for new awards	~ $1.5M but may be supplemented by Target programs
Number of new awards pending adequate proposals of merit	~ 5-9
Maximum duration of awards	Usually only one year. For stand-alone proposals, the maximum is 3 yrs. For appended proposals, refer to the guidelines of the program element to which the PMEF proposal is submitted.
Due date for proposals	For stand-alone PMEF proposals, Step-1 and Step-2 proposals must be submitted by the PMEF due dates in Tables 2 and 3 of ROSES. For PME proposals appended to new research proposals, no separate Step-1 proposal is required; PMEF requests may be appended to any Step-2 proposal submitted according to the schedule of the eligible program.
Planning date for start of investigation	See the specific science research program element for Appended proposals. Stand-alone proposals should plan on funding that begins approximately 6 months after the Step-2 due date.
Page limit for the describing the instrument request	Variable depending on type of request. See above. • Appended Investigator Instruments, 4 pp • Stand-Alone Investigator Instruments, 5 pp • Stand-Alone Facility Instruments, 10 pp
Relevance	This program is relevant to the Planetary Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	Please see ROSES *Summary of Solicitation, esp.* Table 1 and Section I(g) Order of Precedence, and the *NASA Guidebook for Proposers*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)

Web site for submission of proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	Appended PMEF requests: Please refer to the specific science research program element. It will be of the form NNH20ZDA001N-AAA where AAA is the abbreviation for that program. Stand-alone PMEF requests: NNH20ZDA001N-PMEF
Point of contact concerning this program	Jeffrey N. Grossman Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1218 Email: HQ-PME@mail.nasa.gov

C.18 EARLY CAREER FELLOWSHIP START-UP PROGRAM FOR NAMED FELLOWS

NOTICE: Amended May 19, 2020. Previously named Early Career Fellows who intend to submit to this program element, must email the point of contact listed in Section 4 by September 1, 2020 to discuss their eligibility. It is anticipated that this is the last year that this program element will be solicited. Proposals are due on the date given in Section 4 and in Tables 2 and 3 of this ROSES NRA. The point of contact has changed. New text is in bold and deleted text is struck through.

This program element is to allow those who were named Early Career Fellows prior to ROSES-17 to submit proposals for start-up funds. See program element C.19, The NASA Planetary Science Early Career Award Program, for information on the extant program.

1. Scope of Program

The Early Career Fellowship (ECF) program supports the development of individual research programs of outstanding scientists early in their careers and stimulates research careers in the areas supported by the Planetary Sciences Division. This Program is based on the idea that supporting key individuals is a critical mechanism for achieving high-impact science that will lead the field forward with new concepts, technologies, and methods.

This program element solicits seven-page proposals for up to $100K in start-up funds from those who have previously been named an "Early Career Fellow" and have obtained a 'permanent-track' position, defined in Section 3.3. The eligibility requirements for applying for the ECF start-up funds are given in Section 2. To apply for the extant Planetary Science Early Career Award program, please refer to program element C.19.

2. Fellowship Start-up Funds

The application for start-up funds is the second component of this program, i.e., those who respond to this program element must have been already named an "Early Career Fellow" in response to a proposal previously selected to ROSES. The request for up to $100K of start-up funds, for those who meet the eligibility requirements in Section 2.1, takes the form of a proposal submitted in response to this program element at any time during the open period for ROSES (i.e., there is no single fixed due date).

2.1 Eligibility for Start-up Funds

To be eligible for start-up funds, the PI must have previously been named an Early Career Fellow.

Previously named Early Career Fellows who intend to submit to this program element, must email the point of contact listed in Section 4 before September 1, 2020 to discuss their eligibility. [Added May 19, 2020]

Proposals for start-up funds must be submitted in response to this program element within ten calendar years of the year in which the PI received their Ph.D. (or equivalent degree). See Section 3.2 for more information on this requirement.

To be eligible for the ECF start-up funds, the PI may not already be in a permanent position at the time of submission of their proposal for start-up funds. To be eligible for start-up funds, the PI must be in a 'permanent-track' position at the time of submission of their proposal for start-up funds. The definitions of 'permanent' and 'permanent-track' positions are provided in Section 3.3.

Fellows (or organizations) applying for the ECF start-up funds are strongly encouraged to communicate with the point of contact listed below to verify that the position that has been offered to the Fellow satisfies the requirement for award of start-up funds.

2.2 Procedure to Propose for Start-up Funds

The process for submitting proposals for start-up funds is as follows:

1. Have previously received an award letter explicitly stating that you have been named an ECF;
2. Gain a 'permanent-track' position;
3. Meet the eligibility requirements in Section 2.1; and
4. Submit a proposal to this program element via the organization where you have the permanent-track position.

Eligible PIs may submit proposals for up to $100K in start-up funds in response to this program element at any time during the eligibility period, via the organization through which they have the permanent track position. The start-up package is intended to aid Fellows in establishing a research group or laboratory in their new permanent track position. This funding is not guaranteed simply based on having been named a Fellow. Rather, it depends on the proposal submitted to this program element passing a scientific review.

The proposal must clearly describe how the funds will be used to establish the Fellow's research program and how the proposed research is relevant to the Planetary Science Division (e.g., the Planetary Science questions and goals in the NASA Science Plan). In addition to the immediate use of the start-up funds, the proposal must contain a strategy describing the Fellow's plans for the research program over the long term.

A detailed budget with a narrative justification is required as part of the proposal.

The proposal must provide evidence that the appointment meets the requirements for a 'permanent-track' position provided in Section 3.3.

Proposals for start-up funds must adhere strictly to the rules for ROSES in general, unless superseded by this program element. Proposers should note that the scientific/technical/management (STM) section of a proposal to this program element is limited to seven pages. All proposal sections required for general ROSES proposals are also required for proposals to this program element. A data management plan (DMP) must be included as part of the proposal for start-up funds (outside of the S/T/M section). See Appendix C.1 (section 3.7.1) and the *NASA Guidebook for Proposers* for full information and rules regarding DMPs.

2.3 Evaluation Criteria for Start-Up Proposals

Proposals for start-up funds will be evaluated on the basis of the three standard criteria given in ROSES: intrinsic merit, relevance to the Planetary Science Division, and cost

reasonableness. The evaluation of intrinsic merit will focus on aspects related to: the immediate goals of the proposed research program; the proposed equipment, facilities, and staffing; and the long-term research program strategy. The evaluation of start-up proposals will be completely independent of any prior evaluation of the original application to be an ECF.

3. Programmatic Information

3.1 Role of Fellow on Proposal vs. Organizational rules

Some institutions do not allow researchers in certain kinds of positions (e.g., those who are not in tenure-track positions) to independently apply for NASA grants, which might prevent potential PIs from proposing to this program. The Early Career Fellow may therefore be listed as the Co-I/Science PI, and include an organizationally approved individual as the PI, to allow the application to this element to be submitted by the Authorized Organizational Representative (AOR). In such a case, the Co-I/Science PI will be the named Fellow and the person applying for the start-up funds.

3.2 Time Since Degree

Time taken away from career activities for family (e.g., for the birth or adoption of a child, or for the care of a dependent) or health reasons, or for military service will not be counted against the time limit for eligibility outlined in Section 2.1. Potential proposers who took a leave of absence for one of these reasons may request a waiver to this eligibility restriction. Such applicants should write to the ECF point of contact given in Section 4 prior to proposal submission.

3.3. Definition of a Permanent and Permanent Track Position

A 'permanent' position is one in which the organization substantially compensates the PI for his or her salary, without making it conditional on outside funding, nor limiting the term of employment. Examples of permanent positions include, but are not limited to, tenured faculty and permanent civil service appointments.

A 'permanent-track' position is one with a clearly defined process and schedule that can lead to a permanent position. Examples of permanent-track-equivalent positions include, but are not limited to, tenure-track faculty and certain-term civil service appointments.

4. Summary of Key Information **[Updated May 19, 2020]**

Expected program budget for first year of new awards	N/A; all funds are distributed by the corresponding research program element
Number of Fellow appointments pending adequate proposals of merit	1 to 3 per relevant planetary research program element
Maximum duration of awards	3 years for start-up funds
Due date for Notice of Intent to propose (NOI)	No Notices of Intent are requested for this program element.
Mandatory email to the POC	**September 1, 2020**

Due date for proposals	~~Proposals from Fellows selected in prior years for start-up funds may be submitted at any time until~~ 11:59 pm Eastern time on March 29, 2021.
Planning date for start of investigation	6 months after proposal receipt
Page limit for the central Science/Technical/Management section of proposal	7 pp, for proposals from current Fellows for start-up funds; see also Table 1 of the ROSES *Summary of Solicitation* and the *NASA Guidebook for Proposers*
Relevance	Proposals must be relevant to the Planetary Science Division. See also Section 2.2.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	Please see ROSES *Summary of Solicitation* Table 1, Section I(g) Order of Precedence, and the *NASA Guidebook for Proposers*.
For Additional Information	Contact point of contact listed below
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-ECF
Point of contact concerning this program	**Melissa Morris [Updated May 19, 2020]** Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Email: melissa.a.morris@nasa.gov Telephone: **(202) 774-8476**

C.19 PLANETARY SCIENCE EARLY CAREER AWARD

NOTICE: August 21, 2020. Sections 2 and 5 have been updated to clarify eligibility. New text is in bold and deleted text is struck through. Due dates remain unchanged, the due date for proposals remains December 8, 2020.

Amended on August 10, 2020. This program element has been revised in many ways, so please read the text carefully. The due date for proposals has been delayed to December 8, 2020.

1. Scope of Program

The Planetary Science Early Career Award (ECA) program supports the professional development of outstanding early-career scientists in areas relevant to the Planetary Science Division (PSD). Support from this program will allow promising individuals to play an increasing and meaningful role in the planetary science community.

2. Eligibility for the ECA

To be eligible to propose to this ECA program in ROSES-2020, all of the following criteria must be met:

a. The applicant must be the Principal Investigator (PI), or a Co-investigator designated as the Science-PI, on an award (referred to below as the "parent award") from a participating program element solicited in ROSES-2018 or ROSES-2019 (see Table 1 of this program element, below). See Section 5.1 (role of PIs and Science-PIs) and Section 2.1 (ECA-participating programs) for more information. **If both the PI and Science PI are early career according to Sect. 2.b. (below), only the Science PI is eligible for an award under the ECA program.**
b. The applicant must have received their **terminal degree (held at the time of the parent award)** ~~Ph.D. (or equivalent degree)~~ no earlier than January 1, 2010. Time taken away from career activities for family or health reasons, or for military service, will not be counted against this time limit for eligibility. See Section 5.2 for more information.
c. The applicant must be affiliated with a U.S. institution.
d. A ROSES parent award **may be used a second time** ~~cannot have been used previously~~ as the basis for a proposal to the ECA program **if the first submission is declined**.
e. The applicant may only submit one proposal to the ECA program per ROSES year.
f. The applicant may not be a previous recipient of NASA-managed early-career funding that is similar in scope and size to the ECA (e.g., the PSD Early Career Fellowship Program, other SMD early career programs, Presidential Early Career Awards for Scientists and Engineers, etc.).

2.1 Participating ROSES Program Elements for the ECA

ROSES-2020 ECA proposals may be submitted on the basis of ROSES-18 and ROSES-19 parent awards from the Exoplanet Research Program, Habitable Worlds

and all Appendix C program elements except Planetary Major Equipment and Early Career programs.

3. ECA Proposal Submission Process

Proposals to this program must be submitted via NSPIRES or Grants.gov. Formatting rules laid out in program element C.1 (Section 3.1) and the *ROSES Summary of Solicitation*, apply to this program, unless superseded by information in Section 3.1 of this element.

3.1 ECA-specific proposal requirements

(a) Parent Award Information

The proposal must contain information about the eligible parent ROSES award that is the basis of the ECA proposal. The parent award information must be provided before the Science/Technical/Management (S/T/M) section of the proposal and is not included within the S/T/M page limit. The parent award information must include only the following:

- Parent award program;
- Parent award ROSES year,
- Parent award title;
- ECA applicant role on parent award (PI or Science PI);
- Parent award number;
- Parent award start date; and
- Parent award abstract (as provided in the parent award proposal, without modification).

(b) Science/Technical/Management Section

The proposal's S/T/M Section may be no more than five pages and must include the following:

- A description of the applicant's future research and career plans (see Section 4.3 regarding evaluation of scientific endeavors);
- How the proposed activities would serve to enhance the applicant's career;
- How the proposed activities would support the planetary science community (for example, service activities, dedication to diversity and inclusion, mentorship, science communication).

(c) Curriculum Vitae (CV) and Publication History

The proposal must contain a CV for all team members. The CV may not exceed two pages for the PI (or Science-PI) and may not exceed one page for any other team members. The CV may include details of collaborative activities (e.g., involvement on large scientific teams, including mission teams), awards, service, and any other relevant information. The PI's publication history should be provided separate from the CV, with no page limit.

4. ECA Evaluation Criteria and Selection

Proposals to the ECA program will be evaluated independently of the parent research proposals (which will not be available to reviewers of the ECA proposals), and the scientific scope/focus of the two proposals may be different. The following factors will be considered to make ECA selections:

- relevance to PSD and the ECA program;
- the applicant's potential for impact, leadership, and involvement in the planetary science community;
- the potential for significant impact in the career development of the applicant, through the proposed use of ECA funds; and
- cost reasonableness

Those proposals that demonstrate high impact of the proposed use of ECA funds will be given programmatic priority.

4.1 Relevance

Proposals are relevant to the ECA program if the proposed activities would support the goals and scope of PSD.

4.2 Potential for Impact, Leadership, and Community Involvement

The applicant's potential for future impact, leadership, and involvement in the planetary science community - based on their career goals, engagement in the field, and previous leadership experience (at all scales) - will be evaluated. Information of interest includes, but may not be limited to: invited and/or public lectures, awards received, participation on scientific program committees, conference or workshop organization, professional society activities, special international or industrial partnerships, review or editor activities, as well as significant education and public outreach activities (especially activities aimed at broadening participation and inclusion of under-represented groups in planetary science).

4.3 Potential career-development impact of proposed use of ECA funds

The S/T/M section of the proposal will be used to assess the likely impact of the proposed use of ECA funds on the future career of the proposer. When scientific research activities are proposed, only the impact and merit of the *new* proposed scientific endeavors will be evaluated, i.e., since the scientific prowess of the PI (or Science-PI) will already have been demonstrated through the selection of the parent award.

4.4 Cost reasonableness

The budget justification and detailed budget will be used to evaluate the reasonableness of the proposed costs.

5. Programmatic Information

5.1 Role of Early Career Applicant on Proposal vs. Organizational Rules

Some institutions do not allow non-tenured researchers to hold the role of the PI on proposals to NASA, which might prevent early-career researchers from proposing to this

program. At either stage of the ECA process (i.e., either for the parent research proposal or for the full ECA application package) the proposal may therefore list the early-career researcher as the "Co-I/Science PI", and include an organizationally approved individual as the "PI" to allow the application to be submitted by the Authorized Organizational Representative.

5.2 Time Since Degree

To be eligible for the ECA program, applicants must have received their **terminal degree (held at the time of the parent award)** ~~Ph.D. (or equivalent degree)~~ no earlier than January 1, 2010. Time taken away from career activities for family (e.g., for the birth or adoption of a child, or for the care of a dependent) or health reasons, or military service will not be counted against this time limit for eligibility. Applicants who received their **terminal degree** ~~Ph.D.~~ before January 1, 2010, but who may therefore still be eligible for the ECA should email the point of contact for this program (see Section 6), before submitting their proposal, to request a waiver for eligibility. This waiver should subsequently be included as an appendix in the ECA proposal. See Section 5.4 for more information about the window of eligibility.

5.3 Duration of Awards

ECA awards will be issued as awards of up to five years in duration. The ECA will only be awarded one time to any given proposer.

5.4 Relation to the Previous Early Career Fellowship program

The previous PSD Early Career Fellowship (ECF) program (C.18 in ROSES-2020) was not solicited in ROSES-2017 and -2018, while the program was evaluated and reformulated. The following information is relevant to the change of programs (see also Section 5.2):

- The period of eligibility for the new ECA program has been expanded, from seven to ten years post-**terminal degree** ~~Ph.D.~~ to allow PIs who 'aged out' of eligibility during the hiatus to apply for the new ECA. It is therefore anticipated that the window of eligibility will again be reduced in future ROSES years.
- Unlike the previous ECF program, the new ECA program places no restriction on the type of position held by the ECA applicant. To be eligible for the ECA, applicants may hold a "permanent" position, but this is no longer required. Awards, however, must be made to a U.S. institution with which the applicant is affiliated.
- Individuals previously named ECF fellows are eligible to propose to this ECA program for funding, provided they (1) meet all other eligibility requirements and (2) have not yet received ECF funding under the prior program. Previously named Early Career Fellows who apply for both ECF and ECA funding may only receive an award from one of the two programs, not both. ECF fellows who have received ECF funding are not eligible to propose to the ECA program.

5.5 Future feedback from awardees

For the purposes of evaluating the impact of the ECA program, please note that successful ECA applicants may be asked, going forward, to provide PSD with general feedback regarding the award and their career development.

6. Summary of Key Information

Expected program budget for first year of new awards	~$1M
Award size	Up to $200K each
Number of awards	~ five per year
Maximum duration of awards	Five years
Due date for Notice of Intent (NOI) to propose	NOIs are not requested for this program element.
Due date for proposals	See Tables 2 and 3 of this ROSES NRA (to be considered for an ECA in ROSES-2020).
Planning date for start of use of ECA funds	Six months after ECA proposal submission.
Page limit for proposal	5 pages. See also Section 3
Relevance	Proposed use of ECA funds must be relevant to the Planetary Sciences Division. See also Section 4.1.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See C.1 the Planetary Science Research Program Overview, and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376).
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726).
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-ECA
Point of contact concerning this program	Melissa Morris Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Email: melissa.a.morris@nasa.gov Telephone: (202) 774-8476

C.20 DEVELOPMENT AND ADVANCEMENT OF LUNAR INSTRUMENTATION PROGRAM

NOTICE: June 22, 2020. Subsection 3.2 has been clarified to remind proposers of the necessity for a letter of support for facilities not under the direct control of the PI or Co-I. New text is in bold and deleted text is struck through.

Amended June 4, 2020. This amendment delays the Step-2 proposal due date for this program element. The due date for Step-2 proposals is now July 10, 2020.

This program element includes a special emphasis on lunar science instruments, including, but not limited to, flight hardware for small commercial lunar landers. This program element uses a two-step proposal submission process described in Section 2 of Appendix C.1. Proposals must include an entry Summary Chart submitted as a separately uploaded appendix along with the Step-2 proposal, see Section 2.1 for more details. No data management plan is requested for this program element.

1. Scope of Program

The Development and Advancement of Lunar Instrumentation (DALI) Program supports the advanced development of spacecraft-based instruments that show promise for use in future lunar missions including expected commercial ventures. The goal of the program is to develop and demonstrate lunar science instruments to the point where they may be proposed in response to future announcements of flight opportunity without additional extensive technology development (approximately technology readiness level [TRL] 6). The proposed instrument must address specific scientific objectives of likely future lunar science missions.

The DALI Program seeks proposals for development activities leading to instrument systems in support of the Science Mission Directorate's (SMD) Planetary Science Division. The objectives of the program are to develop new technologies that significantly improve instrument measurement capabilities for lunar science missions (such as Discovery, New Frontiers, and other planetary programs, including those flown on commercial spacecraft). It is the responsibility of the proposer to demonstrate how their proposed technology addresses significant scientific questions relevant to stated NASA goals and not for NASA to attempt to infer this.

Only proposals relevant to Planetary Science Division’s strategic goals and objectives will be considered for this program element. The DALI Program is intended to enable technology infusion into NASA planetary science missions to take place in a timely and efficient manner. As such, the technology readiness levels (TRLs) that DALI supports are TRL 4-6.

This program seeks to mature lunar science instruments that support NASA’s broader lunar exploration goals, including human exploration and *in situ* resource utilization (ISRU), as well as lunar science. While all lunar instrument types, including rover-based and orbital, will be considered, instruments for small stationary landers are especially of interest. For this DALI solicitation, we are most interested in technologies that will reach

at least TRL 6 by the end of the grant period, and ideally would be ready to build flight hardware for a lander with flight opportunities in the next four years.

It is the responsibility of the proposer to justify the entry and exit level TRL of the proposed technology. Instrument development activities must be planned and initiated so that major technological risks are retired prior to being submitted to a future lunar mission solicitation. This program will permit appropriate funding to be applied at each stage of readiness associated with the development and demonstration of key and enabling technologies, such as breadboarding, brassboarding, and testing of critical components and complete instruments in a relevant environment.

A full description of technology readiness levels (TRLs) 1- 9 appears in Appendix E of NASA Procedural Requirement 7123.1B and is available on the web at *http://nodis3.gsfc.nasa.gov/displayDir.cfm?Internal_ID=N_PR_7123_001B_&page_name=AppendixE*.
Prospective proposers are encouraged to review "Visions and Voyages for Planetary Science in the Decade 2013-2022" (https://solarsystem.nasa.gov/docs/Vision_and_Voyages-FINAL.pdf) for the most recent Decadal Survey) and Science Plan for NASA's Science Mission Directorate 2014 (https://science.nasa.gov/about-us/science-strategy) to learn more about relevant missions. Proposers are encouraged to review the Scientific Context for the Exploration of the Moon (https://www.nap.edu/catalog/11954/the-scientific-context-for-exploration-of-the-moon), the recent LEAG Special Action Team reports, NEXT SAT and ASM SAT (https://www.lpi.usra.edu/leag/reports.shtml), the Lunar Human Exploration Strategic Knowledge Gaps (https://www.nasa.gov/exploration/library/skg.html), and the specifics of planned commercial missions supported by NASA (https://www.nasa.gov/feature/nasa-extends-agreements-to-advance-commercial-lunar-landers).

Proposals not appropriate for DALI are feasibility studies, concept formulation, and proof of concept or advanced component development. These proposals should be submitted to the C.12 Planetary Instrument Concepts for the Advancement of Solar System Observations (PICASSO) Program in ROSES. In addition, DALI does not support proposals that seek to develop ground-based laboratory instruments; astronomical or astrophysics space observations; auxiliary instrumentation, such as spectrometers for ground-based telescopes, mission operation and system software; or any spacecraft technology that does not directly address lunar science instrumentation.

The nature of specific efforts selected for funding will vary, with emphasis given to innovative technologies that improve instrument measurement capabilities. It is anticipated that the science payloads on most future planetary science spacecraft will be limited to small, low mass, and low power consumption instruments.

The Planetary Science Division strongly encourages proposers to investigate current and recent Small Business Innovative Research awards (http://sbir.gsfc.nasa.gov/abstract_archives) as well as NASA programs such as Planetary Instrument Concepts for the Advancement of Solar System Observations (PICASSO) and Game Changing Technologies for possible collaboration and leveraging of already-funded emerging technologies.

2. Programmatic Considerations

2.1 Special Requirements for Proposals

Proposals are solicited under this program element for instrument development only for the mission focus areas described in Decadal Survey or the Science Plan. All Step-2 proposals submitted to this program element must specify:

- The mission focus area for which the proposed instrument is applicable. Instruments that are applicable to more than one mission are permitted.
- The relationship between the science objectives and the instrumental capabilities must be clearly demonstrated. For those instruments that are applicable to more than one mission or capable of meeting multiple science objectives, examples of science objectives for the proposed mission or missions must be given.
- A detailed description and justification for the entry technology readiness level and a detailed plan for raising the instrument to the proposed exit technology readiness level. The plan must include descriptions of planned tests or demonstrations and milestones, as well as discussions of how those tests or demonstrations will advance the technology readiness level of the instrument.
- Technological advances are to be pursued as an inherent element of achieving the science objectives. Proposals that include the potential for technology transfer to other users, including commercial sector for possible applications beyond the immediate one of meeting mission science objective, are encouraged. Proposals that discuss such potential must also provide possible mechanisms for such transfer.
- The technical, schedule, and cost risks to the proposed project and risk mitigation strategies shall be addressed in the proposal work plan.
- Because of the anticipated greater degree of complexity, the Scientific/Technical/Management section of proposals for these investigations may be 25 pages long, instead of the default 15 pages specified in the *NASA Guidebook for Proposers*.
- An entry level Summary Chart, not counted in the page limit, shall be submitted as a separately uploaded appendix PDF file to the Step-2 Proposal. A template for the entry level Summary Chart is available from the SARA web page at https://science.nasa.gov/researchers/templates-planetary-science-division-appendix-c-roses-proposals. The Summary Chart shall contain the following information:
  - Title, Principal Investigator (PI) Name and Institution
  - Target (Moon)
  - Bulleted list of science that will be enabled by a new instrument
  - Bulleted list of major objectives of proposed work
  - Co-Investigators (Co-Is) Names and Institutions
  - A figure illustrating and clarifying the proposed concept
  - Top level Milestones
  - Entry and exit technology readiness levels (TRL)
  - An optional TRL Assessment spreadsheet is available from the SARA web page may be included in the Step-2 Proposal to help justify the TRL case. This optional spreadsheet does not count against the page limit and is to be placed

immediately following the References and Citations section for the Scientific/Technical/ Management portion of the proposal.

2.2 Additional Evaluation Considerations

In addition to the criteria specified in Section VI. (a) *ROSES Summary of Solicitation* and (by reference) the *NASA Guidebook for Proposers,* the assessment of Merit includes the extent to which the proposed instrument would address a priority science goal of the lunar mission or missions.

2.3 Award Duration and Types

It is expected that most proposals will request awards with durations of three years, but proposals may be submitted for projects of duration from one to four years. For proposals that request an award of four years in duration, a detailed justification is required and will be used in determining the duration of any award, should the proposal be selected. Awards to non-governmental organizations will be in the form of grants (or cooperative agreements if appropriate).

2.4 Technical Reporting Requirements

Once awarded, all Progress Reporting deliverables applicable to this solicitation shall be submitted to the web-based Planetary Electronic Reporting System (ERS). A user account on ERS will be provided to the PI upon award. Due to NASA IT security requirements, all Principal Investigators (PIs) must register with the Identity Management and Account Exchange (IdMAX) system before a user account on ERS will be established. To create an IdMAX account, some personal information will be required. All submissions shall be made in PDF format, except the Summary Chart which shall be in Microsoft PowerPoint.

The following deliverables shall be required of institutions that win awards. In cases where subcontract arrangements exist, consolidated project reports are the responsibility of the Principal Investigator (PI). The proposed budget should provide for these reporting requirements. In this context, "Annual" refers to a twelve-month task effort that commences at award.

2.4.1 *Initial Plans and Reports*

If a proposal was "descoped" (i.e., only part of the scope of the project will be supported by NASA), the PI should contact the NASA Program Officer after having been notified of the descope to discuss a revised Budget and Work Plan. No funding will be awarded until an updated project plan and budget have been received and approved by the NASA Program Officer. The project plan and budget shall be emailed to the cognizant NASA Program Officer.

2.4.2 *Quarterly Technical Reports*

The quarterly technical report shall focus on the preceding three month's efforts. Each report shall address:

1. Technical status: The PI shall summarize accomplishments for the preceding three months, including technical accomplishments (trade study results,

requirements analysis, design, etc.), technology development results, and results of tests and/or demonstrations.

2. Schedule status: The PI shall quantitatively address the status of major tasks and the variance from planned versus actual schedule, including tasks completed, tasks in process, tasks expected to complete later than planned, and tasks that are delayed in starting, with rationale for each and recovery plans, as appropriate.

Quarterly Technical Reports shall be uploaded to the ERS system starting on the third-month anniversary date of the signing of the award vehicle. All awardees will receive a ERS user name and password after selections have been made.

In months for which the PI is providing an Annual Review, the requirement for a quarterly report is superseded by the review requirements discussed in the next two sections.

Reports shall be submitted in PDF, except the Summary Chart which shall be in Microsoft PowerPoint compatible file formats by the required due date, or by close of business of the first workday following the due date, if the due date falls on a weekend or a holiday. A teleconference or brief meeting may be conducted between the NASA Program Officer and the PI to review and discuss each report.

2.4.3 *Annual Progress Report Deliverable*

The PI shall provide an Annual Review at the end of the first twelve-month calendar period commencing from the date of award and at twelve-month intervals thereafter. The PI must conduct an oral presentation summarizing the work accomplished and results leading up to this Annual Review and must:

1. Describe the primary findings, technology development results, and technical status, e.g., status of design, construction of breadboards or prototype implementations, results of tests and/or proof-of-concept demonstrations, etc.;
2. Describe the work planned for the remainder of the project and critical issues that need to be resolved to successfully complete the remaining planned work;
3. Summarize the cost and schedule status of the project, including any schedule slippage/acceleration. A schedule milestone chart of all major task activities shall be created and maintained and shown at all reviews. A cost data sheet shall be created and maintained, showing total project costs committed, obligated, and costed, along with a graphical representation of the project cost profile to completion;
4. Provide a summary of accomplishments and anticipated results at the end of the task;
5. Report any educational and outreach components of the project, e.g., graduate degrees, educational activities; technology infusion or patents applied for or granted; journal or conference publications; presentations at professional conferences, seminars, and symposia; demonstrations; media exposure; and, other activities that contributed to the overall success of the research project;
6. The Annual Review should be comprehensive and should include a discussion of the planned content of the written report.

The NASA Program Officer will conduct the Annual Review at the PI's facility or via teleconference. If the review is conducted at the PI's facility, or a mutually agreed to location, the PI may also provide a laboratory demonstration, if appropriate, to show technical results and status. The presentation slides (Power Point) shall be uploaded to the ERS system at least two working days prior to the review.

Following the review, the presentation shall be updated in accordance with comments and discussion resulting from the review; this will constitute the Annual Review. The presentation, updated in accordance with comments and discussion resulting from the review, together with the separate written Annual Report, shall constitute the Annual Progress Report deliverable. A copy of each report shall be uploaded to the ERS system and, for grants, emailed to the NASA Shared Services Center (NSSC) at NSSC-Grant-Report@mail.nasa.gov. For grants, the Annual Review may be scheduled as early as 60-days before the grant start date anniversary. The release of the annual budget allocation is contingent on the timely submission of the Annual Progress Report deliverables.

2.4.4 *Final Review and Final Report*

The PI shall provide a comprehensive Final Review at the completion of the activity. The Final Review is similar to the Annual Reviews and includes all of the products required at an Annual Review with the following exceptions:

1. The Final Review must provide conclusions of the work performed and make recommendations for follow-on activities that should be pursued, with estimates of the cost and schedule to achieve TRL 7.
2. As this is the Final Review, there is no need to present future work plans or a cost profile.

The written Final Report shall include the following:

1. Background of the project, including the science rationale for conducting this technology development;
2. Results of all analyses, element, subsystem, or system designs, breadboards, and/or prototyping implementations and designs;
3. Performance analysis results of tests and/or demonstrations; estimation of reduction(s) in size, mass, power, volume, and/or cost; improved performance; description of newly enabled capability; and documentation of technology dependencies;
4. Tables, graphs, diagrams, curves, sketches, photographs, and drawings in sufficient detail to comprehensively explain the results achieved;
5. An updated TRL assessment, including a rough order of magnitude cost and a description and estimate of the duration of the follow-on activities necessary to achieve TRL 7;
6. At the end of the period of performance, the PI shall provide a final Accomplishments Chart which contains the following information
   - Upper Left: "Description and Objectives."
   - Middle: "Accomplishments."
   - Upper Right: A visual, graphic, or other pertinent information.

- Bottom: "Co-Is" (name and affiliation), "Entry TRL," and "Exit TRL."

The written Final Report, Accomplishments Chart, and updated TRL assessment shall be uploaded to the ERS system within ten days of the final review. In addition, for grantees, a copy of the written report shall be emailed to the NSSC.

2.5 Planetary Science Early Career Award

Details of the new Planetary Science Early Career Award (ECA) program are given in program element C.19. The aim of this program is to support research and professional development of outstanding early-career scientists, and to help stimulate research careers in areas supported by the Planetary Sciences Division. This program is an ECA-participating ROSES program element. Proposals from eligible PIs, or Science PIs if applicable, selected from this program in 2020 may become the 'parent award' for future ECA proposals (i.e., in 2021 or later).

2.6 NASA Postdoctoral Program Fellows

Grantees in the program are eligible to serve as mentors to NASA Postdoctoral Program (NPP) Fellows. More information about the NASA Postdoctoral Program may be found at http://npp.usra.edu/.

3. Resources: Information, Data, and Facilities

3.1 Limits on Use of Mission Data

Proposals to this program element must follow the rules for use of mission data given in Section 3.5 of C.1, The Planetary Science Division Research Program Overview. If the data to be analyzed have issues that might represent an obstacle to analysis, the proposers must demonstrate clearly and satisfactorily how such potential difficulties will be overcome.

3.2 Facilities and Data Sources Available to Proposers **[Clarified June 22, 2020]**

Proposers are advised to read Section 4 of C.1, The Planetary Science Division Research Program Overview, for information on facilities and data sources that are available to supported investigators. If their use is anticipated, this should be discussed and justified in the submitted proposals (especially note the provision for such discussion in the proposal section entitled Facilities and Equipment). Also note that, per the directions in Section 3.17 ~~and 3.18~~ of the *NASA Guidebook for Proposers*, **and Table 1 of the *ROSES Summary of Solicitation*, any facility or resource not under the direct control of the PI or a Co-I requires a letter of support acknowledging that it is available for the proposed use during the proposed period.** ~~a letter of support may be required from any facility required for the proposed effort.~~

4. Proposal Submission Process

This program element uses a two-step proposal submission process described in Appendix C.1, Section 2.

Proposers are reminded that Step-1 proposals are mandatory and must be submitted by the proposing organization.

Proposals must follow all formatting requirements that are described in program element C.1 and Section IV(b)ii of the ROSES Summary of Solicitation. Violation of these rules is sufficient grounds for a proposal to be rejected.

5. Summary of Key Information

Expected program budget for first year of new awards	~ $1.0M per year per award
Number of new awards pending adequate proposals of merit,	~ 5
Maximum duration of awards	4 Years, (See Section 2.3)
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA.
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	Six months after the Step-2 proposal due date
Page limit for the central Science/Technical/Management section of proposal	25 pp; see also Table 1 of the *ROSES Summary of Solicitation.*
Relevance	This program is relevant to the Planetary Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See C.1 the Planetary Science Research Program Overview, and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of Step-1 and Step-2 proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of Step-1 and Step-2 proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-DALI

Main point of contact concerning this program	Ryan Stephan Planetary Science Division Science Mission Directorate National Aeronautics and Space Administration Washington DC 20526-0001 Telephone: 832-289-5533 Email: Ryan.A.Stephan@nasa.gov
Other points of contact for related programs	Questions concerning Discovery Program may be addressed to: Michael H. New Lead Discovery Program Scientist Planetary Science Division National Aeronautics and Space Administration Washington DC 20526-001 Telephone: 202-358-1766 Email: michael.n.new@nasa.gov Questions concerning New Frontiers Program may be addressed to: Curt Niebur New Frontiers Program Scientist National Aeronautics and Space Administration Washington DC 20526-001 Telephone: 202-358-0390 Email: curt.neibur@nasa.gov The Lunar Science Point of Contact is: Sarah Noble Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-2492 Email: sarah.noble-1@nasa.gov

C.21 DART PARTICIPATING SCIENTIST PROGRAM

NOTICE: Amended September 18, 2020. This Amendment delays the proposal due date for this program element to give more time for proposers displaced by fires and hurricane. Proposals are now due October 1, 2020

Amended June 25, 2020. This Amendment releases the final text for this program element. This program requires a Notice of Intent (NOI). Proposals that are not preceded by the mandatory NOI may be returned without review. No feedback will be provided in response to the NOI. See Section 3.1.1. Mandatory NOIs are due August 10, 2020 ~~and proposals are due September 24, 2020~~.

Important information for proposers, including the Proposal Information Package (PIP) and a Frequently Asked Questions (FAQ) list, are provided on the NSPIRES page for this program element. Questions may be submitted by email to the point of contact identified in the summary table of key information no later than 30 days before the proposal deadline. Relevant questions (regardless of frequency) and answers will be added to the FAQ, which will be revised as needed in a timely manner.

1 Scope of Program

The objective of the Double Asteroid Redirection Test (DART) Participating Scientist Program (DART-PSP) is to enhance the scientific return of the DART mission through new investigations, conducted during the primary flight and post-flight phases (mission Phases E and F), that broaden and/or complement DART's primary investigation.

1.1 Background Information

The DART mission is the first full-scale demonstration of kinetic impact deflection applied to an asteroid. Scheduled for launch in the second half of 2021, DART will reach its destination, the binary asteroid system (65803) Didymos, in late September 2022. The DART project's objectives are to hit the secondary member, Dimorphos (formerly Didymos B), with the spacecraft; to measure the resulting change in the binary orbit using Earth-based telescopes; and to combine these and other available data to estimate the enhancement in the momentum transferred to the asteroid due to ejecta from the spacecraft impact. By targeting an object in a binary system while it is in relatively close proximity to Earth, DART's mission architecture allows Earth-based telescopes to measure the induced change in the target's motion by way of its effect on the slow (~20 cm/s) binary orbit rather than the fast (~30 km/s) heliocentric orbit, and results in far higher precision than would be possible otherwise. With a mean diameter of approximately 160 m, Dimorphos's size is representative of the smallest – and therefore most abundant – objects capable of causing regional or broader scale destruction if one were to impact Earth.

The baseline Level 1 Mission Requirements for DART are:

DART-1. DART shall intercept the secondary member of the binary asteroid (65803) Didymos as a kinetic impactor spacecraft during its September to October,

2022 close approach to Earth.

DART-2. The DART impact on the secondary member of the Didymos system shall cause at least a 73- second change in the binary orbital period.

DART-3. The DART project shall characterize the binary orbit with sufficient accuracy, by obtaining ground-based observations of the Didymos system before and after spacecraft impact, to measure the change in the binary orbital period to within 7.3 seconds (1-σ).

DART-4A. The DART project shall use the velocity change imparted to the target, to obtain a measure of the momentum transfer enhancement parameter referred to as "Beta" (β) using the best available estimate of the mass of Didymos B.

DART-4B. The DART project shall obtain data, in collaboration with ground-based observations and data from another spacecraft (if available), to constrain the location and surface characteristics of the spacecraft impact site, and to allow the estimation of the dynamical changes in the Didymos system resulting from the DART impact, and the coupling between the body rotation and the orbit.

DART carries one instrument, the Didymos Reconnaissance and Asteroid Camera for Optical navigation (DRACO). DRACO is a panchromatic imager with a field of view of 0.29 degrees and a pixel scale of 2.5 μrad. It is a dual-purpose instrument, used both for navigation – particularly for the autonomous terminal approach – and for characterizing the Didymos system in general and Dimorphos and the DART impact site specifically. Because DART's approach to the Didymos system will take place at a relative velocity of approximately 6.6 km/s, Didymos will be spatially resolved only about 4 hours before DART impacts, and Dimorphos only in the last hour. Sub-meter-scale resolution is achieved in the final 30 seconds. In the terminal phase, data downlink is expected to support a frame rate of approximately 1 Hz.

DART will also carry a 6U CubeSat, the Light Italian Cubesat for Imaging of Asteroids (LICIAcube), which will be deployed several days before the impact on Dimorphos. After deployment, LICIAcube will maneuver so as to trail behind DART (with a perpendicular offset), making its closest approach to Dimorphos a few minutes after DART's impact. LICIAcube will carry two imagers, with the primary goals of imaging the ejecta plume and the non-impact hemisphere of Dimorphos that DRACO will not see, and the secondary goal of imaging the crater (if visible through the plume). LICIAcube data will be downlinked in the weeks following the DART impact.

Earth-based observations are critical to DART's mission, as neither DART nor LICIAcube is in the vicinity of the Didymos system long enough to detect the subtle change in the motion of Dimorphos caused by DART's impact. This change will instead manifest itself in a shift, on the order of 1%, in the 11.9-hour binary orbital period, which will be detected using Earth-based telescopes in the subsequent weeks. Although the binary is not resolvable by optical/infrared (O/IR) telescopes, the system is oriented such that mutual events (eclipses and transits) are detectable in light curves; the timings of these events are used to determine the period. Multiple O/IR observing campaigns

have already been, and will continue to be, carried out by the DART Investigation Team (IT) to fully characterize the pre-impact dynamics. These efforts will continue during and after primary spacecraft operations.

Prospective proposers are referred to the Proposal Information Package (PIP) distributed along with this Program Element Appendix for specific information on the DART mission, the DRACO instrument, LICIAcube and its imagers, the planned imaging sequences, data downlink, Earth-based observations, and activities of the DART Investigation Team, plus additional information described below.

1.2 Solicited Investigations

For purposes of this solicitation, the word "DART", unless explicitly indicated otherwise, implicitly encompasses all of the components of the DART project, including the DART spacecraft itself as well as LICIAcube, their instrumentation, the Earth-based observing campaign, and all of the resulting data. “Spacecraft data” refers to both DART and LICIAcube data.

The DART-PSP solicits proposals for science investigations to be carried out during the primary flight and post-flight phases that significantly enhance the overall knowledge obtained from the DART mission and that address outstanding questions related to Planetary Defense. Proposed investigations shall have objectives directed toward understanding the Didymos system in particular, and (optionally) characteristics relevant to the deflection of near-Earth asteroids in general. Proposed activities may include any or all of: (a) analysis of raw and/or calibrated spacecraft data, (b) acquisition and/or analysis of ground-based data, (c) model development and/or fitting, (d) data interpretation, (e) correlative studies, (f) laboratory experiments, and (g) fundamental theory.

Proposed investigations may not duplicate activities or tasks being carried out by the IT as part of the mission; the responsibility for meeting Level-1 Requirements rests with the DART Project and its IT, not with Participating Scientists. However, investigations that are focused on improving the characterization of the physical state of Dimorphos and/or the Didymos system and that, as a byproduct, can also be used to refine and/or improve the precision of the determinations of β are in scope.

Proposals must explicitly describe why the proposed investigation should be conducted during the primary flight and post-flight phases, and how integration of the proposing team into the DART IT during these phases will enhance the mission’s return of knowledge.

Proposers should not anticipate that DART spacecraft operations, including trajectory, communications, and imaging sequences, will be changed to accommodate Participating Scientist investigations. Proposed activities must not increase risk to the mission.

1.3 Exclusions

Investigations that duplicate activities being carried out by the IT are not in the scope of this program. For a list of activities being carried out by the IT please refer to the PIP that may be downloaded from below the heading "Other Documents" on the NSPIRES

page of this program element.

Investigations focusing on the performance of the NEXT-C solar electric propulsion system carried on DART, or any other spacecraft systems, are also not in scope and not responsive to the solicitation and will be returned without review.

1.4 Roles of Proposal Team Members

The PI of a selected proposal, and that person alone, will be added to the DART IT as a Participating Scientist with the same rights and responsibilities as IT Co-Is, as per the DART Rules of the Road (contained in the PIP). In the case that, for institutional reasons, a proposal names a Science PI distinct from the Principal Investigator, that individual (and not the named Principal Investigator) will be added to the DART IT as a Participating Scientist; for these proposals, all further uses of the term "Principal Investigator" mean "Science PI" in this Program Element Appendix. Proposal Co-Is, collaborators, and other team members will join the DART IT with the same status as IT Collaborators. The Participating Scientist and their proposal team members must sign and abide by the DART Rules of the Road.

2 Programmatic Information

2.1 Eligibility

Any U.S. institution may propose to this solicitation. However, current U.S. Co-Is on the DART IT are not permitted to be PI or Co-I on any DART-PSP proposal; these people may be Collaborators on a proposal, and their status on the DART IT will not change as a result of the selection or non-selection decision. Current DART U.S. Collaborators may be PI on a DART-PSP proposal; they will be "elevated" to Co-I status on the DART IT (as Participating Scientists) if their proposal is selected and will retain their Collaborator status if not.

2.2 Proposals from Non-U.S. Institutions

Proposals from non-U.S. institutions are not solicited by this announcement. There is a route for non-U.S. scientists to join the DART IT through the international AIDA collaboration. This route is described in the DART Rules of the Road, provided in the PIP.

2.3 Sources of Information and Data Used in the Proposal

Information on the DART and LICIAcube instruments and anticipated data can be found in the PIP.

All information used in the proposal document that pertains to DART or other missions must be available in the public domain at least 30 days before the full proposal deadline. For the purposes of this restriction, the public domain includes publication in a publicly accessible archive (e.g. Planetary Data System), final publication in a scientific journal, and posting on the NSPIRES pages for this program element.

The requirement on the public availability of spacecraft mission data to be used in the proposed project (Appendix C.1, Planetary Science Research Program Overview, Section 3.4) does not apply to the DART mission data for this program element. Proposals may incorporate the use of future DART mission data.

The requirement on the public availability of spacecraft mission data to be used in the proposed project does not apply to missions that the PI is currently funded to participate in. Proposals may use future mission data from a spacecraft mission that is currently or will be undergoing senior review, but the outcome of that mission's review will be considered by NASA in selection decisions.

2.4 Start Dates, Duration, and Size of Awards

The Planetary Science Division expects to make a single set of selections for this program starting in FY 2021, with investigations running for up to three years. The expected budget for the program is approximately $1M total for all program years; the number of selections is expected to be no more than six.

Proposals should specify start dates of March 15, 2021.

2.5 Reporting and Funding Increments

After selection, each Participating Scientist shall provide, to the DART IT Lead and the DART Program Scientist at NASA Headquarters, an Implementation Plan with a schedule for deliverables (including, but not limited to, software, data products, reports, and publication plans), and details, as appropriate to the selected investigation, regarding plans for data analysis, computing facilities, ground data system support, software development, support of instrument calibration, data archiving, and participation in outreach activities. Each Participating Scientist shall provide an annual report, submitted to NSSC and copied to the Program Scientist and IT Lead, that include: accomplishments over the past year, plans for the next year period, issues and concerns, schedule performance, financial performance, recovery plans, and status of publications and other deliverables.

Release of incremental funding for the second and third years of the selected investigation will be contingent upon demonstration of adequate progress against the schedule in the Implementation Plan. NASA reserves the right to cancel an award on the basis of insufficient progress or repeated violations of the Rules of the Road.

3 Proposal Submission, Evaluation, and Selection

3.1 General Information

3.1.1 *Mandatory Notice of Intent*

To facilitate the early recruitment of a conflict-free review panel and ensure that proposals are submitted to the appropriate category, an NOI will be required for all submissions to this program element. Proposals that are not preceded by an NOI may be returned without review. The PI may not be changed after NOI submission and proposers who want to add funded investigators between the NOI and the proposal submission must inform the point of contact identified in the summary table of key information at least two weeks in advance of the proposal due date. Additions of funded investigators within two weeks of the proposal deadline require explicit permission from the NASA point of contact. Submission of an NOI does not obligate the proposer to submit a full proposal later.

3.1.2 *Proposal Formatting and Content*

Proposals must follow all formatting requirements that are described in program element C.1 and Section IV(b)ii of the *ROSES Summary of Solicitation*. Violation of these rules is sufficient grounds for a proposal to be rejected or declined. In particular, violation of font, spacing, margin, or page requirements, or omission of a required component of the proposal, will result in rejection. Proposers are especially urged to avoid these common errors in proposals:

- Do not add an extra page containing the abstract before the main body of the proposal. The abstract is limited to the cover pages generated by NSPIRES.
- Do not add a table of symbols or abbreviations as an extra page beyond the 15-page Scientific/Technical/Management (STM) section. Such definitions must fit within the 15 pages.
- Do not describe team members' roles and responsibilities in the table of work effort or budget sections. Only list job titles in these sections. Team member responsibilities must be included in the STM section.
- Do not add information to the Facilities and Equipment section beyond descriptions of the facilities and equipment. Any discussion of how they will be used in the project must be in the STM section.
- Do not include work statements from Co-Is in the budget sections covering sub-awards/subcontracts. These may only appear in the STM section.

Proposers are reminded that, per the directions in Table 1 of the *ROSES Summary of Solicitation*, any facility or resource to which the PI or a Co-I does not have guaranteed access requires a letter of resource support from the owner of the facility or resource demonstrating that it is available for the proposed use during the proposed period.

3.2 <u>Program-Specific Proposal Content</u>

Proposed investigations should be aligned with one or more of the goals of NASA's Planetary Defense Coordination office, which is charged to:

- Provide early detection of potentially hazardous objects (PHOs) – the subset of near-Earth objects (NEOs) with orbits predicted to come within 5 million miles of Earth's orbit; and of a size large enough (30 to 50 meters) to cause significant damage on Earth;
- Track and characterize PHOs and issue warnings of the possible effects of potential impacts;
- Study strategies and technologies for mitigating PHO impacts; and
- Play a lead role in coordinating U.S. government planning for response to an actual impact threat.

The Scientific/Technical/Management (STM) section must clearly articulate:

i. How the proposed work enhances the overall knowledge resulting from the DART mission without increasing risk to the mission;
ii. How the proposed work complements but does not duplicate work being done by the existing DART Investigation Team (described in the PIP);
iii. Why the proposed work should be done during DART's primary flight and post-flight phases; and

iv. How integration of the proposing team into the DART IT during these phases will enhance the mission's return of knowledge.

The STM section must also contain a work plan with sufficient detail to show how the proposed schedule and milestones fit within the mission timeline and should fully describe all resources required from the mission in order to accomplish the work.

Proposers should plan and describe their potential membership on one or more of the DART Investigation Team Working Groups (described in the PIP). Participating Scientist Co-Investigators will be expected to take part in the activities of these groups. Final assignment of the PIs of selected proposals to working groups will be made upon selection.

Proposal work plans, schedules, and budgets must allow PIs to attend all DART Investigation Team meetings during the period of performance, preferably in person but by remote means if necessary.

3.3 Data Management Plans (DMPs)

Proposals must include a Data Management Plan (DMP) that describes how data products produced by the funded investigation will be made publicly available, following the guidelines described in Section 3.7 ("Data Management Plans and Archiving") of C.1 *Planetary Science Research Program Overview*. The DMP must be placed in a special section, not to exceed two pages in length, immediately following the References and Citations section for the Scientific/Technical/Management portion of the proposal. The DMP does not need to cover archiving of spacecraft data returned by the mission, which is already controlled by the mission-level DMP; however, it must cover new data and software products that would be generated under the proposal, including those derived from spacecraft data.

Proposed data products for delivery to the PDS must be clearly described, appropriate time and effort for delivery and ingestion must be budgeted, and the proposal must include a supporting letter from the manager of the PDS Small Bodies Node. For additional information, refer to the PDS Proposer's Archiving guide at https://pds.nasa.gov/home/proposers/proposing-programs.shtml. Data products, including maps, improved calibrations, etc., must be submitted to the PDS or the U.S. Geological Survey (USGS), as appropriate, by the end of the funded research period, unless the investigator explicitly makes a case in the proposal for a later date.

3.4 Evaluation Criteria

All proposals with be evaluated for Intrinsic Merit, Cost, and Relevance, as defined in the *NASA Guidebook for Proposers* and described in Section VI.(a) of *the ROSES Summary of Solicitation* and C.1 *Planetary Science Research Program Overview*. As a part of Intrinsic Merit, proposals will be additionally evaluated on the basis of the following Program-Specific Review Factors:

i. Extent to which the proposed work enhances the overall knowledge resulting from the DART mission without tangibly increasing risk to the mission (note: an increase in risk will be considered a fatal flaw).
ii. Extent to which integration of the proposing team into the DART IT during the primary flight and post-flight phases will enhance the mission's return of

knowledge.

As part of Relevance, proposals will be additionally evaluated on the basis of the following Program-Specific Review Factors:

iii. Extent to which the proposal demonstrates that the proposed work should be done during DART's primary flight and post-flight phases.
iv. Extent to which the proposed work complements but does not duplicate work being done by the existing DART Investigation Team.

And as part of Cost, proposals will be additionally evaluated on the basis of the following Program-Specific Review Factor:

v. Extent to which the budget supports participation by the PI, if selected, in DART Investigation Team meetings.

Note that, consistent with changes in ROSES-2020 and Section 3.7 of C.1, The Planetary Science Research Program Overview, the sufficiency of the data management plan will be evaluated as part of the proposal's intrinsic merit and will have a bearing on whether or not the proposal is selected. The evaluation of the DMP will include a consideration of the appropriateness of the specified archive(s) for data sets and data products resulting from the proposed work effort. Justifications for not archiving mission-data-derived higher-order data products in the PDS will also be evaluated.

3.5 Selection Process

The selection process for this PSP will largely follow that in the documentation governing this program element. While a meritorious proposal will remain a necessary condition for selection, programmatic factors in this PSP may play a larger role in selection decisions than in other program elements solicited in the ROSES NRA.

The selection process for this PSP will also include consideration of the distribution of tasks among the proposal team members. Although Co-Is and other funded team members are necessary components to many science investigations, it is expected that the PI will execute the majority, if not all, of the proposed work effort.

The DART Participating Scientist selection process will include consideration of the proposer’s previous mission participation, if any.

4 Summary of Key Information

Expected program budget for first year of new awards	~$0.33M
Number of new awards pending adequate proposals of merit	3-6
Maximum duration of awards	3 years
Due date for mandatory NOIs	See Tables 2 and 3 of this ROSES NRA.
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	March 15, 2021

Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of the *ROSES Summary of Solicitation*.
Relevance	This program is relevant to the Planetary Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See *the ROSES Summary of Solicitation*.
General requirements for content of proposals	See C.1 the Planetary Science Research Program Overview, and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov. Help desk available at support@grants.gov or (800) 518-4726.
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-DARTPS
Point of contact concerning this program	Thomas S. Statler Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Email: thomas.s.statler@nasa.gov Telephone: (202) 774-0272

C.22 RADIOISOTOPE POWER SYSTEMS (RPS) ENABLING MISSIONS BEGINNING WITH RESEARCH AND TECHNOLOGY

NOTICE: NOTICE: Amended May 11, 2020. This program, which was previously listed as TBD, will not be solicited this year.

1. Scope of Program

The goal of the Radioisotope Power Systems (RPS) Enabling Missions Beginning with Research and Technology (REMBRandT) program element of ROSES is to develop innovative energy conversion and supporting technologies for use in future planetary science missions (such as those selected under the Discovery, New Frontiers, SIMPLEx, Mars Exploration, and other planetary science programs, including those flown on commercial spacecraft) in support of the Planetary Science Division. Specifically, the REMBRandT program seeks to enable advancements in thermoelectric, thermionic, thermodynamic cycle-based technology, and other viable means of converting heat flux directly into electrical energy for use in radioisotope power systems for deep space science missions. The goals of the program are to improve radioisotope power systems by:

- increasing their performance, reliability, and efficiency
- enabling long life operation (greater than 20 years), and/or
- enhancing manufacturing processes for materials and components

2. Summary of Key Information

Point of contact concerning this program	Leah Nakley Radioisotope Power Systems Program Office NASA Glenn Research Center Space Flight Systems Directorate Telephone: (216) 433-8173 Email: leah.m.nakley@nasa.gov

C.23 INTERDISCIPLINARY CONSORTIA FOR ASTROBIOLOGY RESEARCH

NOTICE: The Planetary Science Division does not intend to offer this program element in ROSES this year. It is anticipated that it will be solicited in ROSES-2021.

1. Introduction and Scope of Program

The goal of the NASA's Astrobiology program is the study of the origins, evolution, and distribution of life in the Universe. It is central to NASA's continued exploration of our Solar System and beyond. Research is centered on the origin and early evolution of life, the potential of life to adapt to different environments, and the implications for life elsewhere. NASA, together with the science community, has developed the 2015 Astrobiology Strategy that describes the scientific goals and objectives of NASA's Astrobiology Program (see https://astrobiology.nasa.gov/research/astrobiology-at-nasa/astrobiology-strategy/).

A wide array of NASA Science Mission Directorate (SMD) flight missions incorporate astrobiology goals and objectives. For this reason, with this program element NASA is seeking proposals responding to both the long-term goals and objectives identified in the Astrobiology Strategy and focused on ensuring that the NASA Astrobiology community is prepared to respond to the challenge of planning and implementing these missions. Accordingly, proposals that place emphasis on research that will help prepare for current or future flight programs directed at astrobiological targets are encouraged.

NASA's Astrobiology Program (see http://astrobiology.nasa.gov/) supports awards for individual investigator research, instrument and technology development and testing. More information on the strategic priorities and research/technology investments of the SMD can be found in the 2014 Science Plan for NASA's Science Mission Directorate, available at http://science.nasa.gov/about-us/science-strategy/.

Proposals for Interdisciplinary Consortia for Astrobiology Research (ICAR) must describe an interdisciplinary approach to a single compelling question in astrobiology, and address at least one aspect of the 2015 Science Strategy. Team size and resources requested should be appropriate to the scale of the proposed research. There is no ideal size of an ICAR Team. Because this is an opportunity for larger teams and for five years of support, the scope of the research, and subsequently the resources needed, should exceed those typically considered in a ROSES program element.

NASA recognizes and supports the benefits of having diverse and inclusive scientific, engineering, and technology communities and fully expects that such values will be reflected in the composition of all panels and teams including peer review panels (science, engineering, and technology), proposal teams, science definition teams, and mission and instrument teams. Critical steps must be taken to broaden the participation of underrepresented groups and institutions serving minority students in NASA activities. The following web page from the Office of Civil Rights, U.S. Department of Education links to lists of institutions of higher education enrolling populations with significant percentages of undergraduate minority students, or that serve certain populations of minority students:

https://www2.ed.gov/about/offices/list/ocr/edlite-minorityinst.html

The Astrobiology Program is committed to increasing the participation of under-represented groups in its activities, and it strongly encourages their participation as Lead or Co-Institutions.

2. Summary of Key Information

Point of contact concerning this program	Mary Voytek Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: 202-358-1577 Email: Mary.A.Voytek@nasa.gov

C.24 YEARLY OPPORTUNITIES FOR RESEARCH IN PLANETARY DEFENSE

NOTICE: Amended October 22, 2020. This program is not participating in the stand-alone portion of C.17 Planetary Major Equipment and Facilities (PMEF) in ROSES-2020, i.e., those with awards from this program, may not submit stand-alone proposals to ROSES-2020 PMEF. Deleted text is struck through. See Section 2.1.

June 4, 2020. This amendment delays the Step-2 proposal due date for this program element. The due date for Step-2 proposals is now June 17, 2020.

This program element uses a two-step proposal submission process described in Section 2 of C.1 The Planetary Science Division Research Program Overview.

1. Scope of Program

Near-Earth Objects (NEOs) are defined as asteroids or comet nuclei whose perihelia are less than 1.3 AU and potentially hazardous NEOs are defined as those larger than 140 meters in size whose orbits bring them within 7.5 million km of Earth's orbit. NASA's Planetary Defense Program has as a goal to inventory more than 90 percent of the NEO population larger than 140 meters in size as soon as is feasible. This sub-element, Yearly Opportunities for Research in Planetary Defense (YORPD), supports investigations to accomplish this goal, as well as investigations that would inventory all NEOs (especially those that support NASA's exploration goals or that may pose an impact threat). Proposals that characterize a representative sample of NEOs by measuring their sizes, shapes, and compositions, or that address potential mitigation of NEOs that pose an impact threat are also encouraged.

Full PI-led suborbital missions involving balloons, sounding rockets, or aircraft are not being solicited until further notice. Hosted payloads on already-funded suborbital platforms will be considered.

1.1 NEO Survey Operations

In support of NASA's commitment and goal above, this program supports NEO investigations whose primary objectives include:

- NEO Survey for new discoveries - Investigations that demonstrate the potential to significantly contribute to the current state-of-the-art for a sustained, productive search for previously unknown NEOs and rapid reporting astrometry of candidate discoveries and all other position measurements to the Minor Planet Center (see Section 3.3)
- NEO Rapid Astrometric Follow-Up – Investigations that strategically obtain follow-up observations of sufficient astrometric precision to allow the accurate prediction of the trajectories of potential new NEO discoveries and priority NEOs, with reporting to Minor Planet Center (see Section 3.3). These may include:
    - Candidate NEO discoveries in need of rapid confirmation (see https://minorplanetcenter.net/iau/NEO/toconfirm_tabular.html)

- Candidate NEO discoveries in need of rapid confirmation and orbit determination that appear on the Scout list as approaching within 1 lunar distance (see https://cneos.jpl.nasa.gov/scout)
- Potentially hazardous NEOs with a non-zero impact probability in the next 100 years that appear on the Sentry list (see https://cneos.jpl.nasa.gov/sentry)
- Other NEOs declared to be of priority to NASA

- NEO Rapid Characterization – Investigations that utilize ground-based or space-based telescopes to develop and demonstrate quick turnaround characterization capabilities yielding NEO compositions, shapes, sizes, surface properties, and/or other physical properties using passive (across the spectrum) and active (*e.g.,* radar) techniques
- NEO Operational Tools – Software development toward rapid response capabilities for NEO search, follow-up, and characterization

1.2 NEO Science

This program also supports investigations that do not fit NEO Operations but return science that enhances NASA's planetary defense footing by adding to the overall understanding of the NEO population to make progress towards NASA's goals. Science investigations not responding to these planetary defense goals must be directed to other appropriate program elements. NEO Science investigations may include:

- New ground-based and space-based astronomical observations of NEOs
- Analysis of NEO data from spacecraft missions (*e.g.,* NEOWISE, Spitzer, HST, TESS) and from ground-based telescopes (*e.g.,* NASA's Infrared Telescope Facility), which reside in NASA or other public archives (see Section 3.1) with the goal of finding previously undiscovered NEOs, finding pre-discovery detections for extending astrometric arcs of NEOs, and/or determining NEO physical characteristics, and not appropriate to other NASA research programs
- Archiving and analysis of unarchived legacy NEO survey and follow-up data with the goal of finding previously undiscovered NEOs, finding pre-discovery detections for extending astrometric arcs of NEOs, and/or determining NEO physical characteristics
- Laboratory investigations involving meteoritic materials that directly add to the understanding of the physical characteristics of the NEO population
- Dynamical modeling studies of the overall NEO population and/or the potentially hazardous NEO population leading to improved population predictions

1.3 Impactor Threat Mitigation Studies

A limited amount of funding under this program will be made available for research to determine the parameters necessary to understand the characteristics of Potentially Hazardous Objects (PHOs) which are important for implementation of mitigation actions against a detected impact threat – that is, data supporting the operations designed to disrupt or deflect the trajectory of an asteroid on an impending Earth impact trajectory. These studies may include laboratory and modeling studies geared toward understanding NEO strength and composition properties for informing mitigation mission design.

2. Programmatic Considerations

2.1 Additional Funding for Relevant Instrumentation Construction or Upgrade

Proposers to Yearly Opportunities for Research in Planetary Defense (YORPD) are eligible to request funds for major equipment under the Planetary Major Equipment and Facilities (PMEF) program. See program element C.17 for information on how to append a PMEF request to a regular YORPD research proposal ~~or submit a stand-alone PMEF proposal to supplement an existing YORPD award~~. **[Amended October 22, 2020]**

2.2 Proposals Utilizing Goldstone Planetary Radar

Proposals intending to use the planetary radar capabilities of the Deep Space Network Goldstone complex may contact the JPL Goldstone Solar System Radar (GSSR) Task Manager listed below for information on using the Goldstone radar.

GSSR Task Manager:
Martin Slade
Telephone: (818) 354-2765
Email: Martin.A.Slade@jpl.nasa.gov

2.3 Proposals Utilizing Arecibo Planetary Radar

Proposals intending to use the planetary radar capabilities of Arecibo Observatory may contact the Arecibo Radar PI Anne Virkki at anne.virkki@ucf.edu for information on using the Arecibo radar.

2.4 Planetary Science Early Career Award

Details of the Planetary Science Early Career Award (ECA) program are given in program element C.19. The aim of the ECA program is to support research and professional development of outstanding early-career scientists, and to help stimulate research careers in areas supported by the Planetary Sciences Division. YORPD is an ECA-participating ROSES program element. Proposals from eligible PIs, or Science PIs if applicable, selected from YORPD this year may become the 'parent award' for future ECA proposals.

3. Resources: Information, Data, and Facilities

3.1 Limits on Use of Mission Data

Proposals to this program element must follow the rules for use of mission data given in program element C.1, section 3.4. If the data to be analyzed have issues that might represent an obstacle to analysis, the proposers must demonstrate clearly and satisfactorily how such potential difficulties will be overcome.

3.2 Facilities and Data Sources Available to Proposers **[Clarified June 22, 2020]**

Please refer to ROSES program element C.1, section 4, for a detailed list of the data and astromaterials resources, and facilities available to proposers to this program element, and how to use them. If their use is anticipated, this should be discussed and justified in the submitted proposals (especially note the provision for such discussion in the proposal section entitled Facilities and Equipment). Also note that, per the directions

in the *NASA Guidebook for Proposers* a letter of support may be required from any facility required for the proposed effort.

3.3 Data Management Plans (DMPs)

Proposals submitted to this program element must include a Data Management Plan (see program element C.1, Section 3.6). This must be placed in a special section, not to exceed two pages in length, immediately following the References and Citations section for the Scientific/Technical/Management portion of the proposal.

In keeping with NASA data rights policies, all funded NEO search or follow-up programs will be expected to make their data permanently available in a timely manner to the scientific community. Specifically, this requirement shall apply to all astrometric measurements of asteroids and comets made by NEO search and follow-up projects funded under this program, both operational and archival, to be made immediately available to the internationally recognized archive for these data, the International Astronomical Union (IAU) sanctioned Minor Planet Center, currently located at the Harvard Smithsonian Astrophysical Observatory (see http://minorplanetcenter.net/).

3.4 Geologic Maps

Proposers who plan investigations involving geologic mapping should consult program element C.1, Section 3.8, for guidance on submission and requirements for publication of U.S. Geological Survey (USGS) maps. The scientific goal of such a geologic map product should be clearly explained and justified.

4. Proposal Submission Process

This program element uses a two-step proposal submission process described in program element C.1, Section 2.

Proposers are reminded that Step-1 proposals are mandatory and must be submitted by the proposing organization.

Proposals must follow all formatting requirements that are described in program element C.1 and Section IV(b)ii of the ROSES Summary of Solicitation. Violation of these rules is sufficient grounds for a proposal to be rejected.

5. Summary of Key Information

Expected program budget for first year of new awards	~$10M
Number of new awards pending adequate proposals of merit	~15-20
Maximum duration of awards	Typical awards are 3 years. Up to 5 years permitted.
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA.
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	~7 months after Step-2 proposal due date.

Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of ROSES and the *NASA Guidebook for Proposers.*
Relevance	This program is relevant to the Planetary Science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See C.1 the Planetary Science Research Program Overview, and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Web site for submission of Step-1 and Step-2 proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of Step-1 and Step-2 proposals via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-YORPD
Points of contact concerning this program both of whom share the following postal address: Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001	Kelly Fast Email: kelly.e.fast@nasa.gov Phone: (202) 358-0768 Lindley Johnson Email: lindley.johnson@nasa.gov Phone: (202) 358-2314

C.25 MARS ORGANIC MOLECULE ANALYSER PARTICIPATING SCIENTIST PROGRAM

NOTICE: Amended March 13, 2020. This Amendment announces that Mars Organic Molecule Analyser participating scientists Program will not be solicited in ROSES-2020. New Text is in bold and deleted text is struck through.

~~The Planetary Science Division intends to solicit proposals for Mars Organic Molecule Analyser Participating Scientists as a program element in ROSES-2020. If so, it is expected that the final text for this program element will be released in NSPIRES no fewer than 90 days prior to the full or Step-2 proposal due date~~.

Scope of Program

The European Space Agency and the Roscosmos Space Corporation have postponed the launch of the second ExoMars to 2022. As a result, Mars Organic Molecule Analyser participating scientists Program will not be solicited in ROSES-2020.

~~NASA intends to solicit proposals for participating scientists (PSs) for the MOMA (Mars Organic Molecule Analyser) instrument, which will be flown on the European Space Agency/Roscosmos ExoMars rover mission. The launch of the ExoMars rover is scheduled for July/August 2020.~~ The MOMA instrument is a gas chromatograph/laser desorption and ionization (GC/LDI) mass spectrometer, designed to detect and analyze organic compounds in martian surface and subsurface materials. MOMA is led by Prof. Fred Goesmann at the Max Planck Institute for Solar System Research in Göttingen, Germany. NASA Goddard Space Flight Center in Greenbelt, Maryland is a major partner on the instrument (led by co-PI and MOMA Project Scientist Will Brinckerhoff), and is supplying main and secondary electronics boxes, the ion trap mass spectrometer, and associated hardware. The gas chromatograph is led by François Raulin at the University of Paris. ~~The call will be open to U.S. scientists who will be able to contribute to the goals and enhance the science return of the MOMA instrument for the ExoMars mission~~.

Point of Contact

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C.26 CONCEPTS FOR OCEAN WORLDS LIFE DETECTION TECHNOLOGY: AUTONOMY, COMMUNICATIONS, AND RADIATION-HARD DEVICES

NOTICE: Amended October 30, 2020. This amendment presents a new opportunity in ROSES-2020 in the form of this program element C.26 COLDTech: Autonomy, Communications, and Radiation-Hard Devices. Proposals to this program will be taken by a two-step process in which the Notice of Intent is replaced by a required Step-1 proposal submitted by an organization Authorized Organizational Representative. Only proposers who submit a Step-1 proposal are eligible to submit a Step-2 (full) proposal. See Section 3 for details. Step-1 proposals are due December 1, 2020 and Step-2 proposals are due February 19, 2021.

1. Scope of Program

The goal of the Concepts for Ocean worlds Life Detection Technology (COLDTech) Program is to support the development of spacecraft-based technology for surface and subsurface exploration of ocean worlds such as Europa and Enceladus to develop and reduce the technical risk of technology so that they may eventually be incorporated into future flight missions and/or proposed in response to future Announcements of Opportunity (AOs) for these missions.

This particular program element, "COLDTech: Autonomy, Communications, and Radiation-Hard Devices", does not solicit the development of scientific instruments or sample acquisition systems, nor does it solicit technology for a flight opportunity. Specific technologies sought for this COLDTech opportunity are 1) autonomy for landed operations, 2) technology to enable communication through many kilometers of ice thickness; and 3) radiation-hard digital devices. Proposals are expected to consider the practicality of incorporating the technical advances into flight missions, i.e., mass, volume, power, computational resources, and data rates will be constrained on typical planetary science missions so proposed technologies should aim to minimize their demands on these resources.

NASA has not specified the science objectives and the mission architecture for future ocean worlds missions. A driving requirement for any such a mission is the sampling strategy, particularly the depth from which a sample is acquired. Two concepts exploring the extremes of sampling depth are offered to provide context to proposers as to how proposed technologies might be used. A long-lived vertical ice penetrator reaching many kilometers below the surface of Europa was considered in a workshop organized by the Keck Institute for Space Studies; a summary of the technical challenges related to this concept is described in Cwik et al. 2018. Proposers to the COLDTech communication technical area should refer to this study for representative physical constraints of such a mission. A second study conducted by the Jet Propulsion Laboratory considered a short-lived lander acquiring samples from ~10 cm below the surface (Europa Lander Study 2016). Proposers to the COLDTech-2 autonomy and radiation-hard digital devices technical areas should refer to this for a representative concept of operations.

Many similarities exist between these concepts and landers and *in-situ* explorers for other worlds, and so the proposed technologies may be relevant to a broad range of planetary science missions.

Proposals must state which one of the three technical areas are being addressed, and should consider the following information:

1.1 Through-the-Ice Communication

Europa's interior ocean is covered by a layer of water ice that may be on the order of kilometers to tens of kilometers thick. In addition, the moon's surface likely flexes on the order of tens of meters every day because of tidal forces. This poses a data communication challenge to any future mission targeting ocean exploration because of the stresses placed on tethers connecting them to the surface. Much about the electrical and mechanical properties of Europan ice is unknown, and proposers are encouraged to review the current literature on the topic.

Any technique for through-the-ice communication must be long lived, low power, cold tolerant, and address the environmental challenges posed by Europa.

1.2 Radiation-Hard Digital Devices

Europa orbits within Jupiter's strong radiation belts, where energetic particles are trapped within the strong magnetic field resulting in extremely high radiation levels. Some portions of the surface experience less radiation, but the environment is still severe. Standard flight electronic systems are significantly degraded in this environment and, even with shielding, can limit the duration of lander missions.

Radiation-hard electronics are sought that can operate at a total ionizing dose of 5 Mrad (Si equivalent) without shielding. Specifically, digital electronic devices are needed for on-board computing and communication systems, including microcomputers and radio frequency transmitters and receivers using radiation-hard transistors and integrated circuits.

1.3 Autonomy for Landed Operations

Proposers to the autonomy topic should not propose the control of specific instruments or end effectors but instead focus on functional and system-level autonomous capabilities for future ocean worlds missions that:

a) increase the productivity of surface science operations;
b) reduce the frequency of ground control contact and uplink/downlink command cycles necessary for surface science operations; and
c) enable autonomous adaptation to spacecraft faults, degradations, failures or other unexpected conditions.

Autonomous capabilities may include, but are not limited to, technologies that:

1) autonomously adapt spacecraft activities to unpredictable faults due to operation in an unknown and uncertain environment;
2) autonomously react to unanticipated environmental stimuli (including dynamic effects from surface interaction);
3) autonomously operate for long durations with minimal ground control demand or interaction;

4) autonomously prioritize on-board operations to maximize mission life (e.g., efficient energy management) and/or science return; or
5) autonomously adapt to changes in system dynamics (e.g., manipulator performance) caused by degradation or failure (actuator wear, intermittent sensor noise, etc.).

Proposals are encouraged to address dealing with unexpected and unanticipated situations - developing technology to enable "fail operational" capabilities for time-critical and resource limited sampling activities.

NASA testbeds, both virtual and physical, are available for the development and validation of autonomy systems and the use of one or both is required. Information about these testbeds can be found at TESTBEDS and proposers are encouraged to contact the testbed leads listed in Table 1 with questions.

Table 1. NASA Ocean World Autonomy Testbed Points of Contact

Ocean Worlds Autonomy Testbed	Point of Contact
Virtual Testbed	Mike Dalal NASA Ames Research Center Phone: (650) 279.3262 Email: Michael.Dalal@nasa.gov
Physical Testbed	Hari Nayar NASA Jet Propulsion Laboratory Phone: (818) 393-2505 Email: hdnayar@jpl.nasa.gov

2. Programmatic Considerations

Proposers to this program are not required to provide a data management plan.

NASA SMD has invested in similar technologies through the prior solicitation of COLDTech in ROSES-2016, SESAME, Icy Satellite, and ASIR: ARROW programs. Proposers are encouraged to learn about prior work to avoid duplication of effort and to understand possible system concepts. Description of these tasks can be found on the Planetary Exploration Science Technology Office (PESTO) web page.

2.1 Special Requirements for Proposals

Proposals must state which one of the three technical areas are being addressed and may address only one.

All proposals submitted to the autonomy topic of this program must propose the use of one or both NASA testbeds as described in Section 1.3.

3. The Two-Step Submission Process

To facilitate the early recruitment of a conflict-free review panel, and to ensure proposals are submitted to the appropriate program, this program will use a two-step proposal submission process (see Section IV. (b) vii of the ROSES *Summary of Solicitation*.)

A Step-1 proposal is required and must be submitted electronically by the Authorized Organizational Representative (AOR). No budget is required. Only proposers who submit a Step- 1 proposal are eligible to submit a Step-2 proposal. Full (Step-2) proposals must broadly contain the same scientific goals proposed in the Step-1 proposal. The PI cannot be adjusted and proposers that want to add funded investigators between the Step-1 and Step-2 proposals must inform the point(s) of contact below and cc sara@nasa.gov at least two weeks in advance of the Step-2 due date. Submission of the Step-1 proposal does not obligate the proposer to submit a Step-2 (full) proposal later.

3.1 Step-1 Proposal

Proposers should refer to the "Instructions for Submitting a Step-1 Proposal" under "Other Documents" on the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) webpage for this program. The Scientific/Technical/ Management section of the Step-1 proposal is restricted to the 4000-character Proposal Summary text box on the NSPIRES web interface cover pages and no PDF upload is required or permitted. The Step-1 proposal should include a brief description of the goals and objectives of the proposal, a brief description of the methodology to be used to address them, and the relevance of the proposed research to this call. The Step-1 proposal may be used to determine whether the proposal was submitted to the appropriate program element. No evaluation of intrinsic merit will be performed on Step-1 proposals.

As part of the submission of the Step-1 proposals, in response to the NSPIRES cover-page question, proposers are encouraged to submit names of potential reviewers for their proposals, provided that the suggested reviewers are not from the same organization as the proposer, nor has any financial ties to the proposer.

Proposers will be notified through NSPIRES whether their Step-2 proposal is encouraged or not, at which point they will be able to submit Step-2 proposals.

3.2 Step-2 Proposal

This is a reminder that all proposals submitted to ROSES must strictly conform to the formatting rules in Section IV of the *Summary of Solicitation*. Those that violate the rules may be rejected without review. In previous years, problems with the following aspects of formatting proposals have been noted. Proposers should pay particular attention to:

- Length of the Scientific/Technical/Management section: 15 pages
- Margins: 1 inch on all sides, with a standard page size of 8.5 × 11 inches.
- Font: Text must, on average, be no more than 15 characters per horizontal inch (e.g., Times New Roman or Arial). You may not adjust the character spacing or otherwise condense a font from its default appearance.
- Line spacing: Font and line-spacing settings should produce text that contains no more than 5.5 lines per vertical inch. Do not adjust line-spacing settings for your selected font below single-spaced.
- Figure captions: Must follow the same font and spacing rules as the main text.
- Figures and tables: For text in figures and tables, font and spacing rules listed above do not apply, but all text must be judged to be legible to reviewers without magnification above 100%. Do not place expository text in tables or figures in

order to gain space.

4. Evaluation Criteria

All proposals with be evaluated for Intrinsic Merit, Cost, and Relevance, as defined in the *NASA Guidebook for Proposers* and described in Section VI.(a) of *the ROSES Summary of Solicitation* and C.1 *Planetary Science Research Program Overview*.

In addition to standard definition, the following will also be evaluated as part of merit:

- The likelihood that the proposed effort will successfully mature the proposed technology, as described in the proposal;
- The eventual ability of the technology to be accommodated within the typical resource constraints of an appropriate planetary science mission, e.g., as seen in the references cited in Section 1.

As stated in ROSES, proposals demonstrate relevance to NASA by demonstrating relevance to the particular program element to which it was submitted. Thus, for this program, the evaluation of relevance will be assessed vs. the technical areas in Sections 1.1-1.3 above.

5. Reporting Requirements

The following deliverables shall be required of institutions that receive awards. In cases where subcontract arrangements exist, consolidated project reports are the responsibility of the PI. The proposed budget should provide for these reporting requirements:

- Biannual reports, submitted electronically via ebooks, a web-based data repository.
- Final briefing to program managers at NASA Headquarters via teleconference. Budget should not be allocated for travel for the final briefing.
- Final report to NASA Headquarters not to exceed 10 pages.

Note that the final report will be placed in a publicly accessible website.

6. Summary of Key Information

Expected Total program budget	$12M over 3 years
Number of new awards pending adequate proposals of merit	~ 8 awards: Digital devices: 2 awards are expected at nominally $1M/year Others: 6 awards are expected at nominally $500K/year
Maximum duration of awards	Autonomy: 2 years Others: 3 years
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA.
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	June 1, 2021
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Table 1 of the *ROSES Summary of Solicitation*.

Relevance	This program is relevant to the planetary science questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See *the ROSES Summary of Solicitation*.
General requirements for content of proposals	See C.1 the Planetary Science Research Program Overview, and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.
Website for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov. Help desk available at support@grants.gov or (800) 518-4726.
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-CLDTCH
Point of contact concerning this program	Carolyn Mercer Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (216) 905-1987 Email: cmercer@nasa.gov

APPENDIX D. ASTROPHYSICS RESEARCH PROGRAM

D.1 ASTROPHYSICS RESEARCH PROGRAM OVERVIEW

1. Introduction

The objectives of research solicited in program elements described in program elements D.2 through D.14 of this NASA Research Announcement (NRA) are focused on achieving the goals of the Science Mission Directorate's Astrophysics Research Program, as defined in the *NASA Science Plan* (available at http://science.nasa.gov/about-us/science-strategy). Proposers to the elements described in Appendix D are encouraged to read this *NASA Science Plan* to gauge the relevance of their research to the Astrophysics Research Program.

The *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation* (Section IV) provide clear and specific requirements for the format of proposals submitted in response to this solicitation: page limits, acceptable font sizes, line spacing, margins, etc. See also Table 1 of the *ROSES Summary of Solicitation.* Some of the program elements listed below also include formatting requirements. These requirements have been developed to ensure a level playing field for all proposers. The Astrophysics Division takes these requirements seriously, and proposals found to violate them will be penalized, even to the extent of not being evaluated or considered for funding. It is the responsibility of the proposer to ensure that a submission complies with all formatting requirements.

Proposers are reminded that it is the PDF version of their proposal in NSPIRES that will be judged for compliance. In rare cases, cross-platform translation of PDF documents can alter the formatting of a document. To ensure that they still conform to all formatting requirements, proposers are strongly urged to download copies of all documents after upload to NSPIRES.

1.1 Data Management Plans and Archiving

New in ROSES-2020: The data management plan (DMP) will be evaluated as part of the Intrinsic Merit of the proposal and must be included in a special section (see below).

Most proposals to ROSES will require a data management plan (DMP) or an explanation of why one is not necessary given the nature of the work proposed. Instrument development programs are an exception. Strategic Astrophysics Technology (SAT; D.7) and Nancy Grace Roman Technology Fellowship (RTF; D.8) are exempted from providing a DMP at all, under the presumption that no significant research data will be generated. However, even if a DMP is not required with the proposal, if peer-reviewed publications result from the award then any data behind figures or tables must be available electronically at the time of release, ideally in supplementary material with the article and code developed should be made publicly available when it is practical and feasible to do so, and when there is scientific utility in doing so.

Starting in ROSES-2020, the default presumption is that when a DMP is required, the sufficiency of the data management plan will be part of Merit and thus may have a bearing on whether or not the proposal is selected.

The DMP must cover any data needed to validate the scientific conclusions of peer-reviewed publications, particularly data underlying figures, maps, and tables. It also needs to cover any other data and software that would enable future research or the replication/reproduction of published results.

"Data" does not include preliminary and other unpublished data, data in prepublication documents, private communications, or certain other types of information that have been specifically exempted from the DMP requirement.

In the case of a project that would produce no data, as defined above, or only data specifically exempted, the DMP must state that no data preservation or data sharing is needed and explain why. In a case where no appropriate archive exists for a particular data set, the DMP should discuss alternative methods for making the data publicly available.

The DMP must contain the following elements, as appropriate to the project, in adequate detail for review:

- A description of data types, volume, formats, and (where relevant) standards;
- A description of the schedule for data archiving and sharing;
- A description of the intended repositories for archived data, including mechanisms for public access and distribution;
- A discussion of how the plan enables long-term preservation of data;
- A discussion of roles and responsibilities of team members in accomplishing the DMP. (If funds are required for data management activities, these should be covered in the normal budget and budget justification sections of the proposal.)

DMPs will be reviewed as part of the overall NASA research proposal review process. Proposals that do not address each of these items in their DMP, even if determined to be selected or selectable for funding, may not be funded until an adequate DMP is submitted. Funded researchers, research institutions, and NASA centers are responsible for ensuring and demonstrating compliance with the DMPs approved as part of their awards. Awardees who do not fulfill the intent of their DMPs may have continuing funds withheld and this may be considered in the evaluation of future proposals.

For some program elements, the nature of the work is inexorably linked to the handling of data so DMP is part of the page limited for Scientific/Technical/Management (S/T/M) section of the proposal, e.g., D.2 Astrophysics Data Analysis (ADAP). With the exception of those elements where it explicitly says otherwise, all proposals to any of the ROSES elements that require DMPs must place it in a special section of the proposal, not exceed two pages in length entitled "Data Management Plan" immediately following the references and citations for the S/T/M portion of the proposal. The two-page DMP section does not count against the 15-page limit of the S/T/M section. Formatting requirements for DMPs are the same as for the S/T/M section. For programs that use the 2-phase submission process (Guest Investigator/Observer/Scientist programs D.5, D.6, and D.9-D.12) no DMP is required.

The DMP must cover any data needed to validate the scientific conclusions of peer-reviewed publications, particularly data underlying figures, maps, and tables. It also

needs to cover any other data and software that would enable future research or the replication/reproduction of published results.

Software, whether a stand-alone program, an enhancement to existing code, or a module that interfaces with existing codes, created as part of a ROSES award, should be made publicly available when it is practical and feasible to do so, and when there is scientific utility in doing so. Stand-alone code that is not straightforward to implement, or whose utility is significantly outweighed by the costs to share it, is not expected to be made available. This expectation extends to three types of software, defined as follows:

Short Name	Name	Description	Examples
Libraries	Libraries and toolkits	Generic tools implementing well-known algorithms, providing statistical analysis or visualization, and so on, that are incorporated in other software categories.	Numerical Recipes, NumPy, general FFTs, LAPACK, scikit-learn, AstroPy, GDAL
Analysis software	Analysis, post-processing, or visualization software	Generalized software (not low-level libraries) used to manipulate measurements or model results to visualize or gain understanding.	Stand-alone image processing, topology analysis, vector-field analysis, satellite analysis tools, and so on
Frameworks	Modeling frameworks	Multicomponent software systems that incorporate a variety of models and couple them together in a complex way.	Community Earth System Model (CESM) is a collection of coupled models including atmospheric, oceanographic, sea ice, land surface, and other models

SMD expects that the source code, with associated documentation sufficient to enable use of the code, will be made publicly available as Open Source Software (OSS) under an appropriately permissive license (e.g., Apache-2, BSD-3-Clause, GPL). This includes all software developed with SMD funding used in the production of data products, as well as software developed to discover, access, visualize, and transform NASA data. OSS is defined as software that can be accessed, used, modified, and shared by anyone. Awardees will not be required to continue maintenance of their software beyond the submission of the software to an appropriate repository

1.2 Dual-Anonymous Peer Review

Beginning in ROSES-2020, proposals submitted to some program elements within the Astrophysics Research Program will be evaluated using a dual-anonymous peer review (DAPR) process in which, not only are proposers unaware of the identity of reviewers, but the reviewers are not told the proposing teams or organizations until after they have evaluated the scientific merit of all of the anonymized proposals. The overarching objective of dual-anonymous peer review is to reduce unconscious bias in the

evaluation of the merit of a proposal. This is described in Sections IV(b)i and VI(b) of the ROSES-2020 *Summary of Solicitation* and the descriptions for each of these elements provides instructions on how to prepare 'anonymized' proposals, a link to a special web FAQ on this subject, and each element has a corresponding "Guidelines for Anonymous Proposals" document located on its NSPIRES page. DAPR will be applied to proposals submitted to D.2 Astrophysics Data Analysis and all Astrophysics Guest Investigator/Observer/Scientist programs (D.5, D.6, and D.9-D.12).

Unless otherwise noted in the individual program elements, the Astrophysics Division does not anticipate awarding contracts in response to proposals submitted to program elements in Appendix D, because it would not be appropriate for the nature of the work solicited. If a prospective proposer to a program element that excludes contracts thinks that their work should be a contract, they should communicate with the point of contact for that program element and cc sara@nasa.gov.

The program elements included as of the release date of this ROSES NRA are described below. Abstracts of previously selected investigations may be found online at http://nspires.nasaprs.com/ by choosing "Solicitations" followed by "Closed/Past Selected", searching on the name or abbreviation of the program (e.g., ADAP), and downloading the selections PDF file from the home page of that program element.

2. Prohibition on Duplicate Proposals

Proposers may not submit full proposals for the same, or essentially the same, work to more than one program element described here concurrently. This prohibition is active for a particular submitted proposal until the PI is notified through NSPIRES that the proposal was declined or until the proposal is withdrawn. The prohibition on duplicate proposals applies across ROSES years as well (e.g., a duplicate of a pending ROSES-2019 proposal may not be submitted in response to ROSES-2020). If a second proposal is submitted while a duplicate proposal is still pending in another program element, only the first proposal will be evaluated; the duplicate proposal may not be evaluated or considered and may be returned without review.

If a second proposal contains substantive changes in areas that are critical to the intrinsic merit evaluation, such as the goals, objectives, or methodology, then it is not considered to be a duplicate proposal.

Changes to a proposal that would fall outside of the merit evaluation are not considered substantive, and two proposals with only changes in these areas may be considered duplicates. Examples of proposal sections not considered in merit evaluation include:

- Current and pending support section;
- Relevance statement;
- Budget section; and
- Data management plan.

In addition, minor changes to aspects of a proposal covered by the merit evaluation (team, concepts, implementation, target, etc.) may not be considered substantive.

If it is unclear if changes to a proposal are substantial enough for that proposal to not be considered a duplicate proposal, or it is unclear to which program a proposal should be

submitted, proposers should contact the point of contact for the program element most likely to be appropriate for the proposal, before the proposal deadline.

3. Astrophysics Data Analysis

The Astrophysics Data Analysis Program (ADAP; program element D.2) supports research with a primary emphasis on the analysis of archival data from current and past NASA space astrophysics missions. The magnitude and scope of the archival data from those missions enables science that transcends traditional wavelength regimes and allows researchers to answer questions that would be difficult, if not impossible, to address through an individual observing program. The program now also supports the analysis of publicly available data from the Neutron star Interior Composition Explorer (NICER), the Transiting Exoplanet Survey Satellite (TESS), and some approved Guest Observer (GO) programs using Spitzer, even if those observations have yet to be executed, or the data are still within their proprietary period. Proposals to D.2 ADAP will be evaluated using dual-anonymous peer review, as mentioned in Section 1 above.

4. Astrophysics Research and Analysis

The Astrophysics Research and Analysis program (APRA; program element D.3) supports suborbital and suborbital-class investigations, development of detectors and supporting technology, and laboratory astrophysics. Basic research proposals in these areas are solicited for investigations that are relevant to NASA's programs in astronomy and astrophysics, including the entire range of photons, gravitational waves, and particle astrophysics. The emphasis of this solicitation is on technologies and investigations that advance NASA astrophysics missions and goals. Projects devoted to technology development efforts (Detector Development and Supporting Technology categories) that do not generate scientific data need not provide a data management plan and proposers may simply cite this statement as the entirety of their Data Management Plan.

5. Astrophysics Theory

The Astrophysics Theory Program (ATP; program element D.4) supports theoretical investigations or modeling of the astrophysical phenomena targeted by past, current, or future NASA astrophysics space missions. Laboratory work related to NASA strategic goals in gravitation and fundamental physics is now supported in the Astrophysics Research and Analysis program (APRA; program element D.3). Theoretical work pertaining to atomic and molecular astrophysics and other topics directly related to Laboratory Astrophysics should also be proposed to APRA. Beginning in ROSES-2017, the Astrophysics Theory Program (ATP) element of ROSES converted to soliciting proposals on a biennial basis. Thus, NASA did solicit ATP proposals as part of ROSES-2019, but is not soliciting ATP proposals in ROSES-2020. ATP proposals will be solicited in ROSES-2021.

6. Astrophysics General Observer / General Investigator Programs

Five program elements support science investigations that require and/or support new data obtained with currently operating NASA astrophysics space missions. Guest investigator programs are included for the Neil Gehrels Swift Observatory gamma-ray

burst explorer (program element D.5), the Fermi Gamma-ray Space Telescope (program element D.6), the Nuclear Spectroscopic Telescope Array (NuSTAR) (program element D.9), the Transiting Exoplanet Survey Satellite (TESS, program element D.10), and the Neutron star Interior Composition Explorer (NICER, program element D.11).

Beginning in ROSES-2020, all the above General Observer / General Investigator Programs will be evaluated using dual-anonymous peer review, Section 1, above.

Guest investigator programs for the Hubble Space Telescope (http://www.stsci.edu/hst/), the Chandra X-ray Observatory (http://cxc.harvard.edu/), and the Stratospheric Observatory for Infrared Astronomy (SOFIA) (https://www.sofia.usra.edu/) are solicited separately by the respective science centers of those missions.

7. Strategic Astrophysics Technology

The Strategic Astrophysics Technology program (SAT; program element D.7) supports focused development efforts for key technologies to the point at which they are ready to feed into major missions in the three science themes of the Astrophysics Division: Exoplanet Exploration, Cosmic Origins, and the Physics of the Cosmos. This program is specifically designed to address middle technology readiness level (TRL) "gaps" between levels 3 and 6: the maturation of technologies that have been established as feasible, but which are not yet sufficiently mature to incorporate into flight missions without introducing an unacceptable level of risk. NASA does not require a data management plan for proposals to SAT.

8. Nancy Grace Roman Technology Fellowship Program

The goals of the Nancy Grace Roman Technology Fellowship (RTF) program in Astrophysics are to provide early-career researchers the opportunity to develop the skills necessary to lead astrophysics flight instrument development projects, including suborbital investigations, in preparation to become principal investigators (PIs) of future astrophysics missions; to develop innovative technologies for space astrophysics that have the potential to enable major scientific breakthroughs; and to foster new talent by putting early-career instrument builders on a trajectory towards long-term positions.

The RTF program, as described in program element D.8, now consists of two components with two different submission procedures. The first component is a one-page application from an eligible early-career individual to be named a Roman Technology Fellow. The application is submitted as part of a proposal submitted to the Astrophysics Research and Analysis (APRA) or Strategic Astrophysics Technology (SAT) Program described in program elements D.3 and D.7 of this ROSES solicitation. The second component is the subsequent submission of a proposal for Fellowship Funding by a previously selected Roman Technology Fellow once that individual obtains a permanent or permanent-track position, in order to start a laboratory or develop a research group at the Fellow’s institution. Projects devoted to technology development that will not generate scientific data need not provide a data management plan and proposers may simply cite this statement as the entirety of their Data Management Plan.

9. X-Ray Imaging and Spectroscopy Mission (XRISM) Guest Scientist (XGS) Program

The objective of the XRISM Guest Scientist (XGS) program element D.12 of ROSES-2020 is to enhance the scientific return during the Performance Verification (PV) phase (sometimes referred to as the Guaranteed Time Observing (GTO) phase) of XRISM by opening the opportunity to participate in the analysis of data collected on individual targets during the XRISM PV phase to US-based scientists who are not members of the NASA-appointed instrument team. Proposals to D.12 XGS will be evaluated using dual-anonymous peer review, as mentioned in Section 1, above.

10. Astrophysics Explorers U.S. Participating Investigators

ROSES program element D.13 for Astrophysics Explorers U.S. Participating Investigators solicits potential Astrophysics Explorers investigations in which investigators participate as a Co-Investigator (Co-I) for an instrument, experiment, or technology demonstration that is being built and flown by a sponsor agency other than NASA.

11. Theoretical and Computational Astrophysics Networks

The Theoretical and Computational Astrophysics Networks (TCAN) program element D.14 supports coordinated efforts in fundamental theory and computational techniques in order to make groundbreaking advances in astrophysics and strengthen theoretical and computational astrophysics in the U.S. by uniting researchers in collaborative networks that cross institutional and geographical divides.

12. Exoplanet Research Program (XRP)

The cross-division program on exoplanets is described in program element E.3. Investigations related to the detection and characterization of planetary systems that are directly tied to the NASA strategic goal to search for Earth-like planets are of interest to the Astrophysics Division.

13. Topical Workshops

All proposals for topical conferences, workshops, or symposia related to the Astrophysics Division Research Program must be submitted in response to program element E.2, Topical Workshops, Symposia, and Conferences, of this NRA. Proposers to E.2 should specifically identify the Astrophysics research program element to which the conference, workshop, or symposium is most closely related, and refer to the goals and objectives of that program element in demonstrating relevance.

D.2 ASTROPHYSICS DATA ANALYSIS

NOTICE: Amended June 15, 2020. Proposal due dates for ADAP have been delayed. ADAP proposals are now due July 16, 2020. In addition, the summary table of the key requirements for anonymized proposals, reproduced from the "Guidelines for Anonymous Proposals" in Section 2 has been slightly modified to indicate that not just the budget justification but also the (redacted) budget numbers should be included in the anonymized proposal. New text is in bold and Deleted text is struck through.

Amended April 3, 2020. NOI and Proposal due dates have changed: NOIs are requested by May 5, 2020, and ~~proposals are now due June 30, 2020~~. NOI submissions have been reopened. NOIs are strongly encouraged, but not mandatory. In addition, ADAP proposals will not be solicited in ROSES 2021. It is expected that the next ADAP will be solicited under ROSES 2022, with a proposal deadline in mid-May 2022. This change will reduce the proposal writing burden on the community next year, while also preserving the total funding awarded and providing some certainty of funding a year in advance. Prospective proposers are advised to plan accordingly.

Starting this year proposals submitted to this program will be evaluated using a dual-anonymous review process. Proposals must be prepared according to the guidelines in Section 2 and in the associated "Guidelines for Anonymous Proposals" document under "Other Documents" on the NSPIRES page for this program element.

1. Scope of Program

Over the years, NASA has invested heavily in the development and execution of an extensive array of space astrophysics missions. The magnitude and scope of the archival data from those missions enables science that transcends traditional wavelength regimes and allows researchers to answer questions that would be difficult, if not impossible, to address through an individual observing program. To capitalize on this invaluable asset and enhance the scientific return on NASA mission investments, this Astrophysics Data Analysis Program (ADAP) program in ROSES provides support for investigations whose focus is on the analysis of archival data from NASA space astrophysics missions.

1.1 Special Considerations for ADAP Proposers

- Beginning with ROSES-2020, the Astrophysics Division is consolidating its support for exoplanet science investigations under the Exoplanet Research Program (XRP; ROSES-2020, Appendix E.3). Consequently, archival investigations that are focused on the formation, evolution, detection, or characterization of protoplanetary and debris disks, exoplanets, exoplanetary systems, or the demographics of the exoplanet population are hereby excluded from the scope of the ADAP. Researchers interested in developing proposals in these areas are directed to Appendix E.3 of ROSES-2020. For archival investigations where the focus falls close to the

boundaries between exoplanet science and other areas of astrophysics (e.g. brown dwarf investigations or exoplanet host star characterization), prospective proposers are encouraged to contact the Program Officer listed in Section 4 for guidance.

- Beginning with ROSES-2020, proposals submitted to this program will be evaluated using a dual-anonymous peer review process in which, not only are proposers unaware of the identity of the members on the review panel, but the reviewers will not be told the identity of proposers until after the evaluation of Merit (see Section 2, below). The overarching objective of dual-anonymous peer review is to reduce unconscious bias in the evaluation of the merit of a proposal.

  To implement dual-anonymous peer review, reviewers may not see any information that would identify proposers, so proposers must follow the instructions in Section 2, below and the "Guidelines for Anonymous Proposals" document under "Other Documents" on the NSPIRES page for this program element that explain how to properly prepare the proposal for dual-anonymous peer review.

- Prospective proposers should be aware that the defined ADAP research areas have been revised under ADAP-2020 (see Section 1.4). These changes include:
  a) Studies of exoplanet formation and protoplanetary/debris disks have been removed from the former *Star and Exoplanetary System Formation* research area, and the remainder has been combined with the former *Interstellar Medium* research area to form a single research area titled *Interstellar Medium and Star Formation*.
  b) Investigations involving the detection and characterization of exoplanets has been removed from the former *Stellar Astrophysics and Exoplanets* research area, and that area has been retitled simply *Stellar Astrophysics*.
  c) The former *Collapsed Objects and X-ray Astrophysics* and *Supernovae and Gamma-Ray Bursts* research areas have been restructured into two new research areas titled *Collapsed Objects and Transient Phenomena* and simply *Supernovae*. The scopes of these new research areas are described in Section 1.4.

- The budget justification of any proposal that involves the collection and analysis of new ground-based observations must include (1) an explicit statement that all costs associated with the ground-based portion of the project are less than 25% of the total cost of the investigation and (2) a separate budget breakout detailing the work effort and procurement costs (e.g., travel, equipment**,** consumables, etc.) associated with executing the ground-based observing component of the investigation (see Section 1.3.1). Proposals that do not satisfy this requirement will be penalized, even to the extent of being declined and not considered for funding, regardless of their intrinsic merit rating.

- Proposals to this program element require a data management plan (DMP) or an explanation of why one is not necessary given the nature of the work proposed within the 15-page Scientific, Technical, and Management section of the proposal. The mandatory minimum requirement is making the data behind figures and tables available electronically at the time of publication, ideally in supplementary material with the article. More information on the data management plan is available in the

SARA DMP FAQs. However, ADAP proposals that involve the development of new databases, data products, or data analysis tools for the community must satisfy the more rigorous requirements described in Section 1.3.3. Specifically, any proposal for which *Astrophysical Databases* is identified as either the primary or secondary research area must include a clear description of the products, and how those products will be disseminated to the community.

1.2 Research Objectives

The Astrophysics Data Analysis Program (ADAP) solicits research with a primary emphasis on the analysis of NASA space astrophysics data that are archived in the public domain at the time of proposal submission. Most of these data have undergone considerable reduction and refinement by way of calibrations and ordering and extensive data analysis software tools often exist for these data. Table 1 below provides a representative - but not exhaustive - list of NASA space astrophysics missions for which suitable archival data are publicly available.

Table 1. A Representative List of Projects/Missions that had a Significant NASA Contribution and may Represent the Primary Data Source for an ADAP-2020 Proposal.

Advanced Satellite for Cosmology and Astrophysics (ASCA; formerly Astro-D)	Keck Observatory Archive (KOA)
Chandra X-Ray Observatory**	Kepler and K2
Compton Gamma-Ray Observatory (CGRO)	Midcourse Space Experiment (MSX)
Cosmic Background Explorer (COBE)	Neutron star Interior Composition Explorer (NICER)
Extreme Ultraviolet Explorer (EUVE)	Nuclear Spectroscopic Telescope Array (NuSTAR)
Far Ultraviolet Spectroscopic Explorer (FUSE)	Planck
Fermi Gamma Ray Space Telescope**	Roentgen Satellite (ROSAT)
Galaxy Evolution Explorer (GALEX)	Rossi X-ray Timing Explorer (RXTE)
Herschel Space Observatory	Spitzer Space Telescope
High Energy Astronomy Observatories (HEAO-1, 2, 3)	Stratospheric Observatory for Infrared Astronomy (SOFIA)
High Energy Transient Explorer 2 (HETE-2)	Submillimeter Wave Astronomical Satellite (SWAS)
Hubble Space Telescope**	Suzaku (Astro E2)
Hitomi (Astro-H)	Swift
Infrared Astronomical Satellite (IRAS)	Transiting Exoplanet Survey Satellite (TESS)
Infrared Space Observatory (ISO)	Two Micron All Sky Survey (2MASS)
International Gamma-ray Astrophysics Laboratory (INTEGRAL)	X-ray Multi-Mirror-Newton (XMM-Newton)*

International Ultraviolet Explorer (IUE)	Wide-field Infrared Survey Explorer (WISE)
Keck Interferometer (KI) and Palomar Testbed Interferometer (PTI) Archives	Wilkinson Microwave Anisotropy Probe (WMAP).
Shuttle-based Astrophysical Observatories, including: Hopkins Ultraviolet Telescope (HUT), Wisconsin Ultraviolet Photopolarimetry Experiment (WUPPE), Ultraviolet Imaging Telescope (UIT), Broad-Band X-Ray Telescope (BBXRT), and ORFEUS-SPAS I and II	

* - including US investigators on foreign-led Guest Observer (GO) investigations; some restrictions apply; see Section 1.3.4 for details.
** - data from these missions compliant only when analyzed in conjunction with the data from one or more other NASA space astrophysics missions; see Section 1.3.2 for details.

Researchers interested in analyzing datasets from missions or projects that are not included in Table 1 should contact the ADAP Program Officer before writing their proposal to confirm that their planned research program is compliant with this program element. Proposals found to be noncompliant will be declined and may be returned without review or adjectival rating.

Analyses of data from non-Astrophysics NASA space missions are eligible for ADAP support, provided that (1) all such data are available in the public domain at the time of ADAP proposal submission, and (2) the primary scientific goals of the investigation fall within the scope of NASA's Astrophysics program as described in the agency's *2014 Science Plan* (Section 4.4, p. 74-85) and the *2013 Astrophysics Roadmap*. For example, data collected by NASA Planetary Science missions and made available through NASA's Planetary Data System (PDS) are suitable as the primary basis of an ADAP proposal providing they meet the foregoing requirements. In any such case, the onus is on the proposer to make a convincing case for the relevance of the proposed work to NASA's astrophysics goals in their proposal.

Most NASA space astrophysics data may be found in one or more of the following NASA astrophysics archives:

- High Energy Astrophysics Science and Analysis Data Center (HEASARC) (http://heasarc.gsfc.nasa.gov/);
- Infrared Science Archive (IRSA) (http://irsa.ipac.caltech.edu/);
- Keck Observatory Archive (KOA) (http://nexsci.caltech.edu/archives/koa/)
- Mikulski Archive for Space Telescopes (MAST) (http://archive.stsci.edu/);
- NASA Exoplanet Archive (including the data holdings of the Exoplanet Follow-up Observing Program (ExoFOP) system; http://exoplanetarchive.ipac.caltech.edu/)
- NASA/IPAC Extragalactic Database (NED) (http://ned.ipac.caltech.edu/);
- NASA Astronomical Virtual Observatory (NAVO; https://heasarc.gsfc.nasa.gov/vo/summary/).

Prospective proposers should be aware that considerable research has already been done using NASA space astrophysics data sets by the original mission science teams,

as well as by previously selected participants in the ADAP (see, for example, abstracts of currently and previously funded ADAP projects by following links to Past Selections and searching for ADAP (or ADP for 2009 and earlier) at http://nspires.nasaprs.com). Therefore, ADAP proposals should clearly demonstrate how their proposed research extends the frontier of knowledge or how their proposed data products differ from those currently available in a fundamental and important manner. If a new proposal for this program element is itself based on a previously funded research effort, the proposal must identify that work and clearly summarize all significant results from it.

NASA recognizes and supports the benefits of having diverse and inclusive scientific, engineering, and technology communities and fully expects that such values will be reflected in the composition of all panels and teams including peer review panels (science, engineering, and technology), proposal teams, science definition teams, and mission and instrument teams.

1.3 Scope and Limitations of the Program

As stated in Section 1.2 above, the overarching requirement of the ADAP is that any NASA space astrophysics data involved in a proposed investigation must be available in the public domain at the time of the proposal submission deadline. As a direct consequence of this requirement, proposed investigations may not anticipate future public data releases. The scientific case for any proposed investigation must be based on - and executable with - data that are in the public domain at the time of the original proposal. Moreover, for proposals involving the analysis of higher-level data products from a NASA mission, it is NOT sufficient that the level-1 data are publicly available; it is the data products that will actually be used in the investigation that must be publicly available. Any proposal found to violate the capstone data availability requirement of the ADAP will be ruled noncompliant and will not be rated or considered for funding. The only exception to this requirement is described in Section 1.3.4 below.

NASA does not anticipate awarding contracts in response to proposals submitted to this program element, because it would not be appropriate for the nature of the work solicited.

Several other requirements/limitations of the ADAP are described in Sections 1.3.1 – 1.3.8 below.

1.3.1 *Use of theory, modeling, or other relevant data*

In support of any ADAP proposal – but only as a secondary emphasis and only as needed to interpret and analyze NASA's archival data – the proposed research may include the use and application of: (a) theoretical research or numerical modeling; (b) existing data from ground-based telescopes or suborbital platforms; and/or (c) available laboratory astrophysics data. However, in any such instance, the onus is on the proposer to clearly establish that the data and/or models in question are used only insofar as necessary to accomplish the analysis of approved NASA archival data and are not themselves the primary object of the investigation.

Requests for the support of new ground-based observations are acceptable under the ADAP provided that the requests are clearly described, that the observations are integral to the success of the proposed ADAP effort, and that the proposal includes an

explicit statement that the collection and analysis of those data will account for no more than 25% of the total cost of the proposed investigation by NASA. Any such proposals must include a summary of the work effort (in terms of personnel time commitment) and the budget justification must include a breakout of the other direct costs, e.g., procurements, equipment, consumables, and travel, allocated to executing the ground-based observing component of the investigation. Furthermore, the degree to which the success of the proposed investigation depends on the collection of new ground-based observations, and the perceived likelihood that the proposer will be able to obtain the needed telescope time through the normal time allocation committee process, will be taken into consideration as part of the evaluation of the scientific merit of the proposal. Consequently, proposers should make clear in their proposal whether access to the necessary facilities has already been granted or, if not, provide a rationale for why such access can reasonably be expected.

1.3.2 *Analysis of data solely from Hubble Space Telescope (HST), Chandra X-Ray Observatory (CXO), or Fermi Gamma-Ray Space Telescope*

Proposals for archival research based exclusively on the data from HST, CXO, or Fermi are not eligible for funding under the ADAP. Such proposals are solicited through the associated NASA-chartered science operations centers and funded under each mission's General Observing (GO) program. However, proposals for archival research that involve a combination of data from these observatories, or data from one of these observatories in combination with the data from other NASA missions (e.g., see above list), are eligible for funding under ADAP. In such cases, the onus is on the proposer to clearly establish that the cited additional data set(s) are integral to the success of the proposed investigation and not merely window dressing added only to make what is essentially a Hubble/Chandra/Fermi archival research program compliant with the ADAP.

1.3.3 *Astrophysical databases and development of new data products/analysis tools*

Databases of fundamental atomic, molecular, nuclear, and solid-state parameters that are complete, critically evaluated, and readily accessible to the community represent a powerful tool for analyzing NASA space astrophysics data. The ADAP, therefore, accepts proposals for the development of publicly accessible compilations of existing fundamental atomic, molecular, and nuclear parameters (both experimental and theoretical), as well as the associated computational tools necessary to effectively apply those data to the analysis of astronomical observations. This opportunity is intended to support only the development of new databases or significant enhancement/ maintenance of existing databases. Proposers are cautioned that new measurements or calculations of fundamental atomic, molecular, nuclear, or solid-state parameters are not eligible for support under the ADAP, and proposals found to include any such work will be declared non-compliant and declined without review. Proposals of this type are more appropriate for the Astrophysics Research and Analysis program (APRA; ROSES-2020 program element D.3).

In addition, recent years have seen a dramatic growth in both the size and scope of the archival astronomical data from NASA's space missions. The development of new archival data products through reprocessing or further processing of these datasets, as

well as the development of tools for mining the vast reservoir of information they contain, have the potential to open new areas of investigation and substantially increase the scientific return on those missions. Consequently, such work is also eligible for funding under the ADAP, provided that both the science it will enable and the wider impact/value of the resultant products to the community, is clearly articulated in the proposal.

Of special note, the *Astrophysical Databases* research area (see Section 1.4) accepts proposals for the development of publicly accessible databases of observational data from NASA-sponsored astrophysics suborbital (balloon-borne, sounding rocket, CubeSat) experiments. However, proposals for the analysis of non-public data from suborbital missions should be submitted to the APRA Program. Furthermore, only suborbital experiments funded under the auspices of the APRA program are eligible for this funding opportunity.

An essential component of any activity funded under the *Astrophysical Databases* research area of the ADAP is the ultimate dissemination of high-value data products and data analysis tools to the astronomical community. Consequently, it is essential that any proposal identifying *Astrophysical Databases* as either the primary or secondary research area must include within its 15-page Scientific, Technical, and Management section a Data Management Plan that clearly describes the final products of the investigation, and how those products will be made available to the community. Although not strictly required, the use of open-source code in tools/algorithms developed as part of an ADAP investigation and the subsequent public release of those tools/algorithms is strongly encouraged and is often cited as a strength in the proposal evaluation. If the products are to be ingested and curated at an existing astrophysics archive (see list in Section 1.2 above), the cost of any required support for the proposed activity from the relevant archive must be included in the proposal budget. Proposers are also strongly encouraged to include a letter of acknowledgement from the NASA archive in the separate “Expertise and Resources – Not Anonymized” document (see Section 2).

1.3.4 *Support for US Co-Investigators on Foreign-led XMM-Newton GO Proposals*

U.S. Co-Investigators on foreign-led XMM-Newton GO proposals that are selected for execution and rated as either Category A or Category B are eligible to propose for funding under ADAP even if the associated observations have not yet been executed, or the data are not yet available in the public domain. However, in such circumstances, the (foreign) PI must designate a U.S. PI for the investigation, and only that individual will be eligible to propose for ADAP funding prior to the public release of the data. The designation of the U.S. PI must be established by inclusion of a letter from the foreign PI on institutional letterhead in the proposal document. Failure to include such a letter will result in the proposal being declared non-compliant. This letter should be included in the "Expertise and Resources-Not Anonymized" document. Please note- this waiver does not apply to U.S.-led Category A or Category B proposals selected under the AO-18 cycle (which are funded under the auspices of the XMM-Newton US Guest Observer Facility), or to any Category C XMM-Newton GO proposals.

Proposers seeking funding support for an approved foreign-led GO program are not relieved of the responsibility to provide a compelling proposal that meets all of the requirements of the ROSES-2020 NRA and the ADAP program element. It is generally not sufficient to simply submit the approved GO proposal.

1.3.5 *Citizen Science Investigations*

Proposals for the analysis of NASA space astrophysics data through a citizen science effort are permitted under the ADAP. Proposals for investigations involving a citizen science component will be reviewed along with other ADAP proposals in the research area most appropriate to their science goals (see Section1.4) and shall be held to the same rigorous standards for scientific merit, NASA relevance, and cost realism as any ADAP science investigation, i.e., documented project goals must include advances in science, the merit of which shall be determined by peer review.

1.3.6 *Exclusions*

Proposers to this NRA should note that the ADAP is not intended to support:

- Investigations whose primary emphasis is fundamental theoretical research or the development of numerical models without specific application to the analysis of NASA archival data or where archival data are used only to calibrate or benchmark the output of the computations. Such research is supported under NASA's Astrophysics Theory Program (ATP; ROSES program element D.4);
- Investigations involving new measurements or calculations of fundamental atomic, molecular, or nuclear parameters. This includes analysis or reanalysis of data measured in a laboratory. Such research is supported under the Laboratory Astrophysics element of NASA's APRA Program (ROSES program element D.3);
- Investigations with a primary focus on the analysis of datasets from astrophysics projects or space missions that had no significant NASA contribution (e.g., Hipparcos, *Gaia*, Sloan Digital Sky Survey). Such data may be used to support the analysis of allowed data from a NASA mission, but may not itself be the primary object of the investigation. In any such instance, the onus is on the proposer to clearly establish that analysis of any proscribed data is (1) necessary to the

achievement of the scientific goal(s) of the proposed investigation and, (2) not the object of that investigation.

- Investigations using data from NASA space astrophysics missions to advance our understanding of the origin, evolution, and characteristics of objects within the Solar System. In particular, proposers are cautioned that studies of Near Earth Objects and other Solar System bodies based on archival WISE and/or K2 data are not eligible for funding under the ADAP. Planetary science investigations using the data from NASA space astrophysics missions are eligible for funding through the Research and Analysis (R&A) programs of NASA's Planetary Science Division (see Appendix C).
- Investigations using data from NASA space astrophysics missions to advance our understanding of the Sun and its impact on our Solar System. Such research is eligible for funding through the Research and Analysis (R&A) programs of NASA's Heliophysics Division (see Appendix B).
- Proposals primarily for the general education and/or training of students (Note, however, that this does not preclude the involvement of undergraduate or graduate students in the proposed research);
- Proposals for organizing and/or hosting scientific meetings. Such activities may be proposed under NASA's Topical Workshops, Symposia, and Conferences solicitation (TWSC; ROSES program element E.2); or
- Proposals for the acquisition of substantial computing facilities or resources beyond nominal workstation or network requests.

1.3.7 *Archival Exoplanet Science Investigations*

Beginning with ROSES-2020, the Astrophysics Division is consolidating its support for exoplanet science investigations under the Exoplanet Research Program (XRP; ROSES-2020, Appendix E.3). Consequently, archival investigations that are focused on the formation, evolution, detection, or characterization of protoplanetary and debris disks, exoplanets, exoplanetary systems, or the characteristics of the exoplanet population are hereby excluded from the scope of the ADAP. Potential proposers developing science cases in these areas are directed to Appendix E.3 of ROSES-2020. For archival investigations where the focus falls close to the boundaries between exoplanet science and other areas of astrophysical research (e.g. brown dwarf investigations or exoplanet host star investigations) prospective proposers are encouraged to contact the Program Officer listed in Section 3 for guidance.

1.3.8 *Proposal formatting: further considerations*

In addition to falling within the scientific scope of the ADAP as described in this solicitation, proposals must conform to the proposal formatting requirements set forth in Section IV(b)ii of the *ROSES Summary of Solicitation* (e.g., page limits, acceptable font sizes, line spacing, margins, etc.). These requirements have been developed to ensure a level playing field for all proposers. The Astrophysics Division takes these formatting requirements seriously, and proposals found to violate them will be penalized even to the extent of be ruled noncompliant and not considered for funding, regardless of their perceived merit. It is the responsibility of the proposer to ensure that their proposal complies with all formatting requirements.

Proposers are reminded that it is the PDF version of their proposal in NSPIRES that will be judged for compliance. Since, in rare cases, translation of PDF documents can alter the formatting of a document, proposers are strongly urged to download copies of any documents they upload to NSPIRES to ensure that they still conform to all formatting requirements.

1.4 Identification of Proposal Data Set(s) and Research Areas

The Cover Page for ADAP proposals provides for designation of the data set(s) proposed for analysis and also for the Research Area, as defined below, which designates the primary focus of the proposal. Identification of the appropriate Research Area is important as it facilitates the assignment of each proposal to the appropriate review panel (a secondary Research Area may also be designated).

NASA reserves the right to reassign a proposal to a different primary or secondary Research Area for the purposes of arranging for the most qualified review. The nine defined ADAP Research Areas are:

1. Interstellar Medium and Star Formation - includes studies of dense molecular clouds, star-forming clouds, HII regions, interstellar dust and ices, protostars and YSOs, and the physics and chemistry of protostellar disks; also includes characterization of supernova remnants and the dynamics of their interactions with the ISM; DOES NOT INCLUDE protoplanetary and debris disks, or the formation of exoplanets and exoplanetary systems (see Section 1.3.7).
2. Stellar Astrophysics - includes studies of the structure and evolution of main sequence stars, stellar variability and activity, binary/multiple stars, asteroseismology, the IMF of stellar populations, and stellar archaeology; DOES NOT INCLUDE detection and characterization of exoplanets and exoplanetary systems (see Section 1.3.7).
3. Post-Main Sequence Stars - includes studies of the structure and evolution of post-main sequence stars, late circumstellar outflows and mass loss, white dwarfs and cataclysmic variables, and planetary nebulae.
4. Collapsed Objects and Transient Phenomena - includes studies of neutron stars (ns), stellar-mass black holes (bh), and X-ray binaries (both ns and bh); also includes Gamma-Ray Bursts, mergers (ns-ns, ns-bh, bh-bh), and fast radio bursts.
5. Supernovae - includes studies of supernova progenitors, the physics of catastrophic stellar explosions, supernova-driven nucleosynthesis, and validation of supernovae as standard candles; does not include studies of supernova remnants and their interaction with the interstellar medium (Research Area 1) or supernova surveys as tools for cosmology (Research Area 8).
6. Normal Galaxies and Galactic Structure - includes studies of the formation, evolution, and structure of the Milky Way and other galaxies.
7. Active Galaxies and Quasars - includes studies of interacting galaxies, starburst galaxies, Luminous/ultraluminous infrared galaxies, Seyfert galaxies, radio galaxies, active galactic nuclei and supermassive black holes, and quasars.

8. Large Scale Cosmic Structures - includes studies of clusters of galaxies, galaxy environment and evolution, intracluster medium, diffuse x-ray background, and supernova surveys as tools for cosmology.
9. Astrophysical Databases - includes development of databases of fundamental atomic, molecular, solid state parameters and the tools to apply them to the analysis of astronomical data; also includes development of new data products through further processing or reprocessing of existing archival astrophysical data sets, new publicly-accessible databases of observations from NASA suborbital astrophysics projects, and new data analysis tools.

2. Specific Instructions for Dual-Anonymous Peer Review Proposals

Proposals submitted to this program will be evaluated using a dual-anonymous peer review process in which, not only are proposers unaware of the identity of the members on the review panel, the reviewers will not be told the identity of proposers until after the evaluation of Merit (see below). The overarching objective of dual-anonymous peer review is to reduce unconscious bias in the evaluation of the merit of a proposal.

To implement dual-anonymous peer review, reviewers may not see any information that would identify proposers, so proposers must follow the instructions in the "Guidelines for Anonymous Proposals" document under "Other Documents" on the NSPIRES page for this program element that explain how to properly prepare the proposal for dual-anonymous peer review.

The forms filled out on the NSPIRES web pages with Proposal Summary, Budget, Proposal Team and Program Specific and Business Data known as the NSPIRES "cover pages" will not be seen by peer reviewers. This has two implications: 1) The Proposal summary must also be included as the first page of the proposal PDF and 2) proposers must upload a separate "Expertise and Resources - Not Anonymized" document, that contains all of the personally (and organizational) identifying information.

In order to meet the objectives of dual-anonymous peer review, review panels will be instructed to evaluate the anonymized proposals based on their scientific merit, without taking into account the proposing team qualifications. As a final check, and only after the scientific evaluation is finalized for all proposals, the panel will be provided with the "Expertise and Resources - Not Anonymized" documents. The panel will assess the qualifications of the team in order to allow the reviewers to assess the team capabilities required to execute a given proposed science investigation.

A summary of the key requirements for anonymized proposals, reproduced from the "Guidelines for Anonymous Proposals" document, is listed below:

Item	Requirement
Anonymization	Proposals must be anonymized.
References	References must be in the [1], [2] format.
Proposal Summary	Enter as part of the NSPIRES cover page and first page of uploaded proposal PDF file.

Page Limits	15 pages for the central Science/Technical/Management section of proposal. An additional page is allotted for the Proposal Summary, see above.
Biographical Sketches	Do not include in the anonymized proposal document. This information is gathered in the separate “Expertise and Resources - Not Anonymized” document (see below).
Current and Pending Support	Do not include in the anonymized proposal document. Include in separate "Expertise and Resources - Not Anonymized" document (see below).
Redacted Budget **and Budget** Narrative	Include **both** in proposal document in an anonymized format. **[Clarified June 15, 2020].**
Summary of work effort, including Table of Work Effort	Include an anonymized version (e.g., PI; Co-I#1; Co-I#2) in the main proposal document. Include a not-anonymized version in separate "Expertise and Resources - Not Anonymized" document.
Facilities and equipment	Do not include in main proposal document. Include in separate "Expertise and Resources - Not Anonymized" document.
Letters of Resource Support (e.g., from archives, facilities, etc.)	Do not include in main proposal document. Include in the separate "Expertise and Resources - Not Anonymized" document.
Data Management Plan	All proposals must include an anonymized Data Management Plan within the 15-page Scientific, Technical, and Management section of the proposal. The Data Management Plan for proposals that identify Astrophysical *Databases* as either the primary or secondary research area must meet the requirements described in Section 1.3.3.
High-End Computing request	Submit PDF HEC form as document type "Appendix" in NSPIRES.
Separate "Expertise and Resources - Not Anonymized" document	Submit as document type "Appendix" in NSPIRES. This document provides: 1. A list of all team members, their roles (e.g., PI, Co-I, collaborator), and their contributions to the work; 2. Brief descriptions of the scientific and technical expertise each team member brings, emphasizing the experiences necessary to be successful in executing the proposed work. 3. A description of the contribution that each team member will make to the proposed investigation. 4. A discussion of specific resources (“Facilities and Equipment”, e.g., access to a laboratory, observatory, specific instrumentation, etc.) that are required to perform the proposed investigation. 5. The not-anonymized Table of Work Effort; 6. Biographical Sketches/CVs for the PI and all Co-Is on the proposal (limit 2 pages for the PI, 1 page for others);

Separate "Expertise and Resources - Not Anonymized" document continued	7. Statements of Current and Pending Support for the PI and all Co-Is; 8. A discussion of any specific resources that are key to completing the proposed work; 9. Letters of commitment from any archives, specialized facilities, foreign institutions, etc. that will support the proposed investigation; 10. A letter from the foreign PI identifying the US PI on the XMM GO investigation (required for US PIs seeking ADAP support for participation in Foreign-led XMM-Newton GO investigations; see Section 1.3.4).

3. Current Profile of the ADAP

3.1 Response to the Previous ADAP solicitation

In 2019, as a result of a prolonged shutdown of the Federal Government, ADAP was issued via amendment as D.16 of ROSES-2018 under the title Second Astrophysics Data Analysis (hereinafter 2ADAP18). A total of 248 proposals were submitted in response to the 2ADAP18 solicitation, a number that is entirely consistent with the average proposal pressure in recent years (~250 proposals). The distribution of those proposals over the various research areas covered by the program is shown in Figure 1 below. Also shown in the figure is the distribution of requested durations of the proposals in each Research Area (i.e. one-, two-, or three-years). Note: proposals in the *Astrophysical Databases* Research areas (not broken out separately in the figure) were grouped into one of the other Research Areas, as appropriate, based on the subject matter of the proposal.

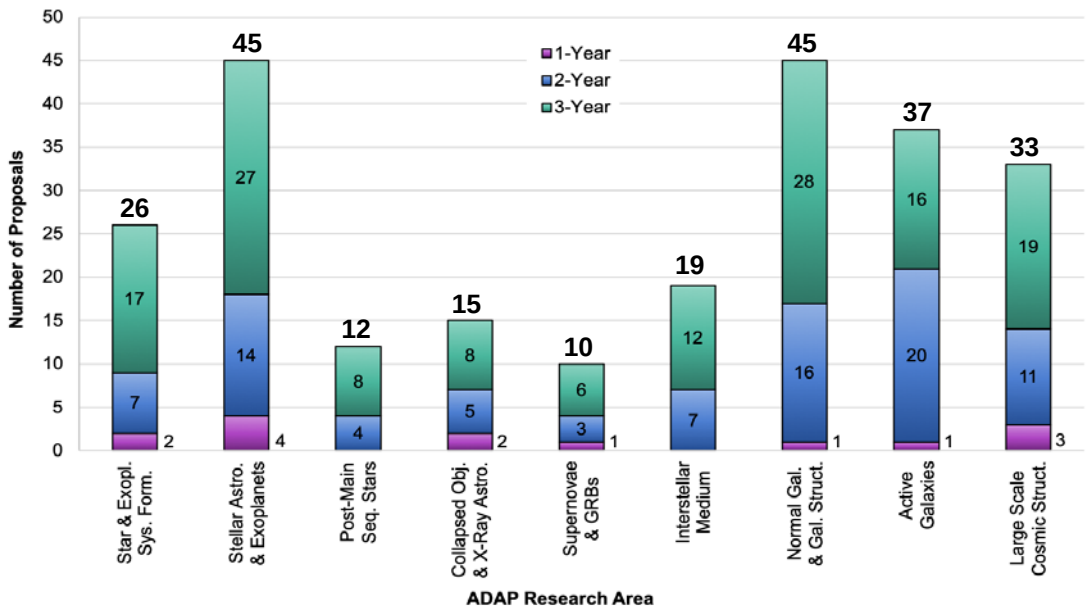


Figure 1. The distribution of 2ADAP18 proposal submissions, broken down by requested funding duration, across the Research Areas covered by the program. The bold number at the top of each column gives the total number

of proposals in the corresponding research area. Proposals in the *Astrophysical Databases* Research Areas were grouped into one of the Research Areas shown based on their subject matter. Six of the submitted proposals were found to be non-compliant and were declined without review.

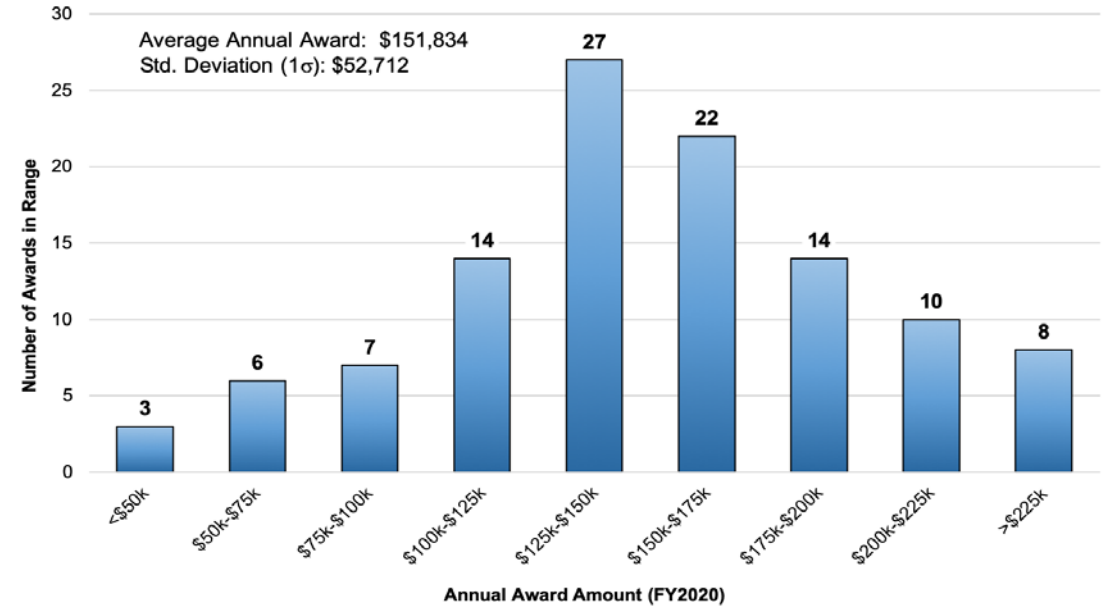


Figure 2. The distribution of annual awards for funded ADAP tasks in FY 2020. Data include both 2ADAP18 new starts and ongoing tasks from previous solicitations.

3.2 Distribution of annual funding levels for ADAP tasks

With an annual budget of around $20M, the ADAP typically supports around 140 investigations in any given year (includes both new starts and continuing investigations). Although the average annual ADAP award is approximately $152,000, actual award amounts span the range from less than $50,000 per year to more than $225,000 per year. Figure 2 shows the distribution of annual awards for the ADAP in FY 2020.

3.3 Evaluation Criteria

In addition to the evaluation criteria for all proposals given in Section VI.(a) of the *ROSES Summary of Solicitation* and the *Guidebook for Proposers*, for proposals in the *Astrophysical Databases* research area, the merit criterion includes an evaluation of the suitability and perceived impact of the proposed data products and/or data analysis tools of the investigation, and how and when they will be made available.

4. Summary of Key Information

Expected program budget for first year of new awards	~$7.0M
Number of new awards pending adequate proposals of merit	~40-50
Maximum duration of awards	3 years; shorter-term proposals are welcome

Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 of this ROSES NRA
Due date for proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	January 1, 2021
Page limit for the central Science-Technical-Management section of proposal	15 pages. One additional page is allotted for the Proposal Summary. See also Table 1 of ROSES.
Relevance	This program is relevant to the Astrophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See D.1 The Astrophysics Research Program Overview and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of the *ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-ADAP
Point of contact concerning this program	Douglas M. Hudgins Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0988 Email: Douglas.M.Hudgins@nasa.gov

D.3 ASTROPHYSICS RESEARCH AND ANALYSIS PROGRAM

NOTICE: Amended September 17, 2020. A number of changes have been made to this program element including: updates to Specific Considerations and Exclusions in Section 1.2, Suborbital-class Investigations (Section 1.2.1), Supporting Technology (Section 1.2.3), Laboratory Astrophysics (Section 1.2.4) where an additional allowance for laboratory astrophysics equipment has been added, General Information (Section 2.1) and the phone numbers for the points of contact in the summary table of information (Section 3). New text is in bold and deleted text is struck through. Due dates remain unchanged.

Prospective proposers should note that mandatory Notices of Intent will be due October 23, 2020, and the proposal deadline is December 17, 2020. This is roughly 3 months earlier than in previous years. This will enable the planned start date for funding for all proposers to begin sooner and with the same window, as opposed to the previous different dates for NASA and non-NASA PIs.

Please note the new language in Sections 1.2 and 1.2.1 regarding data management and archiving.

The allowance for "Co-Investigator Proposals" for suborbital and suborbital-class investigations (permitted by APRA in prior years) has been removed in APRA-2020. Such proposals shall now budget in accordance with the rest of APRA proposals in that the PI will directly subcontract to all non-U.S. Government participating entities.

ISS-attached suborbital-class payloads are not solicited in this APRA opportunity.

1. Scope of Program

1.1 Overview

The Astrophysics Research and Analysis Program (APRA) program solicits basic research proposals for investigations that are relevant to NASA's programs in astronomy and astrophysics and includes research over the entire range of photons, gravitational waves, and particle astrophysics. Awards may be for up to four years' duration (up to five years for suborbital investigations), but shorter-term proposals are typical; four-year or five-year proposals must be well justified. ~~Proposals for suborbital investigations are particularly encouraged.~~ APRA investigations may advance technologies anywhere along the full line of readiness levels, from Technology Readiness Level (TRL) 1 through TRL 9. The emphasis of this program element is on technologies and investigations that advance NASA astrophysics missions and goals.

1.2 Categories of Proposals

The APRA program seeks to support research that addresses the best possible (i) state-of-the-art detector technology development for instruments that may be proposed as candidate experiments for future space flight opportunities; (ii) science

and/or technology investigations that can be carried out with instruments flown as suborbital-class payloads on balloon-borne, sounding rocket, CubeSat, or other platforms; and (iii) supporting technology and laboratory research that are directly applicable to space astrophysics missions. Accordingly, proposals are solicited in the following four broad categories:

- Suborbital/Suborbital-class Investigations
- Detector Development
- Supporting Technology
- Laboratory Astrophysics

Specific Considerations and Exclusions:

- Investigators proposing stand-alone detector development, including detector development that features a ground-based demonstration component, should propose to the Detector Development category, whereas proposals for which detector development is integrated into a suborbital/suborbital-class flight project should be submitted to the Suborbital Investigations category.
- The Laboratory Astrophysics category of this program element includes theoretical investigations that support the determination of fundamental atomic, molecular, nuclear, and solid-state parameters with relevance to NASA Astrophysics missions (see Section 1.2.4). However, all other theoretical investigations are solicited separately under the Astrophysics Theory Program described in program element D.4 of this ROSES NRA.
- This program element excludes proposals for investigations that are in scope of the Exoplanet Research Program (XRP; E.3 of this ROSES NRA). Specifically, this exclusion is for Laboratory Astrophysics**, data analysis method, or other algorithm/software development** investigations that are focused upon measurements **or techniques** related to characterizing the properties of exoplanets, protoplanetary disks, or debris disks. Potential proposers developing science cases in these areas are directed to Appendix E.3. Investigations that advance technology development for exoplanet space missions or conduct suborbital-class experiments that advance exoplanet science, remain appropriate for the APRA program.
- The APRA program element is no longer intended to support ground-based observations except in the context of demonstrating detector development and supporting technology maturity.
- The Fundamental Physics discipline area supports proposals: 1) to conduct tests of fundamental laws of physics or 2) to develop experimental concepts and/or related technologies to test fundamental laws of physics. Proposals submitted to this discipline area must be related to an Astrophysics space project (suborbital, orbital, lunar**,** etc.). This discipline area is not intended to support applied physics or laboratory experiments. Investigations predominantly theoretical in nature should be directed to the Astrophysics Theory Program or to other Federal agencies, as appropriate.
- Projects directed mainly toward the analysis of archival data are solicited under the Astrophysics Data Analysis Program described in Appendix D.2 of this ROSES NRA.

- If a proposal is offered as a direct successor to a previous NASA award, it should include a description of the predecessor effort, including any significant findings, and describe how the proposed work extends the previous accomplishments. See the 2020 *NASA Guidebook for Proposers* for more details.
- The Principal Investigator (PI) institution is expected to fund participating Co-Investigator(s) (Co-I(s)) via subawards, except where the Co-I is at a Government laboratory, including NASA Centers and the Jet Propulsion Laboratory (JPL). However, the proposed budget must explicitly include the funding required for participating Co-Investigator(s) at Government laboratories, including NASA Centers and JPL.
- Projects that are devoted to technology development efforts but will not generate scientific data may satisfy the requirement for a data management plan (DMP) by simply noting in the separate 2-page DMP section of the proposal (See Section 1.1 of D.1, The Astrophysics Research Program Overview), that a DMP is not required because the proposed projects are in the Detector Development or Supporting Technology category. Proposals submitted in the categories of Suborbital Investigations or Laboratory Astrophysics are required to provide data management plans. **Note that the data under consideration need not include the raw data generated during a project, but at a minimum are any processed data needed to validate the scientific conclusions of peer-reviewed publications (such as data underlying graphs, images, spectra, and tables) and associated data and software necessary for the replication/reproduction of published results.**
- Proposals to advance detectors or supporting technologies, other than for data analysis methods, in support of strategic missions that have transitioned to having funded technology lines or that are in Phase A or beyond (e.g., Athena, LISA, Ariel/CASE, **Roman (formerly known as** WFIRST**)**, Euclid, XRISM, JWST) are excluded from APRA, as these technologies are expected to be supported by the mission funding. Technology development for potential future Explorers or Probe-class missions is allowed within APRA.

1.2.1 *Suborbital/Suborbital-class Investigations*

This APRA category supports science investigations and/or technology development utilizing payloads flown on sounding rockets, balloons, CubeSats, commercial reusable suborbital rockets, or similar-class payloads flown as flights of opportunity. Suborbital payloads may be recovered, refurbished, and re-flown in order to complete an investigation. **Proposals with a total proposed cost of over $10M must be submitted to the Astrophysics Pioneers program element of ROSES if they are compliant with that element (that is, not a sounding rocket).**

Suborbital launch vehicle services include those provided by the NASA Sounding Rocket Program Office (SRPO)**,** the NASA Balloon Program Office (BPO)**,** and commercial suborbital reusable launch vehicle **(sRLV)** services **(including balloons) such as those accessed** through the Flight Opportunities Program (**https://www.nasa.gov/directorates/spacetech/flightopportunities/flightproviders**) of NASA's Space Technology Mission Directorate (STMD). In keeping with the process detailed in the *ROSES Summary of Solicitation*, such proposals must follow the

guidelines in section V(**c** ~~b~~)(iii). The Science Mission Directorate also provides for CubeSats. These are described in Section V of the *ROSES Summary of Solicitation*. Investigators are strongly urged to discuss their proposed payload with the contact person(s) for the appropriate Program, as given in that section. Proposers may propose to use a Suborbital Reusable Launch Vehicles to acquire a suborbital launch (including balloons) ~~in keeping with the process detailed in the *ROSES Summary of Solicitation*, such proposals must follow the guidelines in section V(b)(iii)~~. **For all of the above options, SMD will provide funding for the launch services and therefore the cost need not be included in the proposal.** Proposers may also negotiate their own launch services as part of their proposal, in which case the PI is responsible for all aspects of that service contract including its full cost.

Any suborbital investigation involving a sounding rocket or balloon flight with unique requirements must obtain a letter of mission feasibility from the relevant program office point of contact (listed in Section V(b) of the *ROSES Summary of Solicitation*). Unique requirements include, but are not limited to, remote launch campaigns and constraints on the time/date of launch. The mission feasibility letter must be included in the proposal submission, but it does not count against the proposal page limit.

A discussion of the plans for management and for reduction and analysis of the data must be included in the proposal. Moreover, the data management plan (DMP) outside of the page-limited S/T/M part of the proposal must present a plan for making the science data that derives from the investigation publicly available for the long term, in an appropriate archive, such as (but not necessarily) one of the official archives at http://science.nasa.gov/astrophysics/astrophysics-data-centers/. The adequacy of the DMP will be part of the evaluation of the Merit of the proposal and, even if an investigation is selected, should the DMP not satisfactorily present the plan for archiving the science data, the award will be delayed until a satisfactory revised DMP is submitted.

Although most awards are for three- or four- years **in** duration, ~~a~~ five-year proposal**s** ~~may be accepted~~ to develop a completely new, highly meritorious suborbital-class investigation through its first flight **are eligible**. Because of the anticipated greater degree of complexity, the Scientific/Technical/Management section of **all** proposals for **suborbital (and Suborbital-class)** investigations may be 20 pages long, instead of the default 15 pages specified in the *NASA Guidebook for Proposers*.

Budgets are expected to cover all aspects of the proposed investigation, typically (but not always) including payload development and construction, instrument integration and calibration, launch, and data analysis and dissemination/archiving. The number of investigations that can be supported is limited and heavily dependent on the funds available to this program. It is allowable to propose suborbital-class investigations to APRA that do not consist of an entire investigation, defined as a new start through flight and data analysis and archiving, within the maximum five-year period of performance. Investigations that would not complete within the proposed period must make clear what portion of the entire investigation is being proposed and what portion is being deferred to a later proposal and should provide rough estimates for schedule and budget for the deferred portion. The proposal review will consider the merit of the complete investigation, but will also consider the value of only the portion being proposed as a

meritorious precursor for the entire investigation. Note that SMD does not carry reserves to accommodate any cost overrun incurred by a particular investigation, including the loss of the payload owing to a rocket or balloon system failure. Therefore, failure to achieve the proposed goals within the proposed time and budget could require either descoping the initially proposed investigation, delaying it, canceling a particular launch date opportunity, or canceling the investigation altogether.

NASA considers suborbital and suborbital-class investigations to be research and technology projects governed by NASA Procedural Requirements (NPR) 7120.8. Accordingly, such investigations should expect to be required to present a Project Plan (cf. § 4.2.7 of NPR 7120.8A), comprising an agreement on implementation approach, resources, cost, reviews, schedule, and other plans, in order to be approved to proceed from the formulation phase to implementation phase. Typically, this will be required of new investigations during the second year after initiation of funding. Should review of the Project Plan identify significant challenges (in, for example, cost, schedule or technology maturity) a Cost and Continuation Review (CCR) may be held. Outcomes of the CCR may include termination of the project or continuation with a revised baseline. For purposes of tailoring NPR 7120.8, the 'program manager' shall be the appropriate point-of-contact as listed in this program element (or that person's successor) and the 'project manager' shall be the PI of the investigation or a person selected by the PI for this role; issuance of an award shall be considered as Authority to Proceed and hence the beginning of formulation. At the end of each project year, the project manager shall submit an annual report to fulfill the role of a Continuation Assessment, with the final one being considered to fulfill the submission for Project Closeout, unless otherwise documented in the Project Plan.

Suborbital and suborbital-class investigations provide unique opportunities, not only for executing intrinsically meritorious science investigations, but also for advancing the technology readiness levels of future space flight detectors and supporting technologies and preparing future leaders of NASA space flight missions, such as early-career researchers and graduate students. For these proposals, specific factors that will be considered when evaluating a proposal's intrinsic merit are the scientific merit as defined in **Appendix D of** the *Guidebook for Proposers* and, in addition, the degree to which it advances the technology readiness level of a detector or supporting technology, and secondarily the degree to which it advances the readiness of early-career researchers or graduate students to assume leadership roles on future NASA space flight missions.

The intent is to support more small instruments for science investigations, technology development, and/or training of early-career scientists and engineers. Investigators should identify, on the proposal cover page, which of these three categories is the main focus of the proposal.

1.2.1.1 *Sounding Rocket Payloads*

Investigators proposing payloads to be flown on sounding rockets should answer the program-specific questions on the APRA proposal cover pages. For planning purposes, the Sounding Rocket Program Office uses this information to generate a rough order-of-magnitude cost estimate for the operational requirements associated with a proposed

investigation. The required information includes the envisioned vehicle type, payload mass, trajectory requirements, launch site, telemetry requirements, attitude control, or pointing requirements, and any plans for payload recovery and reuse.

1.2.1.2 *Balloon Payloads*

The Balloon Program is planning to provide a shared platform capable of carrying multiple, independent, piggyback-like instruments in order to offer suborbital flight opportunities to more users. The following table summarizes the standard services and anticipated constraints for a flight supporting about six instruments:

Balloon Altitude:	Flight Duration:	Per instrument Weight/Size:	Data Rate/Power:	Launch location:
30-37 km	6-24 hours	136 kg; 0.4 cubic meters; Standard interface	> 50 kbps LOS; 50-100 watts, regulated 28 V battery nominal	Ft. Sumner (Spring or Fall) Palestine (Summer)

Projects needing unique engineering and/or technical support services, including a flight from Antarctica, and/or vehicles and/or the Wallops Arc-Second Pointing System (WASP), should contact the Balloon Program Office directly for an estimate of the Government Furnished Equipment (GFE) cost of the desired support.

1.2.1.3 *CubeSat Payloads*

CubeSats are described in the *ROSES-**2020** Summary of Solicitation* Section V(**c** ~~b~~)(v). Sizes from 1U to 6U have been launched via the CubeSat Launch Initiative (CSLI) program previously. Recently CSLI has retained a 12U dispenser on contract, so the 12U (2x2x3) form factor is now possible under CSLI and therefore under APRA. However, as stated in the *Summary of Solicitation*, integration and launch services costs must be included in the submitted PI budget.

Following and extending the *Summary of Solicitation* Section V(**c** ~~b~~)(v), the cost of launch to Low Earth Orbit (LEO) for a single ≤ 3U spacecraft will be covered under the CSLI at no cost to the investigation. For this case proposers should merely mention in the budget justification that only the standard CSLI-provided launch services are needed and proposers should not include such launch service charges in the proposal budget. Proposals to go beyond LEO, utilize more than one spacecraft, or involve a CubeSat >3U must contact CSLI representatives listed in the *Summary of Solicitation* to obtain a cost estimate. Proposals must state explicitly in the budget justification that there are additional costs for launch within the proposed budget, and include those costs in the NSPIRES cover page budget. However, such CSLI-quoted launch services costs are not the responsibility of the proposing organization and overhead must not be charged on those costs. As a result of their secondary status, CubeSats are placed into orbits that are dictated by the primary. Therefore, in any given year a finite number of specific orbits (e.g., inclinations and altitudes) will be available for CubeSats, and the types of orbits available will vary from year to year. Thus, CubeSat-based missions requiring very specific orbital parameters may be at a disadvantage for securing a timely launch. Proposals must include a CubeSat Mission Parameters Table (see *Summary of*

Solicitation) and clearly indicate both the required and the acceptable range of orbital parameters needed to meet mission objectives. Both the CSLI-quoted launch service cost and the likelihood of manifesting the CubeSat will be considered in the selection decision.

1.2.1.4 *Special Instructions for Multiple-Institution Proposals for Suborbital/Suborbital-class Investigations*

Proposals for suborbital and suborbital-class investigations often involve the development of payloads that require major hardware collaborations among several organizations. In such cases, the lead Principal Investigator (PI) shall propose a direct subcontracting arrangement between his/her organization and the Co-Investigator (Co-I) organization(s) other than U.S. Government organizations, in which case all the nominal instructions in the *NASA Guidebook for Proposers* (see further below) apply. The activities of Co-Is at U.S. Government organizations, such as NASA centers, are always funded directly by NASA, and thus their portion of the budget must be clearly delineated in the PI proposal budget. If the PI is from a U.S. Government organization, Co-Is will be funded by subawards made from that organization. NASA centers apply no overhead cost to the budgets for Co-I organizations. The proposed budget must explicitly include the funding required for participating Co-Investigator(s) at U.S. Government organizations, including NASA Centers and JPL, unless the effort of those organizations is contributed (in which case a Letter of Commitment is required). Participants on a proposal who are designated as Collaborators by virtue of their foreign institution affiliation but whose contribution is essential to the success of the investigation must provide a Letter of Commitment from their institution. The allowance for "Co-Investigator Proposals" for suborbital and suborbital-class investigations has been removed.

1.2.2 *Detector Development*

This APRA category solicits investigations that either advance our understanding of the fundamental operational aspects of detectors or develop new types of detectors to the point where they can be proposed in response to future announcements of flight opportunities. Either new measurement concepts or methods to improve the performance of existing detectors may be proposed, provided they would be candidates for use in space. Among the characteristics typically desirable in space-quality detection systems are high sensitivity to relevant signals, low mass, low sensitivity to particle radiation, low power consumption, compactness, ability to operate in a vacuum (such that high-voltage arcing is minimized), vibration tolerance, ease and robustness of integration with instrumentation, and ease of remote operation, including reduced transient effects and ease of calibration.

This category does not support development of detectors or instrument subsystems that are intended primarily for ground-based astronomy. However, observing with ground-based facilities may be proposed to verify new detectors or overall system performance, if adequately justified as an integral part of a detector development.

Proposals for new detectors will be evaluated in the context of currently available space astronomy detector technologies. Proposers are encouraged to identify potential

mechanisms that could facilitate transfer of these detector technologies to other users, including Homeland Security, National security, and/or the private sector, for possible application beyond the immediate goals of NASA's programs.

1.2.3 *Supporting Technology*

This APRA category supports investigations of technologies not yet ready for incorporation into new detector or space mission systems, but that offer promise of potential breakthroughs that could lead to future advances in instrumentation useful for NASA's space astronomy and astrophysics programs. This category includes small technology efforts for future NASA Astrophysics missions, such as development of optics, mirrors, coatings, or gratings.

This category also supports proposals for development of new data analysis methods **or other algorithm/software development** for future space missions **(i.e., those not yet listed in Table 1 of the ADAP solicitation in ROSES-2020)**. These proposals should be mission enabling or mission enhancing and directly applicable to future space flight missions, in particular (but not necessarily limited to) those that have been considered in the most recent decadal survey or Astrophysics roadmap. Proposals aimed primarily at carrying out mission concept studies are excluded.

1.2.4 *Laboratory Astrophysics*

The Laboratory Astrophysics category of the APRA program element supports the determination of fundamental atomic, molecular, nuclear, and solid-state parameters that are essential for analyzing and interpreting the data from NASA Astrophysics missions. The category supports both laboratory (experimental) and computational efforts to explore the spectroscopic properties of atoms and molecules and particulate matter, as well as their chemical, physical, and dynamical properties under astrophysical conditions. The resulting data products directly impact our understanding of a wide range of astrophysical phenomena spanning the electromagnetic spectrum, and ranging from the epoch of reionization and the evolution of cosmic structure to the formation and evolution of galaxies, stars, and exoplanetary systems in the current epoch.

Laboratory Astrophysics proposals must be well motivated by a detailed description of the relevance of the proposed investigation to the analysis of measurements from NASA astrophysics missions (past, current, or future). Such proposals pertaining to James Webb Space Telescope (JWST) or the X-ray Imaging and Spectroscopy Mission (XRISM) would be particularly timely. Proposals for projects that aim to produce data products for wide use across the astronomical community should explain how those products would be made available to the intended users in a stable fashion.

Added in APRA-2020: as part of a new laboratory equipment initiative, proposals to the Laboratory Astrophysics category may include a request for upgrades to and/or replacement of laboratory equipment in support of the proposed investigation. To be considered for such support, a one-page justification must be included with the proposal, immediately following the Scientific/Technical/Management section. This justification is not counted against the S/T/M overall page limit. Currently, the limit for such requests is $50k per

proposal total and may be spread across no more than two of the proposed funding years. Equipment requests will only be considered as part of a Laboratory Astrophysics science investigation proposal. Evaluation of the overall proposal will be based on the main proposal with a separate evaluation of the equipment request. Selection of the main proposal will be made on the basis of its merit alone, without the equipment request. The additional selection of the equipment request would then be made on the basis of its merit in (a) improving the outcome or effectiveness of the proposed investigation, (b) its suitability to enable other investigations, and (c) cost reasonableness. Requested equipment costs must be included in the overall proposal budget in the NSPIRES cover sheets. The basis of estimate for the equipment costs must be provided in the Budget Justification section. Since the equipment request is a severable part of the proposal, these costs must be clearly demarcated in the tables provided in the detailed appendices to facilitate the possibility of selecting the main proposal without the equipment request.

2. Programmatic Information

2.1 General Information

The following table provides the amount of Year-1 funding and the number of investigations that have been selected for the four APRA categories in five recent cycles; note that proposals for APRA-14 (denoted A-14) were due in 2015 and funded in FY 2016, etc. If the budget allows, it is expected (but cannot be guaranteed) that the selections in the coming year will be similar.

APRA Category	Total allocated to first year of new selections [$M]					Number of New Selections (excluding Co-I proposals)				
	A-14	A-15	A-16	A-17	A-18	A-14	A-15	A-16	A-17	A-18
Suborbital Investigations	7.3	6.4	6.8	7.9	8.0	10	13	13	9	10
Detector Development	2.6	3.5	4.1	4.6	4.7	11	13	12	14	12
Supporting Technology	1.8	4.0	2.1	2.6	3.0	9	12	7	12	10
Laboratory Astrophysics	1.1	1.6	1.6	1.2	1.2	8	10	11	8	8

Note that the new Laboratory Astrophysics equipment initiative allotment is not included in these selection allocations. Further, absent the appropriation by Congress of funding for the recovery of research from the COVID-19 pandemic, SMD's policy (SPD-36) to prioritize augmentations in support of early career researchers at https://science.nasa.gov/researchers/sara/library-and-useful-links, and the extension of suborbital investigations resulting from flight campaign cancellations, is producing a financial strain that requires accommodations within the research program, *i.e.*, new selections from APRA-2020 may have their

starting dates delayed and/or the number of selections from the APRA-2020 solicitation may be reduced compared to historical norms.

2.2 Student Participation

The participation of graduate students is strongly encouraged, especially if the project can be concluded within the nominal tenure of graduate training. In such cases, brief details of the educational goals and training of the participants should be included in the proposal. Specific factors that will be considered when evaluating a proposal's intrinsic merit include the degree to which it advances the readiness of early-career researchers or graduate students to assume roles in advancing NASA's strategic objectives.

2.3 Request for reviewer names

Proposers are strongly encouraged to provide names and contact information of up to five experts qualified to review their proposal. These experts must not be from the institutions of the PI or Co-Is or stand to benefit financially from the selection (or otherwise) of the proposal. This information should be included in the program specific data question in the Notice of Intent, or emailed to the relevant Program Officer listed below.

2.4 Proposal Submission Requirement: Mandatory NOIs

To facilitate the early recruitment of a conflict-free review panel and ensure that proposals are submitted to the appropriate category, an NOI will be required for all submissions to this program element. Proposals that are not preceded by an NOI will be returned without review. No feedback will be provided in response to the NOI.

After NOI submission, the PI may request to reassign that role only to listed Co-Is, and proposers may request to add funded investigators. The PI must inform the point(s) of contact identified in the summary table of key information and cc sara@nasa.gov at least two weeks in advance of the proposal due date. Additions of funded investigators within two weeks of the proposal deadline require explicit permission from the NASA point of contact. Submission of an NOI does not obligate the proposer to submit a full proposal later.

For Laboratory Astrophysics, please include a statement whether the proposal will include an equipment request (see Section 1.2.4).

2.5 Availability of MSFC X-ray Test Facilities

The X-ray optics facilities maintained by MSFC include the X-ray and Cryogenic Facility and Stray Light Facilities as Agency Capabilities. In the past, PIs wishing to make use of the MSFC Stray Light Facility and/or the X-ray Cryogenic Facility included Co-I funding to MSFC in order to fund this usage. These facilities are now supported for **some of** this work by directed work packages under the NASA Internal Scientist Funding Model, so ~~proposals may no longer need to include this in their budget. For more information~~ **proposers planning to request use of the MSFC facilities should** contact brian.ramsey@nasa.gov **to discuss what portion of the request can be covered by current support and what portion needs to be included in the APRA proposal budget.**

2.6 Clarification of Proposal Content

Rules concerning the preparation and submission of proposals are provided in **four** documents in the following priority order: this program element; **D.1 Astrophysics Research Program Overview;** the ROSES-2020 *Summary of Solicitation*; and the *NASA Guidebook for Proposers*. Proposers should ensure that the most recent versions of these documents are consulted prior to proposal submission as clarifications and amendments are made throughout the year.

~~As the proposals for D.3 APRA and D.7 SAT are submitted simultaneously, it is not necessary to include proposals submitted to either program element in the ROSES-20 solicitation in the Current and Pending section of the proposal.~~

Since, by definition, investigators at foreign institutions are not provided funding and are therefore Collaborators, letters or support are not generally required. However, if the Collaborators at foreign institutions are providing portions of the investigation that are required in order for it to be fully successful, then a letter from an appropriate representative of that institution must be provided that illustrates the institutional commitment to the provision of those required portions.

The application to become a Nancy Grace Roman Technology Fellow (RTF; see program element D.8 of this ROSES solicitation) is a one-page addendum submitted along with an APRA proposal. To be eligible for an RTF, the applicant must be designated as the PI, **or** Science PI ~~or Institutional PI~~ as their proposal role on the APRA cover sheet, and must be shown to have a substantial, leading, and responsible role in the proposal work plan. An applicant on a successful, technology-centered APRA proposal will then be considered for designation as a Roman Technology Fellow based on this one-page application.

2.7 Evaluation Criteria

All proposals with be evaluated for Intrinsic Merit, Cost, and Relevance, as defined in Appendix D of the *NASA Guidebook for Proposers* and consistent with Section VI(a) of the *ROSES Summary of Solicitation* and D.1 the Astrophysics Research Overview (e.g., see Section 1.1 regarding the new requirement for Data Management Plans and Archiving. In addition, for suborbital and suborbital-class investigations (as noted in Section 1.2.1), the evaluation of intrinsic merit will include the degree to which it advances **the technology readiness level of a detector or supporting technology, and secondarily the degree to which it advances** the readiness of early-career researchers or graduate students to assume roles in advancing NASA's strategic objectives.

3. Summary of Key Information

Expected program budget for first year of new awards	See Section 2.1
Number of new awards pending adequate proposals of merit	See Section 2.1
Maximum duration of awards	4 years (5 years for suborbital investigations)
Due date for Mandatory Notice of Intent to propose (NOI)	See Tables 2 and 3 of this ROSES NRA.

Due date for proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	Typically, October, but allowed between July and December in the year after the proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp (20 pp for suborbital proposals); see also Table 1 of ROSES and the *NASA Guidebook for Proposers*.
Relevance	This program is relevant to the Astrophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	Please see *ROSES Summary of Solicitation Section 1(g)* Order of Precedence and the *NASA Guidebook for Proposers*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-APRA
Main point of contact concerning this program	Dominic J. Benford Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: ~~(202) 358-1261~~ **(301)758-9305** Email: Dominic.Benford@nasa.gov

Questions about the APRA Program should be directed to the point of contact above. Questions about specific discipline areas may be directed to the relevant Program Officers listed below, along with their areas of expertise. If uncertain about whom to contact, please direct your inquiries to the APRA point of contact listed above.

NAME	DISCIPLINE RESPONSIBILITY	TELEPHONE	EMAIL
Eric V. Tollestrup	Infrared, Submillimeter, and Radio Astrophysics	(202) 358-0907 **(202) 308-3056**	Eric.V.Tollestrup@nasa.gov
Michael R. Garcia	Ultraviolet and Visible Astrophysics	(202) 358-1053 **(202) 320-6341**	Michael.R.Garcia@nasa.gov

Valerie Connaughton	X-ray and Gamma-ray Astrophysics	(202) 358-1763 **(202) 578-8504**	Valerie.Connaughton@nasa.gov
Thomas Hams	Particle Astrophysics and Fundamental Physics	(202) 358-5162	Thomas.Hams-1@nasa.gov
William B. Latter	Laboratory Astrophysics	(202) 358-0734 **(202) 578-0222**	William.B.Latter@nasa.gov

D.4 ASTROPHYSICS THEORY

NOTICE: Not solicited this year. In 2017 it was announced that the Astrophysics Theory Program element of ROSES would be solicited solicited biennially. Thus, ATP proposals will not be solicited in ROSES-2020 but will be solicited in ROSES-2021.

1. Scope of Program

The Astrophysics Theory Program (ATP) supports efforts to develop the basic theory for NASA's space astrophysics programs. Abstracts of previously selected ATP projects may be found online at http://nspires.nasaprs.com/ (choose "Solicitations" then "Closed/Past Selected" on the left). The periods of performance of investigations for this research element may range from one to four years. Most awards will have a duration of three years, but four-year awards may be made if the need for the longer duration is sufficiently well justified in the proposal.

The Astrophysics Theory Program does not permit multiple Principal Investigators (PIs) (see Section IV(b)i of the *Summary of Solicitation*). Each proposed investigation must be led by a single PI. The PI institution is expected to fund Co-Investigator(s) (Co-I(s)) participating via subawards, except where the Co-I is at a Government institution, including the Jet Propulsion Laboratory (JPL).

The proposed work submitted for this program must both:

- Be directly relevant to space astrophysics goals by facilitating the interpretation of data from space astrophysics missions or by leading to predictions that can be tested with space astrophysics observations; and
- Consist predominantly of theoretical astrophysics studies or the development of theoretical astrophysics models.

ATP proposals satisfying both of the above requirements may involve development of data analysis methods for astrophysics missions and may incidentally include actual data analysis as a test of the theory or the method.

Proposals to the ATP program may not:

- Consist primarily of data reduction or data analysis (such proposals should be directed to the mission-specific programs or the Astrophysics Data Analysis Program (ADAP) described in program element D.2 in this solicitation);
- Propose theoretical work pertaining to atomic and molecular astrophysics and other topics directly related to Laboratory Astrophysics (such proposals should be proposed to the Astrophysics Research and Analysis (APRA) program element described in program element D.3);
- Develop experimental payloads to test theories of gravitation and fundamental physics (such proposals should be submitted to the APRA program element described in program element D.3);
- Address theoretical topics that are predominantly unrelated to the needs of NASA's space astrophysics programs (such proposals should be directed to other appropriate Federal agencies);

- Deal strictly or predominantly with Solar System objects or solar-terrestrial interaction studies, including solar energetic particles (see Appendices B and C for appropriate programs);
- Propose to develop technologies or experimental concepts for future NASA missions (these proposals should be submitted to the APRA program element described in program element D.3 or the Strategic Astrophysics Technology (SAT) program element described in program element D.7);
- Propose to develop new data analysis methods for future space missions (these proposals should be submitted to the APRA program element described in program element D.3);
- Primarily aim at studying new mission concepts; or
- Request support for organizing and/or hosting scientific meetings. Support for such events may be eligible for funding through the Topical Workshops, Symposia, and Conferences (TWSC) program element E.2.

2. Point of Contact

Point of contact concerning this program	Evan S. Scannapieco Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-3730 Email: HQ-ATP@mail.nasa.gov

D.5 NEIL GEHRELS SWIFT OBSERVATORY GUEST INVESTIGATOR – CYCLE 17

NOTICE: Beginning in Cycle 17, all Phase-1 proposals submitted to the Neil Gehrels Swift Guest Investigator Program will be evaluated following a dual-anonymous peer review process. Proposals must be accordingly prepared following the guidelines in Section 2.2.2 and in the associated "Guidelines for Anonymous Proposals" document.

1. Scope of Program

1.1 Overview

The Neil Gehrels Swift Observatory (hereafter known as Swift) Guest Investigator (GI) Program solicits proposals for basic research relevant to the Swift gamma-ray burst mission. The primary goal of this mission is to determine the origin of gamma-ray bursts (GRBs) and use these bursts to probe the early Universe. Swift is also a valuable asset for obtaining multiwavelength images, spectra, and light curves on interesting Targets of Opportunity (ToOs) and other non-transient sources.

Cycle 17 observations and funding will commence on or around April 1, 2021, and last approximately 12 months. Further details on the Cycle 17 program will be posted on the Swift web pages (https://swift.gsfc.nasa.gov/proposals) in August 2020. As was the case in Swift GI Cycles 4 through 16, observing time will be made available to scientists at U.S. and non-U.S. institutions to study a wide variety of astrophysical sources. Consistent with Explorer Program policy, there will be no proprietary data rights to observations conducted with Swift. All science data will be made freely available through the Swift Quick Look web site (https://swift.gsfc.nasa.gov/cgi-bin/sdc/ql), as soon as they are received and processed.

Funding through the NASA Swift GI Program is available only to scientists at U.S. institutions who are identified as the Principal Investigators (PIs). U.S. based Co-Investigators (Co-Is) on foreign-led proposals do not qualify for funding. Funding for accepted target proposals will be initiated only after the relevant observations have begun. Proposers from non-U.S. institutions are strongly encouraged to include a letter of commitment promising financial support.

The Swift GI program is intended to provide the following to participating scientists:

1. Funding (U.S. GIs only) for:

- New Swift projects;
- Correlative GRB and non-GRB observations;
- Other correlative GRB projects; and
- Theoretical investigations that will advance the Swift mission science return.

2. Observations (and funding for U.S. GIs) for:

- Non-ToO observations of non-GRB targets;
- ToOs;
- Large Programs requesting more than 100 targets or more than 100 kiloseconds (ks) total exposure time;
- "Fill-in" targets; and
- Key projects.

1.2 The Swift Mission

Swift is a Medium-class Explorer mission developed at the NASA Goddard Space Flight Center. The lead domestic partners include Pennsylvania State University and Los Alamos National Laboratory. Groups in the United Kingdom and Italy made significant contributions to the hardware development and are active participants in the operations, including provision of the Italian ground station at Malindi. The Swift Mission Operations Center (MOC) is at Pennsylvania State University, and the Swift Science Center (SSC) is at the NASA Goddard Space Flight Center.

The Swift mission was launched on November 20, 2004, from Cape Canaveral Air Force Station, Florida. Swift was launched into a low Earth orbit with an inclination of 21 degrees and an altitude of 600 km. The baseline mission duration was two years, but the mission has been extended beyond this initial period because of its continuing scientific productivity. The orbital lifetime of the satellite is estimated to be approximately 20 years.

The Swift spacecraft carries three science instruments: a wide-field gamma-ray Burst Alert Telescope (BAT) and two sensitive, co-aligned narrow-field instruments – the X-ray Telescope (XRT) and the Ultraviolet/Optical Telescope (UVOT). The spacecraft can be autonomously pointed to direct the XRT and UVOT toward events detected by the BAT. The BAT is a wide-field gamma-ray imager that detects GRBs and rapidly sends positions of arcminute accuracy to the spacecraft and to the ground. The BAT operates in the 15–350 keV range and has a 1.4 steradian (half-coded) field-of-view. The BAT has a GRB detection sensitivity ~2 times better than the Burst and Transient Source Experiment (BATSE) that flew on the Compton Gamma-Ray Observatory (CGRO). In addition to detecting GRBs, the BAT is performing a survey of the hard X-ray sky to a sensitivity of ~1 mCrab (2×10^{-11} erg cm^{-2} s^{-1}). The BAT also scans most of the sky each 90-minute orbit and serves as a sensitive monitor for high-energy transients. Positions and spectra of transients detected by the BAT are telemetered to the ground and distributed immediately to the community.

In response to GRB alerts from the BAT, the spacecraft reorients on a time scale of ~1 minute to point the XRT and UVOT instruments at a GRB or other transient. These instruments perform multiwavelength measurements of the bright early afterglow (and also later-time afterglow) emission to provide subarcsecond positions, precise photometry, and fine spectroscopy. The XRT is a Wolter 1 grazing incidence telescope that operates in the 0.2–10 keV band and has a field-of-view of 23.6 arcminutes with an angular resolution of 18 arcseconds (Half Power Diameter) and positional determination accuracy of better than 5 arcseconds. The detector is a cooled CCD, providing spectroscopy with a resolution $E/\Delta E$ ~10 at 1 keV and an effective area of 120 cm^2. The UVOT is a Ritchey-Chrétien folded-optics telescope operating in the 170–650 nm band. It has a field-of-view of 17 arcminutes $\times$ 17 arcminutes, with an angular resolution of 2.5 arcseconds and positional determination accuracy of 0.3 arcseconds. UVOT provides a sensitivity to afterglows of 22nd magnitude for a 1,000 second integration in its V filter, one of six filters for color photometry. It also has a white-light filter and two grisms for fine spectroscopy ($E/\Delta E$ ~ 300) of sources brighter than 17th magnitude. The narrow-field instruments yield an accurate position and X-ray spectra of the afterglow within a

few minutes of the burst. This information is distributed immediately over the Internet. Data from continued observations of the afterglow are made available via Circulars and Reports on the Gamma-ray bursts Coordinates Network (GCN, http://gcn.gsfc.nasa.gov/) and on a public web site (https://swift.gsfc.nasa.gov/archive/). Notification of transient source detections is made through IAU Circulars (http://www.cbat.eps.harvard.edu/services/IAUC.html) and Astronomer's Telegrams (ATELs, http://www.astronomerstelegram.org/). Data from serendipitous source detections in the field-of-view of both instruments are routinely sent to the ground for analysis.

Further information on the Swift mission may be found at https://swift.gsfc.nasa.gov/.

1.3 Types of Proposals

This Swift GI Program solicits proposals in the following areas:

1. New Swift projects not requiring GI-specified observatory pointing;
2. Correlative GRB observations involving new or enhanced IR ground-based capabilities for investigating high-redshift bursts, and other correlative GRB and non-GRB observations involving non- Swift instruments and observatories;
3. Theoretical investigations that will advance the Swift mission science return;
4. Non-GRB non-ToO observations that benefit from Swift's unique capability of simultaneous multiwavelength coverage;
5. ToO observations which promise large scientific return and capitalize on Swift's unique capabilities of rapid repointing and multiwavelength observations;
6. Large Programs requesting more than 100 targets or more than 100 ks total exposure time;
7. Fill-in targets to be observed in what would otherwise be gaps in the planned science timeline; and
8. Key Projects which aim at addressing major, high-impact scientific questions by making use of the strengths of Swift.

1.3.1 *New Swift projects*

GIs may propose to initiate their own Swift projects that supplement or enhance the Swift science return with their unique facilities, missions, capabilities, or methods. The extent to which the proposed research will enhance the science return from Swift and the demands placed upon mission resources by an investigation will be considered in the proposal evaluation process. Proposals in this category can also include changes or additions to current Swift strategies to detect and observe GRBs and other transient events (Swift detected or elsewhere) and can propose innovative data reduction and interpretation methods that increase our understanding of cosmic explosions. Proposals that require changes to Swift onboard capabilities or operational procedures may require special scrutiny during the review process by the Swift team for technical feasibility and may require formal approval by the Swift Configuration Control Board before implementation. Investigators considering such proposals are strongly urged to consult with the Swift team prior to proposal submission.

1.3.2 *Swift GRB and non-GRB Correlative Observations*

GRB and non-GRB correlative observations substantially augment the science return from Swift. The Swift instruments, for example, make unique measurements of GRB afterglows starting immediately following the burst, supernova (SN) shock breakouts, or tidal disruption events. However, it is not possible to follow up all targets on all time scales, since viewing constraints and scheduling conflicts will preclude some Swift observations. Also, the onboard capability, although significant, does not cover all of the scientifically valuable measurements that need to be made. Candidate correlative observations that will add significantly to the Swift science include radio imaging and photometry, spectroscopy, deep optical imaging and spectroscopy of the afterglow and possible host galaxy, surpassing the capability of the UVOT to reach 22nd V magnitude in 1,000 seconds, and rapid optical observations with time scales shorter than the 1-minute Swift response time.

To foster correlative observations, the Swift project has established joint GI observing programs with other ground- and space-based facilities: The National Radio Astronomy Observatory (NRAO), the Chandra X-ray Observatory, the International Gamma-Ray Astrophysics Laboratory (INTEGRAL), the X-ray Multi-Mirror Mission (XMM-Newton), and the Nuclear Spectroscopic Telescope Array (NuSTAR). Proposals for joint Chandra, INTEGRAL, TESS, and XMM-Newton observations should be submitted to those programs and the Swift time will be recommended by those reviews. For NRAO observations, the Swift GI program can award radio observations through the Swift's joint program with NRAO. There are a number of technical and policy details regarding the Swift/NRAO joint program, and proposers are strongly encouraged to refer to the Memorandum of Understanding: https://swift.gsfc.nasa.gov/proposals/nrao.html.

The Swift Guest Investigator program can award NuSTAR observations through a joint program with the NuSTAR mission. Observing time under this program will be awarded only to proposals that require use of both observatories to meet the primary science goals. Proposers are strongly encouraged to refer to the Swift/NuSTAR Memorandum of Understanding, which may be found under other documents on the NSPIRES page for this program element.

By this agreement, NuSTAR permits the Swift GI Program to award up to 300 ks of NuSTAR observing time. The minimum NuSTAR response time to Targets of Opportunity is 48 hours. ToO observations with a turnaround time less than one week must be well justified and of high scientific value. NuSTAR data acquired through the Swift GI Program will have a standard 12-month exclusive-use period commencing at the time of receipt of the processed data by the observer. This period is restricted to 6-months for peer-reviewed ToOs. The Swift Mission Project will make funding available to successful U.S.-based investigators who request NuSTAR observing time through the Swift GI process. No funds will be awarded from the NuSTAR project for joint investigations proposed to this Swift program element.

The NuSTAR GI Program will perform feasibility checks on the proposed observations and reserves the right to reject any observation determined for any reason to be technically unfeasible or to jeopardize the NuSTAR mission. Such a rejection would likely affect the entire proposed science program and could impact the award of Swift

observing time as well. Selected proposals will be allocated NuSTAR observing time without additional scientific review, if judged technically feasible.

GRBs at high redshift are particularly compelling due to their distance and rely especially on high quality infrared (IR) observations for distance estimates, since the optical counterpart is redshifted out of Swift/UVOT's wavelength range. To encourage the development of rapid IR ground-based response to potentially high redshift GRBs, special consideration will be given to such projects. Proposals to bring new or enhanced ground-based IR capabilities online may require funding in the range of $100,000 per year. Such budget requests will be considered, provided they are strongly justified. A six-page limit for the scientific justification applies to proposals submitted in this high redshift "Correlative Observations" proposal category.

For all correlative investigations funded by Swift, rapid public availability of the data or results is in the interest of the Swift mission and the astronomical community and is strongly encouraged. Public data availability for correlative studies should be discussed in these proposals and will be considered in the evaluation of proposals.

1.3.3 *Theoretical Investigations*

GRB and non-GRB theoretical studies have the potential to significantly enhance the scientific impact of the Swift mission. GI proposals for such theoretical investigations are also solicited and should specifically address how the anticipated results will advance Swift science objectives.

1.3.4 *Non-GRB, non-ToO observations*

A total of two million seconds of observing time will be made available during Cycle 17 for non-GRB, non-ToO pointed observations. Swift observations in this category will be performed only as the result of an uploaded ground command through the normal planning process; slewing to the target will not occur autonomously. Non-GRB/non-ToO observations will have a lower scheduling priority than GRBs or ToOs and will be observed on a best-effort basis when time is available in the observing schedule. Hence, successful non-GRB/non-ToO GIs should be aware that they are not assured 100% of the time awarded. Every effort will be made to observe 80% or more of an accepted program within schedule limitations of the mission. A single observation is defined as one requested pointing to a target. Proposers should be aware that, due to Swift's low Earth orbit (95-minute orbit period) and scheduling priorities for other objects, any long observation may be broken up into several different pointings on different orbits. Observations longer than a few kiloseconds (ks) might be split into several days.

Non-GRB/non-ToO proposals are subject to the following limitations:

- The requested time per observation (i.e., a single visit to a target) must be between a minimum of 1 ks and a maximum of 40 ks;
- Monitoring programs are defined as programs requiring two or more observations of the same object, each of which is considered a "visit;" and
- No more than 2,000 visits will be permitted in this Cycle (total for all proposal categories, including both monitoring and non-monitoring requests).

Time-constrained observations are defined as observations that have to be performed within a certain time window. These can be ToOs or non-ToOs, either monitoring (more than one visit to a source) or non-monitoring observations, but not "fill-in" observations. This includes phase-constrained proposals, coordinated observing campaigns with ground-based or satellite-based facilities, etc. Note that the unique scheduling requirements of Swift put severe constraints on time-constrained programs. The window duration for time-constrained observations must exceed three hours.

For coordinated and constrained observations, it is the proposer's responsibility to inform the Swift Science Operations Team of the observing time windows at least one week before observations start. Proposers must clearly describe how their proposal capitalizes on the unique capabilities of Swift.

Only "Key Projects" observing programs may be carried over from Cycle 17 to Cycle 18. Regular proposal targets whose observations have commenced in Cycle 17 will be awarded carryover time in Cycle 18 until the proposed observations are substantially complete. GIs whose observing programs have not begun in Cycle 17 will be required to repropose in Cycle 18 if they wish to acquire observing time. Similarly, Cycle-16-accepted proposals that have not been initiated by the start of Cycle 17 will not be carried over. Cycle 16 GIs concerned that their programs may not be started before the end of the cycle should re-propose for Cycle 17.

1.3.5 *ToO Observations*

GIs are allowed to propose for ToOs in response to transient phenomena, including GRBs found by other observatories. A total of at most one million seconds of observing time will be made available to ToO proposals, subject to the constraints listed below. Swift ToO observations will only be performed as the result of an uploaded command by the Mission Operations Center and will not be slewed to autonomously. ToO observations will have a lower scheduling priority than GRBs and will be observed on a best-effort basis. Because of this restriction, successful ToO GIs should be aware that they are not assured 100% of the time awarded, even if their ToO is triggered. Every effort will be made to observe 80% or more of an accepted program. GIs submitting ToO proposals should note that:

- Each proposal should describe how it capitalizes on the unique capabilities of Swift;
- Proposals must give exact, detailed trigger criteria and a realistic estimate of the probability of triggering the ToO during Cycle 17; and
- Proposals must assign a priority to each ToO target based on the time criticality of the observation. From the time of the trigger, the priorities are defined as
    - Highest Urgency: Observation should be performed within four hours;
    - High Urgency: Observation should be performed within 24 hours;
    - Medium Urgency: Observation can be performed within days to a week; or
    - Low Urgency: Observations can be performed within weeks.

Because new GRBs are constantly being discovered, the Swift observing schedule is revised on a daily basis. Note that Highest Priority ToOs are particularly difficult to handle at night and on weekends when the Mission Operations Center is not staffed. These should be avoided in all but the most urgent cases (e.g., transient events like a

Galactic SN, a very bright GeV gamma-ray burst, or a giant soft gamma-ray repeater flare).

It is the responsibility of the Principal Investigator (PI) of an accepted ToO to alert the Swift Observatory Duty Scientist when trigger conditions for their accepted ToO have been met. This is done through the Swift ToO Request Form at https://www.swift.psu.edu/. It is highly recommended that ToO proposers register as Swift ToO users in advance at https://www.swift.psu.edu/. Registration is required in order to submit a ToO Request.

ToO proposals must have an astrophysical trigger. Once the trigger criteria have been met for an approved target, the PI should check if the target location is more than five hours in RA from the Sun and more than 20 degrees from the Moon before requesting Swift observations (http://heasarc.gsfc.nasa.gov/Tools/Viewing.html). ToO observations that require more than 6 ks on a given day and are closer to the Sun than five hours RA will be less likely to be approved unless they are of exceptionally high scientific priority. Observations greater than nine hours in RA from the Sun are particularly desirable. The purpose of the anti-Sun restriction for ToOs is to maximize the amount of time Swift is pointed toward the night sky in order to optimize optical follow-up observations of BAT-detected GRBs.

Accepted Cycle 17 ToO proposals may be triggered until March 31, 2022. GIs whose ToO programs do not trigger in Cycle 17 will be required to re-propose in later cycles should they wish to acquire observing time on their targets of interest. Only “Key Projects” ToO programs will be carried over from Cycle 17 to Cycle 18, and may be triggered until March 31, 2023.

Note that unsolicited ToO requests for exceptional transients will continue to be possible through the Swift ToO web site, even for those not accepted into the GI Program. The decision on whether or not to observe a ToO of either category will be made by the Swift Principal Investigator or his official designee. Such ToO requests are unfunded.

1.3.6 *Large Programs*

Proposals requesting more than 100 targets or more than 100 ks total exposure time are defined as Large Programs. A total of up to 1 Megasecond (Ms) of exposure time has been reserved for Large Programs, subject to the submission of proposals of high scientific merit.

Both long-duration observations of single targets, tiling of extended sources that exceed the fields of view of the Swift XRT and UVOT instruments, or shorter duration observations of many targets can be requested in the Large Programs proposal category. Proposers should be aware that, due to Swift’s low Earth orbit (95-minute orbit period) and scheduling priorities for other objects, any long observation exceeding a few kiloseconds will be broken up into several different pointings on different orbits.

The observations proposed for Large Programs must be completed within the 12-month period covered by this Cycle.

1.3.7 *Swift "Fill-in" Targets*

GIs may submit a list of targets for consideration as "Fill-in" targets. Their purpose is to provide a set of peer-reviewed targets to be used to fill in gaps in the planned science timeline. These must not be ToOs, must have no observational constraints, and can only be observed once (no multiple observations of the same target). UVOT Grism observations are not permitted as “Fill-in” observations because they require a slew-in-place. The minimum total integration time must be 1 ks per target. Accepted targets will be added to the Swift observing program at the discretion of the science operations team. They will be scheduled, as needed, around the higher priority GRB follow-up observations, ToO and non-ToO observations, to maximize the Swift science program. Funding is not provided for Fill-In proposals. Although GIs should have no expectation that their entire list of “Fill-in” targets will be observed, past experience has shown that fill-in proposals are usually undersubscribed and do get done. Due to the nature of Swift science planning, Swift GI “Fill-in” observations will be scheduled only about 24 hours prior to observation, and PIs will not be notified until observations have been completed for a given target. Scheduling information will be available to GIs via the daily observing plan (http://www.swift.psu.edu/).

To reiterate:

- Fill-in targets are not ToOs and cannot be triggered;
- Fill-in targets cannot be time constrained;
- No monitoring is allowed with fill-in targets. Proposers cannot request multiple target visits, but they can request more than 100 fill-in targets per proposal;
- No UVOT Grism observations are allowed; and
- Fill-in targets are scheduled at the convenience of the science planners. There is no guarantee that any of the targets in any fill-in program will be scheduled or completely observed in this Cycle.

1.3.8 *Swift Key Projects*

Key Projects are intended to greatly advance the Swift science program, enhance its breadth of impact, and represent an enduring legacy of Swift results. Proposals in this category may request support for new Swift projects, theoretical investigations, observations of non-GRB non-ToO targets, and observations of ToO targets. The proposed research plans can be carried out in one or two years. Proposals may also request funding in the range of $100,000 per year. Such budget requests will be considered, provided they are strongly justified.

The number of Key Projects funded in any given year will be limited. It is the responsibility of the proposers to strongly justify how the proposed program will address high-impact scientific questions by making use of the strengths of Swift. A six-page limit for the scientific justification applies to proposals submitted in this "Key Projects" proposal category.

Proposers requesting two-year projects that are selected at Phase 1 should not assume that they have been awarded two years of support; this determination will be made at Phase-2 of the review. PIs of approved multiyear Key Projects will be solicited for a progress report that will be reviewed by NASA to determine if appropriate progress is being made toward the proposed objectives. Because of the significant resources

allocated to multiyear Key Projects, those that do not make progress consistent with the proposed investigation could be reduced or terminated.

2. Programmatic Information

2.1 General Information

It is anticipated that up to $1.4M will be available through this program element for the support of approximately 35 Guest Investigations of one-year duration each (except for Key Projects). Note that additional unfunded Guest Investigations are likely to be selected (for example, Fill-in proposals). Swift non-GRB pointed observations are open to all scientists at U.S. or non-U.S. institutions. Swift GI funding is open to all individuals who are identified as Principal Investigators and employed at U.S. institutions, including Swift science team members. Scientists participating in the Swift mission, including Associate Scientists and members of the Follow-up Team who are not funded by the Project, are eligible for support under this GI Program. Swift science team members who already receive support from the Project must provide a compelling justification for the award of additional funds under the GI Program.

NASA does not anticipate awarding contracts in response to proposals submitted to this program element, because it would not be appropriate for the nature of the work solicited.

2.2 Proposal Submission and Evaluation

2.2.1 *Submission of Proposals to the Swift GI Program*

The Swift GI program uses a two-phase proposal process. A Phase-1 proposal shall comprise the science/technical justification; proposals requesting funds need to include a budget narrative, describing in sufficient detail how the proposed funds will be used to achieve the goals outlined in the proposal. Only proposers whose Phase-1 proposals are accepted will be invited to submit budget proposals in Phase 2. It is not necessary for the PI of the Phase-2 proposal to be the science PI. Proposal content, including the list of investigators, must remain consistent between Phase-1 and Phase-2 proposals. All proposal materials will be submitted electronically.

The Phase-1 peer review will be executed in a "dual-anonymous" fashion, where not only are proposers unaware of the identity of the members on the review panel, but the reviewers do not have explicit knowledge of the proposal teams (see Section 2.2.2).

Awards are expected to average $35,000 per year. Only proposals in the "Key Projects" category and in the high redshift "Correlative Observations" category may require funding substantially above the average award (i.e., in the $100,000 range per year), and will need to provide a detailed cost justification. The amount of the anticipated funding request must be entered into the box provided for this purpose on the Remote Proposal System (RPS) Cover Form. The detailed cost evaluation will be deferred until Phase 2. The funding amount requested in the Phase-2 cost proposal may not exceed the amount proposed in Phase 1. "Fill-in" proposals will be unfunded.

Proposers to the Swift GI Program must adhere to the following proposal submission procedures:

- All Proposers must submit their Phase-1 proposals electronically through the Astrophysics Research Knowledgebase (ARK)/Remote Proposal System (RPS) website at http://heasarc.gsfc.nasa.gov/ark/rps/. Instructions for doing so are provided at the SSC web site, https://swift.gsfc.nasa.gov/;
- Target forms for all observation proposals are to be submitted through ARK/RPS;
- Due to the nature of prospective investigations within the Swift GI program, the Scientific/Technical/Management section of proposals is limited to four pages (six pages for high redshift "Correlative Observations" proposals and "Key Projects" proposals), instead of the default 15 pages specified in the *NASA Guidebook for Proposers*. The requirement for a table of contents in the body of the proposal is waived.
- No supporting material (e.g., Curriculum Vitae, pending/current support) is required or allowed other than what is specified in the supplemental documentation concerning the dual-anonymous review procedure.
- Optional Latex and MS Word templates for the Scientific/Technical/Management section are provided on the SSC web site at https://swift.gsfc.nasa.gov/; and
- The Scientific/Technical/Management section must be uploaded to the RPS website as a PDF file.

All proposal materials must be submitted electronically by 7:30 p.m. Eastern time on the due date for this program given in Section 3 in order to be included in the proposal review for this cycle of the Swift Guest Investigator program. Note that the 7:30 p.m. deadline supersedes the deadline stated in the *NASA Guidebook for Proposers* and in the *ROSES Summary of Solicitation.*

Instructions for the formatting and content of ROSES proposals are given in the *ROSES Summary of Solicitation* and, for topics not addressed there, refer to the *NASA Guidebook for Proposers*. Swift GI Proposers must follow these instructions, except where they are overridden by the instructions given in the Astrophysics Research Program Overview or in this program element.

2.2.2 *Specific Instructions for Dual-Anonymous Peer Review Phase-1 Proposals*

The overarching objective of dual-anonymous peer review is to reduce unconscious bias in the evaluation of the merit of a proposal. Under this system, not only are proposers unaware of the identity of the members on the review panel, but the reviewers do not have explicit knowledge of the proposal teams.

Proposers should consult the "Guidelines for Anonymous Proposals" document in the "Other Documents" section on the NSPIRES of this program element for instructions on writing proposals appropriate for dual-anonymous peer review. The instructions here and in that document supersede the default instructions given in the *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation.* Proposers will also be required to upload a separate "Expertise and Resources - Not Anonymized" document, which is not anonymized. The "Guidelines for Anonymous Proposals" document contains complete information on how to write this separate document.

In order to meet the objectives of dual-anonymous peer review, review panels will be instructed to evaluate the anonymized proposals based on their scientific merit, without initially taking into account the proposing team qualifications. As a final check, and only

after the scientific evaluation is finalized for all proposals, the panel will be provided with the "Expertise and Resources - Not Anonymized" documents. The panel will validate the qualifications of the team in order to allow the reviewers to assess the team capabilities required to execute a given proposed science investigation.

A summary of the key factors for PIs to keep in mind are:

- Proposals should eliminate language that identifies the proposers or institutions, as discussed in the Guidelines for Anonymous Proposals
- PIs are required to upload a one-page “Expertise and Resources – Not Anonymized” PDF through ARK as a separate upload when submitting the science justification. This document must not be anonymized.
- NASA understands that dual-anonymous peer review represents a major shift in the evaluation of General Observer / General Investigator proposals, and as such there may be occasional slips in writing anonymized proposals. However, NASA reserves the right to return without review proposals that are particularly egregious in terms of the identification of the proposing team.

A summary of the key requirements for preparing anonymized Phase-1 proposals is provided in the table below.

Item	**Requirement**
Anonymization	Phase-1 proposals are anonymized. Phase-2 (cost) proposals are not anonymized.
Submission	Phase-1 proposals are submitted through ARK/RPS. Phase-2 (cost) proposals are submitted through NSPIRES.
References	References should be in the [1], [2] format.
Work plan	Include an anonymized one-paragraph work plan in the main body of the Phase-1 proposal.
Proposal length	No change.
Separate “Expertise and Resources - Not Anonymized” document	This document provides a list of all team members, their roles, expertise, and contributions to the work. The document should also discuss any specific resources that are key to completing the proposed work.

2.2.3 *Evaluation of Proposals submitted to the Swift GI Program*

Phase-1 Proposals will be evaluated by a peer evaluation panel with respect to Relevance and Merit, as defined in Appendix D of the *NASA Guidebook for Proposers*. The evaluation of intrinsic merit of a proposal shall include:

- The suitability of using the Swift observatory and data products for the proposed investigation;
- The extent to which the investigation complements and enhances the anticipated science return from the Swift mission;
- The degree to which the proposed investigation places demands upon mission resources;
- The degree to which the proposed investigation capitalizes on the unique capabilities of Swift; and
- For theoretical investigations, the degree to which the investigation directly advances Swift science goals.

2.2.4 *Submission and Evaluation of Phase-2 proposals*

Subject to the availability of funding, successful Phase-1 proposers will be contacted by the Swift Program Officer and invited to submit a cost proposal in Phase 2. Upon notification of selection of a Phase-1 proposal, a proposer must respond by following the instructions for submitting a Phase-2 proposal given in the selection notification from the Phase-1 review. Phase-2 (cost) proposals must be submitted through the NASA NSPIRES electronic proposal website (http://nspires.nasaprs.com) by an Authorized Organizational Representative (AOR) of the proposing organization according to the instructions in the *ROSES Summary of Solicitation* of this NRA. The cost proposal will consist of a Budget Details (maximum of two pages) section and a Narrative section (maximum of two pages).

NASA program personnel (as opposed to peer reviewers) will evaluate the Phase-2 (cost) proposals for cost reasonableness and compare the proposed cost to available funds, as allowed by Section VI(a) of the *ROSES Summary of Solicitation*.

Note that since the Phase-2 proposals will not be peer reviewed, the requirement to redact the budget information (per Section IV(b)(iii) of the *Summary of Solicitation*) is waived. All costs must be included in the proposal. Proposers should note that Phase-2 (cost) proposals should not be anonymized.

2.3 Supplemental Information

Further details concerning the proposal submission requirements and process can be found at the Swift Science Center website https://swift.gsfc.nasa.gov/. This website provides a detailed mission description; technical information about the Swift mission, instruments, and observation feasibility; and instructions for completing the required proposal forms.

3. Summary of Key Information

Expected program budget for first year of new awards	~$1.4M
Number of new awards pending adequate proposals of merit	~35
Maximum duration of awards	1 year; 2 years for proposals in the "Key Projects" category

Due date for Notice of Intent to propose (NOI)	Option not available
Due date for phase-1 proposals	7:30 p.m. Eastern time via ARK/RPS by the date given in See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	Funding will be awarded when the data are made available to the PI. NASA center proposers should use October 1 (6 months after start of Cycle 17 observing) as a planning date for start of funding
Page limit for Phase-1 proposals	4 pages for all proposal categories except for proposals submitted in the high redshift "Correlative Observations" category and in the "Key Projects" category, which are allowed up to 6 pages. The budget narrative has a 1-page limit that will not count toward the above page limits. See Sections 2.2.1 and 2.2.2 for Guidelines for preparing proposals for Anonymous Reviews.
Relevance	This program is relevant to the Astrophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section 3 of the *NASA Guidebook for Proposers* and Section IV and Table 1 of the *ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of the ROSES *Summary of Solicitation*.
Submission medium	Electronic proposal submission is required in PDF format; no hard copy is permitted.
Web site for submission of Notice of Intent to propose (NOI)	Option not available
Web site for submission of Phase-1 proposal and required forms	https://heasarc.gsfc.nasa.gov/ark/rps/ (Help Desk available at http://heasarc.gsfc.nasa.gov/ark/rps/help/)
Web site for submission of Phase-1 proposal via NSPIRES or grants.gov	Option not available
Web site for submission of Phase-2 proposals	http://nspires.nasaprs.com; See Section 2.2

Programmatic information may be obtained from the Swift Program Scientist	Evan Scannapieco Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-3730 Email: evan.scannapieco@nasa.gov
Technical questions concerning this program element may be directed to the Swift Guest Investigator Program	Eleonora Troja Swift Guest Investigator Program Lead Code 662 Goddard Space Flight Center National Aeronautics and Space Administration Greenbelt, MD 20771-0001 Telephone: (301) 286-0941 Email: eleonora.troja@nasa.gov

D.6 FERMI GUEST INVESTIGATOR – CYCLE 14

NOTICE: Amended October 28, 2020. In addition to small changes throughout, the following substantive edits were made: There is a new joint program opportunity with the Transiting Exoplanet Survey Satellite (TESS) mission, so Sections 1.1, 1.3.3 and 1.5 and now include reference to TESS. Section 1.3.2 notes that pointed observations are rarely possible as a result of the solar-array-drive anomaly and section 2 specifies that only proposals led by a PI who is employed by and resident at a U.S. institution are eligible for funding. In the summary table of key information, the estimated number of proposals and the programmatic point of contact have been updated. New text is in bold and deleted text is struck through. The due dates remain unchanged: Phase-1 proposals must be submitted electronically via the ARK/RPS system by 4:30 PM eastern time on February 19, 2021.

Beginning in Cycle 14, all Phase-1 proposals submitted to the Fermi Guest Investigator Program will be evaluated following a dual-anonymous peer review process. Proposals must be accordingly prepared following the guidelines in Section 2.2.2 and in the associated "Guidelines for Anonymous Proposals" document.

1. Scope of Program

1.1 Overview

The Fermi Guest Investigator (GI) program solicits proposals for basic research relevant to the Fermi mission. The primary goal of this mission is to perform 20 MeV to >300 GeV gamma-ray measurements over the entire celestial sphere, with sensitivity a factor of 30 or more greater than that obtained by earlier space missions. A secondary goal includes the study of transient gamma-ray sources with energies extending from 8 keV up to 300 GeV.

The Fermi GI program is intended to encourage scientific participation by providing funding to carry out investigations using Fermi data, to conduct correlative observations at other wavelengths, to develop data analysis techniques applicable to the Fermi data, and to carry out theoretical investigations in support of Fermi observations.

The Fermi GI program also encompasses a number of joint observation program opportunities. Fermi investigators may apply for radio, optical, X-ray, or Gamma-ray observing time through joint programs with the National Radio Astronomy Observatory (NRAO), the National Optical Astronomy Observatory (NOAO), the VERITAS ground-based Cerenkov telescope facility ~~and~~, the INTErnational Gamma-Ray Astrophysics Laboratory (INTEGRAL), **and the Transiting Exoplanet Survey Satellite (TESS).** Please refer to Section 1.3.3 for important details.

Proposers may apply for high-end computing resources. For more information, please see https://www.hec.nasa.gov/request/science.html.

Investigators may propose Fermi pointed observations, but the capability to perform such observations has become severely limited (see Section 1.2). Such observations will require strong scientific justification through simulations and exposure calculations

because default survey mode observations will satisfy the scientific requirements of most studies.

The Fermi GI program is open to all investigators, but we remind proposing organizations that NASA funding is available only to principal investigators (PIs) who are lawfully employed by a U.S. institution at the time the award is made to the institution.

There will be no exclusive-use period associated with the data from Fermi observations. All data will be made available through the HEASARC public data archive after ground processing.

1.2 The Fermi Mission

Fermi is an international and multiagency observatory-class mission that studies the cosmos in the 10 keV to 300 GeV energy range. The primary instrument, the Large Area Telescope (LAT), has a peak effective area (>8000 cm^2), angular resolution (<3.5º at 100 MeV, <0.15º above 10 GeV), field-of-view (>2 sr), and deadtime (<100 µs per event) that provides a factor of 30 or more advance in sensitivity compared to previous missions. The Fermi Gamma-ray Burst Monitor (GBM) also provides the capability for studying transient phenomena, with a field-of-view larger than the LAT and a spectral range that extends from the LAT's lower limit down to less than 10 keV. Although pointed observations are possible, the observatory primarily scans the sky continuously because of the LAT's large field-of-view. In the survey mode employed during the first 10 years of the mission Fermi provided nearly uniform sky exposure every ~3 hours.

Documents providing a more complete description of Fermi can be found at the FSSC website.

Due to an anomaly with one of the solar array drive motors in 2018, alternative sky-survey strategies have been employed to ensure safe spacecraft operation. This leads to exposure nonuniformity on short (~weekly) timescales but near uniformity is eventually achieved. It also limits LAT coverage of the Sun and surrounding sky regions. The ability to respond to Targets of Opportunity (ToOs) or, more generally, to perform pointed observations or customized observation strategies will be very limited. Prospective proposers considering such observations are strongly advised to consult the Fermi Science Support Center prior to preparing their proposal. For more details, please see https://fermi.gsfc.nasa.gov/ssc/observations/types/post_anomaly/.

The product of a collaboration among NASA, the U.S. Department of Energy, and several international partners, the LAT is a pair-conversion telescope. Gamma rays pair-produce in tungsten foils, silicon strip detectors track the resulting pairs, and the resulting particle shower deposits energy in a CsI calorimeter. An anticoincidence detector provides discrimination against the large flux of charged particles incident on the LAT. The anticoincidence detector is segmented to eliminate the self-vetoing problem encountered by previous experiments.

Astrophysical photons are only a small fraction of all the events detected by the LAT on orbit. Most events are primary cosmic rays and their associated secondary charged and neutral particles produced in the surrounding spacecraft and the Earth's atmosphere. Therefore, event filtering on board reduces the ~3 kHz detected event rate to ~350 Hz.

Events that survive the onboard filter are telemetered to the ground. Further ground processing yields a "true" celestial photon average rate of about 1 to 2 Hz.

The GBM detects gamma-ray bursts. Consisting of 12 NaI(Tl) (8–1000 keV) and 2 BGO (0.2–30 MeV) detectors, the GBM extends Fermi's burst spectral sensitivity from ~8 keV to ~30 MeV and monitors more than 8 sr of the sky, including the LAT's field-of-view. Bursts are localized by comparing rates in different detectors and rapidly distributed via the Gamma-ray bursts Coordinates Network (GCN). An initial location, computed automatically, is sent within several seconds, and is expected to have an accuracy of 5 to 10 degrees for strong bursts (fluence > ~10 photons cm^{-2}). A more accurate location (~3 degrees for strong bursts) is sent within 24 hours. The threshold of the onboard trigger is a flux of about 0.7 photons cm^{-2} s^{-1} (50 to 300 keV band), for a 1-second burst, and uses a variety of energy band and time windows.

Fermi was launched on June 11, 2008, into a circular, initial orbit of ~565 km altitude at an inclination of 25.6°. The original mission design lifetime was five years, with a goal of ten years. After a checkout period, science operations began on August 4, 2008, and Fermi has been operating in an extended mission phase since 2013. Based upon the results of the NASA 2019 Senior Review, support for mission operations was extended through September 30, 2022.

The GI community is supported by the FSSC, which is managed by NASA's Goddard Space Flight Center. All publicly available data products, software, calibration files, and technical documents that have been developed jointly with the instrument teams are available through the FSSC.

1.3 Types of Proposals

The Cycle 14 Fermi GI program solicits proposals in the following areas:

1. The analysis of LAT or GBM data from the beginning of science operations or development of data analysis techniques. Investigators are encouraged, but not required, to make software or other resources supporting such new analysis techniques publicly available through the FSSC;
2. Requests for LAT pointed observations. Proposers should be aware that the ability to accommodate such pointed observations has become very limited since Cycle 11. Please see Section 1.2 and https://fermi.gsfc.nasa.gov/ssc/observations/types/post_anomaly/. Pointed observations will follow the same open data policy as sky survey data, i.e., they will become public immediately;
3. Analysis of correlative multiwavelength observations with other instruments and observatories (but excluding operation of such facilities) that are directly relevant to Fermi science objectives (see FUG recommendation at http://fermi.gsfc.nasa.gov/ssc/resources/multi/); and
4. Theoretical investigations that will advance the science return of the Fermi mission.

1.3.1 *Analysis of all LAT gamma-ray and GBM event data*

The LAT team's science goals are: (1) development of event-reconstruction and background-rejection techniques; (2) production of a comprehensive full-sky catalog of

gamma-ray sources; and (3) a description of the diffuse gamma-ray emission. Proposed Fermi investigations should avoid duplication of the first two of these goals. The extent to which the proposed research will enhance the science return from Fermi will be considered in the proposal evaluation process (see Section 2.2 below).

The LAT's primary science data product is a list of events detected within the LAT's field-of-view. These events can be used to detect sources and study their temporal and spectral properties. Fermi observes the sky in a survey mode that provides nearly uniform sky exposure on ~weekly timescales; this mode will suffice for most scientific observations. GIs may request funding to analyze any accumulated data and may receive funding even if they did not request a specific observation.

The GBM provides event lists with measured energies and arrival times, permitting both temporal and spectral studies. In addition, binned background count rates with differing temporal and spectral resolution are also available, enabling background studies and source detection through occultation steps.

The GBM science team is already funded to provide the community with a catalog of GRBs, including localizations and spectra. Proposals construed by peer reviewers as duplicative of this goal may, therefore, be deemed to have lower priority than those perceived as addressing other objectives.

New data analysis techniques that will maximize the mission's scientific yield are also encouraged. While the Fermi mission will provide a set of analysis tools with which a complete analysis of the data can be accomplished (see http://fermi.gsfc.nasa.gov/ssc/data/analysis/ for details)**,** specialized analyses to address specific scientific issues, such as blind pulsar period searches, the discovery of faint transients, or the detection of sources through occultation steps in the GBM background light curves, may require alternative techniques and additional software. GI proposals for such new data analysis techniques must specifically address how the proposed techniques will advance Fermi science objectives.

1.3.2 *Requests for LAT pointed observations or modified observation strategies*

GIs may also request pointed observations, or in exceptional cases modified observation strategies, to accumulate sky exposure of a particular source at a rate higher than provided by survey mode observations. Similarly, GIs may request Target-of-Opportunity observations. As noted in Section 1.2 the capability to support such observations is more limited than in Cycles 1-11. It will, therefore, be incumbent upon the proposer to demonstrate that a pointed observation is required to achieve the scientific objectives. **Please note that the observatory operations are less flexible than has been the case in the past as a result of the solar-array-drive anomaly that occurred in 2018 and pointed observations are most often not possible.** Proposers who intend to request pointed observations are strongly encouraged to contact the FSSC and anyone considering modified observation strategies are required do so (http://fermi.gsfc.nasa.gov/ssc/help/).

1.3.3 *Multiwavelength observations*

Because correlative observations will substantially augment the science return from Fermi, such proposals are encouraged. Examples of correlative observations that will add significantly to the Fermi science include monitoring of blazars, follow-up observations of gamma-ray bursts, and determination of pulsar ephemerides. To foster correlative observations, the Fermi project has established joint observation programs with other ground- and space-based facilities. The Fermi GI program can award optical, radio, X-ray or high-energy gamma-ray observations through Fermi's joint programs with NRAO, NOAO, VERITAS, ~~and~~ INTEGRAL, **and TESS**. Note that only a single year of joint-program observations can be awarded through the Fermi GI Program regardless of the duration of awarded Fermi support. There are a number of important technical and policy details regarding these joint programs and prospective proposers are strongly encouraged to refer to the respective MOUs:

http://fermi.gsfc.nasa.gov/ssc/proposals/nrao.html,

http://fermi.gsfc.nasa.gov/ssc/proposals/noao.html,

http://fermi.gsfc.nasa.gov/ssc/proposals/veritas.html, ~~and~~

http://fermi.gsfc.nasa.gov/ssc/proposals/integral.html, **and**

http://fermi.gsfc.nasa.gov/ssc/proposals.tess.html

The LAT instrument team will post the light curves (including spectral information) of the sources listed at http://fermi.gsfc.nasa.gov/ssc/data/policy/LAT_Monitored_Sources.html. The team will also announce the discovery of high-amplitude variations among these sources or of newly discovered bright transients to the community via Astronomer's Telegrams and GCN notices. The FSSC will provide light curves and locations for these new sources.

1.3.4 *Theoretical investigations*

Theoretical studies related to the observations conducted with Fermi hold the potential to significantly enhance the scientific impact of the mission. GI proposals for such theoretical investigations are also solicited and must specifically address how the anticipated results will advance Fermi science objectives.

1.4 Classes of Proposals

There are two proposal classes: (1) Regular proposals with research plans that can be completed in one year, and (2) Large proposals whose research plans are more expansive and may take up to three years to complete. Large programs will remain prioritized for projects that are inherently resource intensive and large in scope. The number of Large projects funded in any given year will be very limited.

The burden of justifying the need for Large projects is on the proposers. The peer-review committees will not be permitted to descope Large projects and must evaluate them as proposed. Proposing a project in duplication as a single year plus as a Large program is discouraged.

PIs of approved Large projects must submit a progress report annually on the proposal due date, rather than on the anniversary of the award date. The progress report must comply with the page limit and format requirements of Phase-1 Regular proposals.

Progress reports should not be anonymized. It must list the deliverables (papers, public software, etc.) that have resulted from the ongoing work, as well as adhere to the schedule specified in the original proposal. Progress reports must be submitted through the Astrophysics Research Knowledgebase Remote Proposal System (ARK/RPS) system. Because of the significant resources allocated to large multiyear projects, those that do not make progress consistent with the proposed investigation could be reduced or terminated.

1.5 Proposal Length and Format

The page limit for the Science/Technical/Management section of Phase-1 proposals is four pages for Regular proposals and six pages for Large proposals. These page limits include figures and references. An additional page is required to describe the technical justification for the observation time, as well as the telescope and instrumentation configurations being requested through the joint programs with NOAO, NRAO, INTEGRAL, ~~and~~ VERITAS, **and TESS**.

Proposals must be single-spaced, typewritten, English-language text on standard U.S. letter paper, using one column, and using an easily read font size 12-point or larger and having, on average, no more than 15 characters per horizontal inch. No smaller font is permitted in the subsections of the proposal, including references. However, text in figures and their captions may be in fonts as small as 10-point. In addition, the proposal shall have no more than 5.5 lines per inch of text. Pages should have at least one-inch (2.5 cm) margins on all sides. Proposals not conforming to this format will be declared noncompliant and may be rejected without further review.

2. Programmatic Information

2.1 General Information

Awards for Regular (one-year duration) proposals or Large (one to three-year duration) proposals are expected to fall within the guidelines specified in Section 3. Phase-2 proposals requesting funding exceeding those guidelines are unlikely to be approved without a compelling justification.

Awards for triggered analyses (e.g., transients meeting specific criteria) will not be released until after such triggers occur.

Only proposals led by a PI who is employed by and resident at a U.S. institution will be considered for funding.

Fermi science team members already receiving support from the Project are eligible for support, but must provide a compelling justification for the award of additional funds under the GI Program. It is the intent of this program that most of the available GI funding be awarded to proposers not formally associated with Fermi.

NASA does not anticipate awarding contracts in response to proposals submitted to this program element, because it would not be appropriate for the nature of the work solicited.

2.2 Proposal Submission and Evaluation

2.2.1 *Submission of Phase-1 Proposals to the Fermi GI Program*

The Fermi GI program will use a two-phase proposal submission process. The first phase will be the submission and evaluation of the science/technical justification. Proposals must include a management section with a statement of work and an estimate of the resources needed to accomplish the goals of this work. The required proposal forms must be submitted through RPS. The Phase-1 peer review will be executed in a "dual-anonymous" fashion, where not only are proposers unaware of the identity of the members on the review panel, but the reviewers do not have explicit knowledge of the proposal teams (see Section 2.2.2).

Proposals requiring more than one year of effort (Large proposals) must include a schedule and a list of expected deliverables and/or milestones for each year of the requested support. This schedule will be considered in the ~~peer-~~evaluation of progress reports prior to years two and three.

Each proposer who anticipates requesting funding must provide a budget estimate, i.e., an estimated maximum of the total cost to NASA (including overhead) of his/her proposed investigation. A field for entering the total budget is provided on the RPS Cover Form.

In the second phase, proposers whose Phase-1 proposals are accepted will be invited to submit a Phase-2 budget proposal through their home institution. Proposers must append, as an NSPIRES attachment, a budget narrative for each year of proposed work and specify what they expect to accomplish at the end of each of the years proposed. Every line item in the NSPIRES budget needs to be explained in the accompanying text. All proposal materials will be submitted electronically.

Proposers to the Fermi GI Program must adhere to the following procedures for proposal submission:

- Proposers will submit their Phase-1 proposals electronically through the RPS website at: http://heasarc.gsfc.nasa.gov/ark/rps/. Instructions for doing so are provided at the FSSC web site at: http://fermi.gsfc.nasa.gov/ssc/proposals/.
- Target lists are submitted through the RPS form. All proposals involving joint-program correlated observations or Fermi pointed observations, must include a target list.
- Due to the nature of prospective investigations within the Fermi GI program, the Scientific/Technical/Management section of proposals is limited to four pages for Regular proposals and six pages for Large proposals, instead of the default 15 pages specified in the *NASA Guidebook for Proposers*. Figures and references are included within these four or six page limits. An additional page must be added to describe the technical details of proposed joint gamma-ray, X-ray, radio, or optical observing programs.
- The standard ROSES requirement for a table of contents in the body of the proposal is waived.
- No supporting material (e.g., Curriculum Vitae, pending/current support) is required or allowed other than what is specified in the supplemental documentation concerning the dual-anonymous review procedure.

- The Scientific/Technical/Management section will be uploaded to the RPS website as a PDF file.

All Phase-1 proposal materials must be submitted electronically by 4:30 p.m. Eastern Time on the due date for this program given in Tables 2 and 3 of *ROSES* in order to be considered in the proposal review for this cycle of the Fermi Guest Investigator program. Note that the 4:30 p.m. deadline replaces the standard midnight deadline.

Instructions for the submission of ROSES proposals are given in the *ROSES Summary of Solicitation* and, for topics not addressed there, refer to the *NASA Guidebook for Proposers*. Fermi GI proposers must follow these instructions, except where they are overridden by the instructions given in the Astrophysics Research Program Overview or in this program element.

2.2.2 *Specific Instructions for Dual-Anonymous Peer Review Phase-1 Proposals*

The overarching objective of dual-anonymous peer review is to reduce unconscious bias in the evaluation of the merit of a proposal. Under this system, not only are proposers unaware of the identity of the members on the review panel, but the reviewers do not have explicit knowledge of the proposal teams.

Proposers should consult the "Guidelines for Anonymous Proposals" document in the "Other Documents" section on the NSPIRES ~~of~~ **webpage for** this program element for instructions on writing proposals appropriate for dual-anonymous peer review. The instructions here and in that document supersede the default instructions given in the *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation.* Proposers will also be required to upload a separate "Expertise and Resources - Not Anonymized" document, which is not anonymized. The "Guidelines for Anonymous Proposals" document contains complete information on how to write this separate document.

In order to meet the objectives of dual-anonymous peer review, review panels will be instructed to evaluate the anonymized proposals based on their scientific merit, without initially taking into account the proposing team qualifications. As a final check, and only after the scientific evaluation is finalized for all proposals, the panel will be provided with the "Expertise and Resources - Not Anonymized" documents. The panel will validate the qualifications of the team in order to allow the reviewers to assess the team capabilities required to execute a given proposed science investigation.

A summary of the key factors for PIs to keep in mind are:

- Proposals should eliminate language that identifies the proposers or institutions, as discussed in the Guidelines for Anonymous Proposals
- PIs are required to upload a one-page “Expertise and Resources – Not Anonymized” PDF through ARK as a separate upload when submitting the science justification. This document must not be anonymized.
- NASA understands that dual-anonymous peer review represents a major shift in the evaluation of General Observer / General Investigator proposals, and as such there may be occasional slips in writing anonymized proposals. However, NASA reserves the right to return without review proposals that are particularly egregious in terms of the identification of the proposing team.

A summary of the key requirements for preparing anonymized Phase-1 proposals is provided in the table below.

Item	Requirement
Anonymization	Phase-1 proposals are anonymized. Phase-2 (cost) proposals are not anonymized.
Submission	Phase-1 proposals are submitted through ARK/RPS. Phase-2 (cost) proposals are submitted through NSPIRES.
References	References should be in the [1], [2] format.
Work plan	Include an anonymized one-paragraph work plan in the main body of the Phase-1 proposal.
Proposal length	No change.
Separate "Expertise and Resources - Not Anonymized" document	This document provides a list of all team members, their roles, expertise, and contributions to the work. The document should also discuss any specific resources that are key to completing the proposed work.

2.2.3 *Evaluation of Phase-1 Proposals Submitted to the Fermi GI Program*

Proposals will be evaluated by a peer evaluation panel with respect to Relevance and Merit, as defined in Appendix D of the *NASA Guidebook for Proposers*. The evaluation of intrinsic merit of a proposal shall also include:

- The suitability of using the Fermi observatory and data products for the proposed investigation;
- The extent to which the investigation enhances the anticipated science return from the Fermi mission;
- The degree to which the proposed investigation places demands upon mission resources (this is particularly relevant for pointed observations); and
- In the case of Progress Reports (i.e., requests to continue multiyear projects), demonstrable progress towards the stated milestones of the original science proposal. Progress Reports should not be anonymized.

For development of analysis methods, correlative observations or theoretical investigations, the evaluation criteria of a proposal shall include the degree to which the investigation directly advances Fermi science goals.

2.2.4 *Submission and Evaluation of Phase-2 proposals*

Subject to the availability of funding, successful Phase-1 proposers will be contacted by the NASA Selecting Official and invited to submit a cost proposal in Phase-2. Upon notification of selection of a Phase-1 proposal, a proposer must respond as follows:

- Follow the instructions for submitting a Phase-2 proposal given in the selection notification from the Phase-1 review. Phase-2 (cost) proposals must be submitted through the NASA NSPIRES electronic proposal website (http://nspires.nasaprs.com/) by an Authorized Organizational Representative (AOR) of the proposing organization.

- The total budget may not exceed the budget estimate the proposer provided in the Phase-1 proposal.
- Budget Details are limited to three pages, and the Budget Narrative is limited to two pages. Any substantive changes from the budget management plan already submitted in Phase-1 must be justified explicitly.

NASA program personnel (as opposed to peer reviewers) will evaluate the Phase-2 cost proposals against the third evaluation criterion, cost realism and reasonableness, and will also compare the proposed cost to available funds, as allowed by Section VI(a) of the ROSES Summary of Solicitation. Note that since the Phase-2 proposals will not be peer reviewed, the requirement to redact the budget information (per Section IV(b)(iii) of the *Summary of Solicitation*) is waived. All costs should be included in the proposal. Proposers should note that Phase-2 (cost) proposals should not be anonymized.

2.3 Supplemental Information

Further details concerning the proposal submission requirements and process can be found at the Fermi Science Support Center website http://fermi.gsfc.nasa.gov/ssc/. This website provides a detailed mission description; technical information about the Fermi mission, instruments, and feasibility of different types of observations; and instructions for completing the required proposal forms.

3. Summary of Key Information

Number of new awards pending adequate proposals of merit.	The selection of ~~30~~ **35** Regular proposals with average awards of $75K and generally less than $80K per year, and 1-2 Large proposals with average awards of $125K per year and generally less than $150K per year. Deviations from these targeted figures are possible.
Maximum duration of awards	1 year for Regular proposals and up to 3 years for Large proposals (see Section 1.3)
Due date for Notice of Intent to propose (NOI)	Option not available
Due date for Phase-1 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation* and Section 2.2.1.
Planning date for start of investigation	5-10 months after proposal due date.
Page limit for the central Science-Technical-Management section of Phase 1 proposal	4 pp for regular proposals, 6 pp for large proposals; 1 additional page is required to describe joint program observations (see Section 1.5). Page limits include figures and references. See Section 2.2.2 for Guidelines for preparing proposals for Anonymous Reviews.
Relevance	This program is relevant to the Astrophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.

General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section IV and Table 1 of *the ROSES Summary of Solicitation* and Section 3 of the *NASA Guidebook for Proposers*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of the *ROSES Summary of Solicitation.*
Submission medium	Electronic proposal submission is required in PDF format; no hard copy is required or permitted.
Web site for submission of Notice of Intent to propose (NOI)	Option not available
Web site for submission of Phase-1 proposal and required forms	http://fermi.gsfc.nasa.gov/ssc/proposals/ Help Desk available at: http://heasarc.gsfc.nasa.gov/ark/rps/help/
Web site for submission of Phase-1 proposal via NSPIRES	Option not available
Web site for submission of Phase-1 proposal via Grants.gov	Option not available
Fermi Science Support Center helpdesk	http://fermi.gsfc.nasa.gov/ssc/help/
Programmatic information may be obtained from the Fermi Program Scientist	**William Latter** **Astrophysics Division** **Science Mission Directorate** **NASA Headquarters** **Washington, DC 20546-0001** **Telephone: (202) 358-0734** **Email: William.B.Latter@nasa.gov** ~~Stefan Immler~~ ~~Astrophysics Division~~ ~~Science Mission Directorate~~ ~~NASA Headquarters~~ ~~Washington, DC 20546-0001~~ ~~Telephone: (202) 358-0615~~ ~~Email: Stefan.M.Immler@nasa.gov~~
Technical questions concerning this program element may be directed to the Fermi Science Support Center	Chris Shrader Code 661 NASA Goddard Space Flight Center Greenbelt, MD 20771-0001 Telephone: (301) 286-8434 Email: Chris.R.Shrader@nasa.gov Help Desk: http://fermi.gsfc.nasa.gov/ssc/help/

Questions concerning Fermi capabilities may be directed to the Fermi Project Scientist	Elizabeth Hays Code 661 NASA Goddard Space Flight Center Greenbelt, MD 20771 Telephone: 301-286-0345 Email: Elizabeth.A.Hays@nasa.gov

D.7 STRATEGIC ASTROPHYSICS TECHNOLOGY

NOTICE: Amended May 29, 2020. This program element, which was TBD, will not be solicited in ROSES-2020. Due to its strategic nature, SAT investments are intended to be responsive to 2020 Decadal Survey of Astronomy and Astrophysics recommendations, which are expected to be issued during the 2021 calendar year. This program will be solicited as part of ROSES-2021, with an expected deadline for NOIs in October 2021 and for proposals in December 2021.

1. Scope of Program

Strategic Astrophysics Technology (SAT) program supports the maturation of key technologies for potential infusion in space flight missions. Strongly endorsed by the 2010 Decadal Survey of Astronomy and Astrophysics the SAT program is a key element of the strategy adopted by the Astrophysics Division in implementing the Astro2010 recommendations (see the *Astrophysics Implementation Plan* at https://science.nasa.gov/astrophysics/documents).

The focus of the SAT program is measured in terms of the Technology Readiness Level (TRL) of the technologies involved. NASA uses a nine-level classification system to rate the readiness of a particular technology for use in a space flight mission. The TRL definitions are articulated in detail in NPR 7123.1B Appendix E (http://nodis3.gsfc.nasa.gov/displayDir.cfm?Internal_ID=N_PR_7123_001B_&page_name=AppendixE). Briefly, TRLs 1-3 are generally considered to be basic research on new technologies, while TRLs 7-9 correspond to the development of flight hardware.

The SAT program is designed to support the maturation of technologies for which feasibility has already been demonstrated (i.e., TRL 3), to the point where they can be incorporated into NASA flight missions (TRL 6-7).

The Astrophysics Division has three science themed programs: Exoplanet Exploration (ExEP), Physics of the Cosmos (PCOS), and Cosmic Origins (COR), which cover, respectively, the search for planets outside the Solar System, the origin and evolution of the Universe, and the birth of stars and galaxies. These focus areas are all represented within the SAT program.

2. Points of Contact

In addition to the Program Officers listed in the table below with their areas of expertise, the main point of contact concerning this program is:

Mario R. Perez
Email: Mario.Perez@nasa.gov
Telephone: (202) 358-1535

Name	Science Area	Telephone	Email
Douglas Hudgins	Exoplanet Exploration	(202) 358-0988	Douglas.M.Hudgins@nasa.gov
Daniel A. Evans	Physics of the Cosmos	(202) 358-3882	Daniel.A.Evans@nasa.gov
Kartik Sheth	Cosmic Origins	(202) 358-4805	kartik.sheth@nasa.gov

D.8 NANCY GRACE ROMAN TECHNOLOGY FELLOWSHIPS IN SPACE ASTROPHYSICS FOR EARLY CAREER RESEARCHERS

NOTICE: Proposers to the SAT program element are now also eligible to propose to the RTF solicitation. See Section 2. Also, for ROSES-2020 only, the number of years after the Ph.D. degree has been extended to nine year (instead of eight) because of the APRA/SAT late due dates in 2020.

Proposals to this program element need not includ a DMP.

1. Overview

The goals of the Nancy Grace Roman Technology Fellowship (RTF) program in astrophysics are to provide early-career researchers the opportunity to develop the skills necessary to lead astrophysics flight instrument development projects, including suborbital investigations, in preparation to become Principal Investigators (PIs) of future NASA astrophysics missions; to develop innovative technologies for space astrophysics that have the potential to enable major scientific breakthroughs; and to foster new talents by putting early career instrument builders on a trajectory towards long-term positions. NASA is committed to supporting deserving early career researchers by selecting one or more Roman Technology Fellows every year.

This program consists of two components with two different submission procedures. The first component is the one-page application from an early career individual to be named a Roman Technology Fellow (RTF), see Section 2. The second component is the subsequent submission of a proposal for up to $300K in Fellowship Funds by a previously selected RTF once that individual obtains a permanent or permanent-track position, in order to start a laboratory or develop a research group at the Fellow's institution (see Section 3). Please see Section 2.1 for the definition of an early career position, and Section 4.1 for the definition of a permanent or permanent track position.

2. Eligibility and Application to be named a Roman Technology Fellow

The application to become a Nancy Grace Roman Technology Fellow does not involve a separate proposal to this program element. Rather, the RTF application is a one-page application submitted along with a proposal submitted to either the Astrophysics Research and Analysis (APRA) or Strategic Astrophysics Technology (SAT) Programs described in program elements D.3 and D.7 of this ROSES solicitation. The PI of a successful technology-centered APRA/SAT proposal who is designated as a Roman Technology Fellow based on this one-page application has the opportunity to apply for Fellowship Funds in the future, as described in Section 3.

2.1 Eligibility

To be eligible to be named a Nancy Grace Roman Technology Fellow (as opposed to the application for start up funds, see Section 3), proposing PIs must meet the following requirements at the time of the APRA/SAT proposal submission:

- Have received a Ph.D. degree on or after January 1 of a year that is no more than nine years prior to the issuance date of the ROSES NASA Research Announcement (NRA) to which the APRA/SAT proposal is submitted. Individuals who have

interrupted their careers for substantive reasons, such as family leave or health problems, may seek a waiver to this requirement. Applicants who submit a written request for prior concurrence from NASA before the due date for Notices of Intent to propose to APRA/SAT will receive a written response from NASA within three weeks of receipt of this request.

- Hold an early career position such as a postdoctoral, tenure-track, term civil service, or an equivalent non-permanent position, as defined in Section 4.1, at the time of the APRA/SAT proposal submission and at the time of the selection as an RTF Fellow. In the event that a proposer's institution does not allow non-tenured faculty or postdoctoral researchers to apply independently for NASA grants, the proposal may include a mentor as the Institutional PI with the fellowship applicant as the Science PI, as outlined in the *NASA Guidebook for Proposers.*
- Be a U.S. citizen or have lawful status of permanent residency (i.e., holder of a U.S. Permanent Resident Card, also referred to as the Green Card)[1] to be consistent with the RTF goal of fostering new talent by putting early career instrument builders on a trajectory towards long-term positions at a U.S. institution.
- Not hold, or have held, a career civil service, tenure, or other permanent position, as defined in Section 4.1 on or prior to the proposal due date APRA/SAT.
- Not be a current or former recipient of an RTF or a Presidential Early Career Awards for Scientists and Engineers (PECASE) award.

2.2 Fellowship Application

The procedure for applying to become an RTF Fellow is as follows:

1. Submit a technical proposal as PI (or Science PI, if necessary) to the APRA or SAT program element of this ROSES solicitation.
2. Indicate on the NSPIRES Cover Page of that proposal the desire to be named a Roman Technology Fellow, and meet the eligibility requirements in Section 2.1.
3. Include the required RTF application in the APRA/SAT proposal, as described below.
4. Receive an award letter for that APRA/SAT proposal.

Selection of the APRA/SAT proposal is a prerequisite for consideration as a Roman Technology Fellow, but does not guarantee selection. Those who are named as Roman Technology Fellows will receive an award letter from the RTF program explicitly conferring the title.

The RTF application is a free-form narrative limited to a single page in length. It should convey to the review panel and selecting officials the applicant's qualifications to be named a Roman Technology Fellow, addressing the evaluation criteria in Section 2.3. The application should describe the candidate's current employment position to establish eligibility for the RTF. It should outline career goals and plans, and discuss how an RTF will help advance the applicant's career and achieve those goals. The application should complement, not simply duplicate, the information provided in the Biographical Sketches section of the APRA/SAT proposal.

[1] The prospective fellow may submit a proposal to RTF if he or she is reasonably certain that the Green Card will be in hand soon after the proposal submission. The evaluation of proposals and announcement of selection takes approximately three to four months. NASA will not make an award if the submitting institution cannot certify the prospective fellow's eligibility.

The application should be included in the APRA/SAT proposal immediately following the PI's Biographical Sketch. The one-page RTF application does not count towards the page limits for the Science/Technology/Management section of the APRA/SAT proposal.

2.3 Evaluation Criteria for Fellowship Selection

The APRA/SAT proposal containing the RTF application will be reviewed along with other proposals in the pertinent APRA/SAT review panel, as determined by technical discipline.

The application for the Roman Technology Fellowship will be separately evaluated according to the goals of the RTF program. The fellowship application should demonstrate that through the proposed APRA/SAT research, in conjunction with being named a Roman Technology Fellow, the early career researcher will develop the skills necessary to lead astrophysics flight instrument development projects, including suborbital investigations. The fellowship application is expected to demonstrate how these skills will prepare the Fellow to become a PI of future NASA astrophysics missions, or to develop innovative technologies for space astrophysics that have the potential to enable major scientific breakthroughs. The application is also expected to illustrate how the fellowship will put the applicant on a trajectory towards a long-term position.

Proposals to this program element need not includ a DMP, under the presumption that no significant research data will be generated. However, even though a DMP is not required with the proposal, if peer-reviewed publications result from the award then any data behind figures or tables must be available electronically at the time of release, ideally in supplementary material with the article and code developed should be made publicly available when it is practical and feasible to do so, and when there is scientific utility in doing so.

2.4 Timing of Selections and Awards

The announcement of selections for the technical (APRA/SAT) proposals will be in accordance with the schedule of those program elements of the ROSES solicitation. The naming of the candidate a Roman Technology Fellow will occur within 3 months after the RTF-related APRA/SAT proposal has been selected.

3. Fellowship Funds

Individuals who have previously been named as Roman Technology Fellows may submit a proposal requesting up to $300K in Fellowship Funds to start a laboratory or develop a research group at their institution. This component of the program is intended to aid Fellows in establishing themselves in a permanent-track position. Accordingly, proposers for Fellowship Funds must be in a permanent-track or permanent position (see Section 4.1), and must submit the proposal to this program element from the organization where the permanent-track position is held. Awarding of Fellowship Funds is not guaranteed simply by having been named a Fellow. Awards are contingent upon favorable peer review and available budget.

The proposal may be submitted in response to this program element at any time within two years from the date of the RTF-related APRA/SAT proposal is selected. Proposers must contact the RTF Program Officer prior to submitting a proposal for Fellowship Funds, preferably within the first year of the Fellowship.

3.1 The Fellowship Funds Proposal

The Fellowship Funds proposal must establish that the Fellow's appointment meets the definition of a permanent-track or permanent position as defined in Section 4.1. The proposal must clearly describe how the funds will be used to establish or develop the PI's research and technology development program, how the proposed program will advance the state-of-the-art in astrophysics-related technologies, and how the proposed program is relevant to NASA's Astrophysics Program. The proposal should detail the near-term use of the Fellowship Funds, and outline the Fellow's long-term plans for maintaining the research and development program.

NASA encourages, but does not require, the submitting institution to contribute to the project supported by the Fellowship Funds. An example is support by the employing institution that would provide release time to enable the applicant to concentrate more fully on the activities related to the proposal. Institutional support of equipment purchases and co-funding of student and/or postdoctoral support is recognized by NASA as a valuable contribution. Any institutional commitments for laboratory space, matching or startup funds, and other institutional resources required for the proposed work should be included in the proposal.

The technical management section of the proposal is limited to seven pages, and the proposal must contain a detailed budget with a narrative justification. Projects devoted to technology development that are not expected to generate data need not provide data management plans, but must note on the NSPIRES cover page that they are technology projects that will not generate data. However, if the award does result in peer reviewed publications, then those must still meet the requirement that the data behind figures and tables be available electronically at the time of publication, ideally in supplementary material included with the article.

3.2 Evaluation Criteria for Fellowship Funds Proposals

Proposals for Fellowship Funds will be evaluated for merit, relevance, and cost realism and reasonableness. In addition to the factors stated in the NASA *Guidebook for Proposers*, intrinsic merit will also include the following factors:

- The long-term commitment to the early career researcher's career development by the employing institution.
- The likelihood that the early career researcher will develop the skills necessary to lead astrophysics flight instrument development projects, including suborbital (sounding rocket, balloon, CubeSat) investigations, in preparation to become a PI of future astrophysics missions, or to develop innovative technologies for space astrophysics that have the potential to enable major scientific breakthroughs.

The evaluation against these criteria will be independent of any prior evaluation of the affiliated APRA/SAT proposal or the one-page fellowship application.

If a Fellowship Funds proposal is not selected for award, the Fellow may propose again for Fellowship Funds if a material change in circumstances mitigates the deficiencies identified by the review of the prior proposal. Proposal submission is subject to the fellowship duration specified in Section 4.2.

4. Programmatic Information

4.1 Definition of Permanent and Permanent-Track Positions

A permanent position is one in which the organization substantially financially compensates the PI for his or her work and effort, without making it conditional on outside funding, nor limiting the term of employment. Examples of permanent positions include, but are not limited to, tenured faculty and permanent civil service appointments.

A permanent-track position is one with a clearly defined process and schedule that can lead to a permanent position. Examples of permanent-track positions include, but are not limited to, tenure-track faculty and certain term civil service appointments.

4.2 Award Type and Duration

Since the RTF funds award is contigent on a successful APRA/SAT proposal, NASA does not anticipate awarding a separate direct grant in response to proposals submitted to this program element. The APRA/SAT award can be augmented by the RTF funds award. RTF funds will be awarded over a period of no more than 3 consecutive years. However, the Fellowship designation will last through the duration of the funds award.

5. Summary of Key Information

Expected program budget for new awards	See APRA and SAT program elements of this ROSES solicitation.
Number of new awards (with the option of submitting a subsequent RTF proposal)	Approximately 1-3 early-career selections enabled to submit a RTF proposal for funding.
Maximum duration of awards	Fellowship funds will be awarded over a period of no more than 3 consecutive years.
Due date for Notice of Intent to propose (NOI)	Initial fellowship applications via program elements APRA and SAT, see Section 2.2
Due date for proposals	Initial fellowship applications via APRA and SAT program elements, see Section 2.2. Subsequent proposals for funds may be submitted in response to this program element at any time within two years from the date the RTF-related APRA/SAT proposal is selected.
Planning date for start of investigation	For initial fellowship applications see Section 2 and APRA and SAT. For subsequent proposals for funds, please contact the POC below.
Page limit for the central Science-Technical-Management section of proposal	Initial fellowship application is a one-page addition to a proposal to APRA or SAT program element; 7 pp. for subsequent proposals for fellowship funding

Relevance	This program is relevant to the Astrophysics strategic goals and subgoals in NASA's *Strategic Plan*. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section 3 of the *NASA Guidebook for Proposers* and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	Initial fellowship applications via APRA or SAT program element
Point of contact concerning this program	Mario R. Perez Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1535 Email: mario.perez@nasa.gov

D.9 NuSTAR General Observer – Cycle 7

NOTICE: Amended October 19, 2020. A number of changes have been made to this program element and the Phase-1 due date has changed to January 29, 2021. Changes to the text include: Table 1 on Key Observatory Performance Parameters has been updated to reflect the recent improvement in NuSTAR's timing calibration. Section 1.3.1 on Programmatic Constraints has been updated to remove the limit on total bright source observing time (keeping other restrictions on observing bright targets in place) and to clarify that all joint time proposals need to include a NuSTAR component. Updates to Section 1.3.2 on Multi-Year Programs include that joint programs with NICER can be for Cycle 7 only, i.e., not multi-year. In Section 1.3.4 on ToO Observations the limit on total ToO observing time has been increased to 1 Ms. A few updates and clarifications of Programmatic Information have been made throughout Section 2. In Section 3 the Summary of Key Information table has been modified to display an increased budget and the updated contact information of the new NuSTAR Mission Scientist. New text is in bold and deleted text is struck through.

Phase-1 proposals submitted to this program will be evaluated using a dual-anonymous review process. Under this system, not only are proposers unaware of the identity of the members on the review panel, but the reviewers do not have explicit knowledge of the proposal teams. Proposals must be accordingly prepared following the guidelines in Section 2.2.1 and in the associated "Guidelines for Anonymous Proposals" document.

1. Scope of Program

1.1 Overview

The Nuclear Spectroscopic Telescope Array (NuSTAR) Small Explorer (SMEX) mission is the first orbiting telescope to focus light in the high energy X-ray region of the electromagnetic spectrum (E > 10 keV), with an effective bandpass of 3–79 keV. The observatory provides a combined improvement in sensitivity and spatial/spectral resolution by factors of 10 to 100 over previous missions that have operated at these energies. The NuSTAR General Observer (GO) Program solicits proposals for basic research relevant to the NuSTAR mission.

NuSTAR Cycle 7 will commence on or about June 1, 2021, and last for a nominal period of 12 months. Based upon the outcome of the 2019 NASA Astrophysics Senior Review process, NuSTAR operations are currently funded through September 30, 2022. Further details on the Cycle 7 program may be found on the NuSTAR GO Program website (http://nustar.gsfc.nasa.gov).

Observing time will be made available to scientists at both U.S. and non-U.S. institutions. Individuals may submit proposals for three general types of observations: "standard-mode", "Target-of-Opportunity" (ToO, see Section 1.3.4), and "Large Programs" (LP, see Section 1.3.5). In addition to proposals for ToO observations

submitted in response to this program element, unsolicited requests for ToO observations may be made through the NuSTAR Science Operations Center. Note that unsolicited ToO requests are ineligible for funding under the NuSTAR GO Program. The data from NuSTAR observations selected under this ROSES program element will have a limited exclusive-use period dependent upon the observation type. Data from approved standard-mode GO and LP observations will have a nominal one-year exclusive-use period commencing at the time of the availability of the processed data to the observer. Data from approved ToO observations will have a corresponding six-month exclusive-use period. Note that Principal Investigators (PIs) may waive the exclusive-use period and opt for the observation(s) to be placed directly into the NuSTAR public archive. Data resulting from unsolicited ToO requests will have no exclusive-use period.

In addition to investigations utilizing NuSTAR observations only, proposals involving coordinated observations with the European Space Agency (ESA)/NASA X-ray Multi-Mirror Mission (XMM)-Newton X-ray observatory, NASA's Neil Gehrels Swift observatory, and NASA's Neutron star Interior Composition ExploreR (NICER) mission are also solicited under this ROSES program element. Prospective proposers of joint observations with these facilities should refer to Section 1.3.1 for details concerning the evaluation and implementation of such proposals.

Opportunities for carrying out NuSTAR observations in conjunction with NASA's Chandra X-ray Observatory, Neil Gehrels Swift observatory, NICER, and with ESA's XMM-Newton and INTEGRAL observatories are also available through the relevant Calls for Proposals for those missions. More information is available on the NuSTAR website: https://www.nustar.caltech.edu/page/for_proposers.

Funding for investigations selected under the NuSTAR GO Program is available only to individuals at U.S. institutions who are identified as Principal Investigators (PIs). U.S.-based Co-Investigators on non-US-led proposals are not eligible for funding.

Proposals for investigations directed primarily towards the conduct of supporting theoretical or laboratory astrophysics research or ground-based observations relevant to the NuSTAR mission or observations primarily for calibration of NuSTAR or other instruments are not solicited under this program. Such requests should be made to the NuSTAR PI.

1.2 The NuSTAR Mission

NuSTAR is a PI-led NASA Small Explorer (SMEX) mission. The PI institution is the California Institute of Technology, which is responsible for the overall direction of the program. NASA's Jet Propulsion Laboratory (JPL) is responsible for the project management. The lead domestic partners include Columbia University, the University of California at Berkeley, and NASA's Goddard Space Flight Center. The Danish Technical University Space Centre and the Agenzia Spaziale Italiana (ASI) made significant contributions to the hardware and data analysis software development, respectively. ASI is an active participant in mission operations, providing access to the Italian ground station at Malindi, Kenya. The NuSTAR Mission Operations Center (MOC) is at the University of California at Berkeley Space Sciences Laboratory, and the Science Operations Center (SOC) is at the California Institute of Technology.

NuSTAR was launched on June 13, 2012, from the Kwajalein Atoll in the Marshall Islands into a low-Earth orbit with an inclination of 6 degrees and an altitude of 630 km x 610 km. After an initial six-week checkout period and subsequent two-year baseline mission, **NuSTAR transitioned to being primarily community-led through a General Observer (GO) program, which began in 2015.** ~~the NuSTAR GO program was initiated~~. Based upon the results of the NASA 2019 Senior Review, support for mission operations was extended through September 30, 2022. The observatory has no expendables, and the orbit lifetime is estimated at ~10-15 years from launch. Currently in its ninth year of operations, the observatory continues to function nominally. The NuSTAR spacecraft carries two sensitive, co-aligned, narrow-field instruments. Table 1 summarizes the primary performance specifications. Details of the observatory and instrument design can be found at http://nustar.caltech.edu/, as well as the NuSTAR mission paper, Harrison et al. (2013; ApJ, 770, 103).

Table 1: Key Observatory Performance Parameters

Parameter	Value
Energy range	3–78.4 keV
Angular resolution (HPD)	58″
Angular resolution (FWHM)	18″
FoV (50% resp.) at 10 keV	10′
FoV (50% resp.) at 68 keV	6′
Sensitivity (6–10 keV) (10^6 s, 3σ, ΔE/E = 0.5)	2 x 10^{-15} erg cm^{-2} s^{-1}
Sensitivity (10–30 keV) (10^6 s, 3σ, ΔE/E = 0.5)	1 x 10^{-14} erg cm^{-2} s^{-1}
Background in HPD (3–10 keV) Background in HPD (10–30 keV)	9.0 x 10^{-4} counts s^{-1} 1.1 x 10^{-3} counts s^{-1}
Strong source (>10σ) positioning	1.5″ (1σ)
ToO response time	< 48 hr
Slew rate	0.06° s^{-1}
Settling time	200 s (typically)
Timing accuracy (after barycenter correction)	**65 μs (1σ)**

1.3 NuSTAR Cycle 7 General Information

The total amount of time allocated to GO during NuSTAR Cycle 7 is expected to be 11.3 Ms (70% of the total available observing time), of which 8.5 Ms will be allocated to NuSTAR observations selected through this program element. The remaining GO time will be allocated to joint observations:

- Up to 1.5 Ms to NuSTAR/XMM-Newton joint proposals submitted to the XMM-Newton Cycle 20 Call for Proposals.

- Up to 0.5 Ms to NuSTAR/Chandra joint observing proposals submitted to the Chandra Cycle 23 Call for Proposal.
- Up to 400 ks to NuSTAR/NICER joint observing proposals submitted to the NICER Cycle 3 Call for Proposals.
- Up to 300 ks to NuSTAR/**Neil** Gehrels Swift joint observing proposals submitted to the Gehrels Swift Cycle 17 Call for Proposals.
- Up to 100 ks to NuSTAR/INTEGRAL joint observing proposals submitted to the INTEGRAL Cycle 19 Call for Proposals.

It is anticipated that approximately 50 investigations will be selected for implementation under the NuSTAR Cycle 7 GO program.

The remaining 30% of the observing time will be allocated through the NuSTAR Project to the NuSTAR legacy survey observations (3%); NuSTAR PI discretionary time (17%), including unsolicited ToO observations open to the scientific community; and time reserved for calibration observations, engineering tasks, and resolution of operational issues (10%). The NuSTAR legacy surveys represent extensions of the Galactic and Extragalactic surveys conducted during the baseline mission (see http://www.nustar.caltech.edu/page/legacy_surveys for additional information).

Proposers to this program must clearly describe how their proposed investigation capitalizes on the unique capabilities of NuSTAR. Proposals for investigations involving targets previously observed or currently planned for observation with NuSTAR must provide a justification of the need for the requested additional data. The "as-flown" observing timeline for NuSTAR may be found at http://www.srl.caltech.edu/NuSTAR_Public/NuSTAROperationSite/AFT_Public.php, and lists of the approved NuSTAR GO targets from previous cycles are available at https://heasarc.gsfc.nasa.gov/docs/nustar/previous_cycles.html. Proposers may also search the NuSTAR master catalog (numaster) table for a complete list of targets planned for observations as well as completed observations, including NuSTAR targets awarded through other solicitations (e.g., by Chandra and XMM-Newton joint programs with NuSTAR). See https://heasarc.gsfc.nasa.gov/W3Browse/all/numaster.html.

A list of approved ToO observations accepted through the NuSTAR GO and joint GO programs is available on the NuSTAR SOC website: http://www.srl.caltech.edu/NuSTAR_Public/NuSTAROperationSite/TOO_programs.php

Observations of targets proposed through this ROSES program element will take precedence over legacy program observations of those targets that have not been executed as of the submission deadline. The applicable legacy observations will be suspended until the disposition of the proposed GO observations is determined in the Phase-1 review. Proposed GO observations of legacy targets that are not accepted as part of the Cycle 7 program will be restored to the legacy program. A list of legacy observations that are planned to be performed by the end of Cycle 7 will be made available on the NuSTAR website http://www.nustar.caltech.edu/page/legacy_surveys.

For those Phase-1 proposals recommended for implementation, the approved target observations will be assigned a Category A, B, C or L (L designates a Large program target, see section 1.3.5) and a recommended exposure time. Note that for proposals including observations of multiple targets, the priority of each target observation will be

separately categorized. Assuming nominal operational efficiency, it is anticipated that observations of most standard-mode Category A, B or L targets will be carried out during Cycle 7. Any standard-mode, non-time-constrained Category A, B or L observations not observed during Cycle 7 will be carried over to Cycle 8. See section 1.3.2 for details about multi-year observing proposals.

Observations of Category C targets will be executed on a best-effort basis. Category C targets not scheduled during a particular observing cycle will *not* be carried over to the succeeding cycle; such observations may be re-proposed to a future observing cycle. Finally, note that proposals for observations of Cycle 6 Category C targets that have not been scheduled prior to the Cycle 7 proposal due date may be submitted to Cycle 7. Such proposals will be considered for selection in Cycle 7 only if the corresponding Cycle 6 observation is not executed in Cycle 6.

Proposers should note that NuSTAR's low-inclination (6°), low-Earth orbit allows, on average, a maximum continuous exposure of ~ 3.2 ks per 5.7 ks satellite orbit for targets below a declination |Dec| of ~ 65°; for targets at high declination, |Dec| > 65°, the unocculted period may be longer. Unless there is a specific reason why the total elapsed time of an observation is important, proposers should specify only the net exposure time required for achievement of the proposed science goals, excluding observational efficiency factors (Earth occultations and South Atlantic Anomaly passages) in the observing time calculation; specification of the total elapsed time requirement will result in the observation being classified as time-constrained (see Section 1.3.3).

1.3.1 *Programmatic Constraints*

Proposals are subject to the following limitations:

- The requested time per observation (i.e., a single "visit" to a target) is constrained to a minimum of 20 ks;
- Targets for which time-constrained observations are requested will only be given highest priority for scheduling during Cycle 7 if they are designated Category A (see Section 1.3.3);
- ~~Due to the limited number of ground station passes, observations of high count-rate targets place significant demands upon mission resources. Consequently, it is anticipated that the total time available for observation of bright sources (predicted instrument count rate above 100 counts s^{-1} for both modules using 50% PSF extraction with no deadtime) during Cycle 7 will be limited to a maximum of 1 Ms. Note that, for very bright sources, the instrument count rate is significantly lower than the incident event rate due to detector deadtime effects.~~ Proposals requesting observations of bright sources **(predicted instrument count rate above 100 counts s^{-1} for both modules using 50% PSF extraction with no deadtime)** with durations > 30 ks are operationally difficult to carry out. Accordingly, such proposals must provide a sufficiently compelling motivation to be considered for acceptance. In addition, proposals requesting observations of bright sources with exposures longer than 75 ks will be considered for implementation *only* if the total requested time is distributed in multiple observations, each with exposure < 75 ks and separated by more than 1 week;

- Sources with fluxes > 10^{-11} ergs s^{-1} cm^{-2} within 5° of the target may cause increased nonuniform background gradients due to stray light. Users should check observations for potential stray light contributions using the tools available at http://nustar.caltech.edu/page/researchers. If the results of the constraint check indicates that the position may have a 'Potential stray light issue', proposers should submit a request for a feasibility analysis to nustar-help@srl.caltech.edu at least two business days prior to the proposal submission deadline;
- Proposals for joint NuSTAR/XMM-Newton programs in Cycle 7 will be accepted up to a total of 1.5 Ms of XMM-Newton observing time. Joint proposals must provide a compelling justification of the need for both the NuSTAR and XMM-Newton data for achieving the primary science goals and receive a Category A, B or L rating to be considered for acceptance. **No XMM-Newton observing time will be awarded without the need for NuSTAR observing time on the same target.** Individuals considering submission of a Cycle 7 proposal for joint NuSTAR/XMM-**Newton** observations should consult the XMM-Newton Cycle 20 approved NuSTAR target list prior to submission of their proposal. Duplicate observations of the same targets by NuSTAR will typically not be awarded;
- Proposals for joint NuSTAR/Neil Gehrels Swift programs in Cycle 7 will be accepted up to a total of 300 ks of Neil Gehrels Swift observing time. Joint proposals must provide a compelling justification of the need for both the NuSTAR and Neil Gehrels Swift data for achieving the primary science goals and receive a Category A, B or L rating to be considered for acceptance. **No Neil Gehrels Swift observing time will be awarded without the need for NuSTAR observing time on the same target.** Proposers are strongly encouraged to carefully read the Neil Gehrels Swift/NuSTAR memorandum of understanding. Neil Gehrels Swift data sets obtained through approved joint NuSTAR/Gehrels Swift proposals will not be proprietary and will be immediately released publicly via the HEASARC data archive. Note that for most NuSTAR pointings, 1–2 ks "snapshot" observations are routinely performed by Neil Gehrels Swift (unless there are multiple observations of the same target, coordinated NuSTAR observations with other X-ray observatories, and during times of Gamma-Ray Bursts and Neil Gehrels Swift ToOs) without the need for a specific joint observing proposal. Individuals considering submission of a Cycle 7 proposal for joint NuSTAR/Neil Gehrels Swift observations should consult the Neil Gehrels Swift Cycle 17 approved NuSTAR target list prior to submission of their proposal. Duplicate observations of the same targets by NuSTAR will typically not be awarded;
- Proposals for joint NuSTAR/NICER programs in Cycle 7 will be accepted up to a total of 250 ks of NICER observing time. Joint proposals must provide a compelling justification of the need for both the NuSTAR and NICER data for achieving the primary science goals and receive a Category A, B or L rating to be considered for acceptance. **No NICER observing time will be awarded without the need for NuSTAR observing time on the same target.** NICER data sets obtained through approved joint NuSTAR/NICER proposals have the standard NuSTAR exclusive-use period and will be released publicly via the HEASARC

data archive. Individuals considering submission of a Cycle 7 proposal for joint NuSTAR/ NICER observations should consult the NICER Cycle 3 approved NuSTAR target list prior to submission of their proposal. Duplicate observations of the same targets by NuSTAR will typically not be awarded;

- Proposals requesting joint observing time with XMM-Newton, Neil Gehrels Swift, and/or NICER observatories will have an additional page of text to describe the proposed program.
- Proposals requesting coordinated observations with other space- or ground-based observatories will be designated time-constrained and subject to the restrictions described in Section 1.3.3.

1.3.2 *Multi-Year Programs*

The PI may request that observations (including ToO observations) be scheduled over a two-cycle period. Multi-year programs must be strongly justified in the proposal text. **If a multi-year program, in particular one including ToO observations, is not strongly justified in the proposal text it might be evaluated as a Cycle 7-only proposal.** No multi-year programs awarded in Cycle 7 will be carried beyond Cycle 8, i.e., all observations must occur in Cycles 7 and 8. Multi-year joint programs **with XMM-Newton or Neil Gehrels Swift** may also be proposed. **Joint programs with NICER may be for Cycle 7 only.** All approved multi-year programs must be category A, B or L. It is anticipated that Cycle 8 will commence on June 1, 2022 and have a duration of one year (pending the results of the 2022 Senior Review).

1.3.3 *Time-Constrained Observations*

Time-constrained observations are defined as observations that must be performed within a specific time window. This includes phase-constrained observations and coordinated observing campaigns with ground-based or space-based facilities. Time-constrained observations are subject to the following limitations:

- Time-constrained observations designated Category A, B or L will be given highest priority for scheduling during Cycle 7 (or Cycle 7 and 8 for multi-year programs). Time-constrained observations of Category C targets will be executed on a best-effort basis and therefore should be scientifically justified if the time constraint is not satisfied.
- The time constraints for multi-year programs can occur in Cycle 7 and/or Cycle 8.
- Time-constrained Category A, B or L observations that are not part of a multi-year program and are not scheduled during Cycle 7 may be carried over to Cycle 8 where warranted by scientific or operational circumstances (e.g., in the case of coordinated observations with other space- or ground-based observatories). Category C time-constrained observations not scheduled during Cycle 7 will *not* be carried over to Cycle 8.
- Monitoring programs are defined as investigations requiring two or more observations of the same target, each of which is considered a "visit". For such programs, the time interval between successive visits must be ≥ 14 hours. Note that programs in which the time interval between any two successive visits is ≤ 1 week will be designated as time-constrained.

- Note that proposed Neil Gehrels Swift observing time can include monitoring that precedes, follows and/or (for ToOs) triggers NuSTAR observing time.

For coordinated or time-constrained observations, it is the proposer's responsibility to inform the NuSTAR SOC of the observing time windows as soon as possible, but at a minimum of one month before initiation of the observations. In cases where observations involve coordination with other space-based observatories, the NuSTAR SOC will be responsible for communicating detailed schedule constraints with the relevant operations team(s).

1.3.4 *Target of Opportunity (ToO) Observations*

A total of up to ~~500 ks~~ **1 Ms** of NuSTAR Cycle 7 observing time will be made available for proposals to observe ToOs, subject to the constraints listed below. Individuals interested in submitting ToO proposals should note the following:

- Proposals must provide exact, detailed trigger criteria and a credible estimate (including justification) of the probability of triggering the ToO during Cycle 7 (and Cycle 8 for multi-year proposals);
- Proposers ~~should indicate~~ **must strongly justify the response time required to meet the scientific objectives** on the Astrophysics Research Knowledgebase (ARK)/Remote Proposal System (RPS) proposal submission form (http://heasarc.gsfc.nasa.gov/ark/rps/) ~~the response time required to meet the scientific objectives~~. Note that the minimum response time that may be specified for NuSTAR observations is 48 hours; proposals will be evaluated based on this criterion. However, a more rapid response time may be requested by the PI; such requests will be accommodated on a best-effort basis;
- The observations must have an astrophysical trigger and be designated as Category A;
- Proposals for ToO observations that can be triggered from a class of objects or set of potential targets are permitted;
- Active ToO programs submitted to the Chandra/NuSTAR, XMM-Newton/NuSTAR, INTEGRAL/NuSTAR, Neil Gehrels Swift/NuSTAR or NICER/NuSTAR GO Program Calls for Proposals approved prior to the Cycle 7 solicitation will take precedence over NuSTAR Cycle 7 proposals with the same targets and trigger criteria.
- ToO programs accepted as part of the NuSTAR Cycle 7 GO program will take precedence over unsolicited ToOs.
- In the case of Large Program ToOs with multiple observations, only the initial observation is counted against the ~~500 ks~~ **1 Ms** maximum ToO exposure time (since subsequent observations are considered to be monitoring observations).

It is the responsibility of the PI of an accepted ToO proposal to alert the NuSTAR SOC when the trigger conditions for their accepted ToO have been satisfied. This is done via submission of a NuSTAR ToO Request Form; detailed information is available at http://nustar.caltech.edu/page/too_policy. Prior to submission of this form, the PI should verify the visibility of the target at http://www.srl.caltech.edu/NuSTAR_Public/NuSTAROperationSite/CheckConstraint.php Multi-year ToO programs may be triggered in Cycle 7 or Cycle 8. Accepted Cycle 7 ToO

observations not designated as multi-year can only be triggered until the end of the cycle and observations not triggered during Cycle 7 will not be carried over to Cycle 8. Such observations may be re-proposed to a subsequent cycle. Data from approved Cycle 7 ToO observations will have a six-month exclusive use period after which the data will be placed in the public archive.

Note that requests for observations of unsolicited ToOs may be submitted via the NuSTAR ToO web site (http://www.srl.caltech.edu/NuSTAR_Public/GO/GOsubmit.php). Decisions regarding the disposition of unsolicited ToO requests will be made by the NuSTAR Principal Investigator or official designee. Requests for such unsolicited ToO observations are ineligible for funding under the NuSTAR GO Program.

1.3.5 *Large Programs (LPs)*

A total of up to 2 Ms of NuSTAR Cycle 7 observing time will be made available for the Large Program (LP) category. The minimum total exposure time for LP proposals is 500 ks, and such proposals are allowed an additional page of text to describe the proposed program. Data from approved Cycle 7 LPs will have a one-year exclusive use period after which the data will be placed in the public archive. A single-trigger ToO may be proposed as part of an LP (e.g., where a long observation is needed after the initial trigger). Data from an approved LP with a ToO will have a six-month exclusive use period.

2. Programmatic Information

2.1 General Information

It is anticipated that at least $3.**75** ~~0~~M will be available for the support of General Observations during Cycle 7. Proposals ranked as Category A, B or L by the Phase-1 peer review panel will be given the highest priority for funding. However, limited support will be made available for Category C proposals that are executed during Cycle 7. NuSTAR GO funding is open to individuals who are identified as Principal Investigators and employed at U.S. institutions. The amount of funding awarded to PIs of Category A, B or L proposals will be based upon NASA's evaluation of the cost realism and reasonableness of the Phase-2 cost proposal. In addition, eligible PIs of proposals with Category C targets that are executed during Cycle 7 can expect awards of $~~1~~ **2**0,000 to support the publication of the results. NuSTAR science team members and scientists participating in the NuSTAR mission are eligible for support under this GO Program. Note that GO proposals from NuSTAR team members who receive funding from the Project must clearly demonstrate that the proposed investigation is not redundant with their science team responsibilities. U.S. Co-Is on a U.S. PI proposal can only receive funding through a subaward from the PI institution. Following the Phase-1 peer review, Phase-2 (cost) proposals will be solicited from eligible PIs and subsequently evaluated for cost realism and reasonableness via the Phase-2 review process. Joint NuSTAR/XMM-**Newton** and NuSTAR/**Neil** Gehrels Swift, and NuSTAR/NICER Phase-1 proposals selected through this Call for Proposals are eligible for funding solely through the NuSTAR GO program; the corresponding Phase-2 cost proposals may request support for the analysis of both the NuSTAR and XMM-Newton, Neil Gehrels Swift, or

NICER data. Such proposals should not be submitted to the U.S. XMM-Newton General Observer Facility nor to the **Neil** Gehrels Swift or NICER Projects.

Proposals from non-U.S. institutions are acceptable and will only be considered on a no-exchange-of-funds basis. Non-U.S. proposals will be reviewed to the same standards as proposals from U.S. institutions and selected solely by NASA.

2.2 Proposal Submission and Evaluation

The NuSTAR GO program utilizes a two-phase proposal process. Phase-1 proposals shall provide a detailed description of the proposed investigation, including the requested NuSTAR observation(s) and associated scientific/technical justification. The Phase-1 peer review will be executed in a "dual-anonymous" fashion, where not only are proposers unaware of the identity of the members on the review panel, but the reviewers do not have explicit knowledge of the proposal teams (see Section 2.2.1).

U.S. PI's whose Phase-1 proposals with targets assigned a Category A, B or L rating by the peer review panel will be invited to submit a Phase-2 (cost) proposal. Category C programs do not require a Phase-2 proposal. Subject to acceptance of the associated Phase-2 cost submission, proposals for standard-mode observations (excluding proposals involving ToO or time-constrained observations) assigned a Category A, B or L rating will be eligible for funding immediately. Due to the uncertainty of their execution, the remaining accepted Phase-2 proposals will become eligible for funding only after the proposed observations have been carried out. Phase-2 proposals must include a detailed budget and accompanying narrative, providing a detailed description of how the requested funds will be used to achieve the goals outlined in the proposal. It is nominally expected that the PI of the Phase-1 proposal will serve as the Phase-2 proposal PI; however, for administrative purposes, an alternate individual from the Phase-1 PI's institution may serve as PI on the Phase-2 proposal. All proposal materials shall be submitted electronically, as specified below.

Instructions for the formatting and content of ROSES proposals are given in the *ROSES Summary of Solicitation* and, for topics not addressed there, refer to the *NASA Guidebook for Proposers*. Proposers must follow these instructions, except where they are overridden by the instructions given in the Astrophysics Research Program Overview or in this program element. Templates for Phase-1 proposals will be made available on the NuSTAR GO website at https://nustar.gsfc.nasa.gov. **Note that Phase-1 proposals should have a single-column format.**

2.2.1 *Specific Instructions for Dual-Anonymous Review Proposals*

The overarching objective of dual-anonymous peer review is to reduce unconscious bias in the evaluation of the merit of a proposal. Under this system, not only are proposers unaware of the identity of the members on the review panel, but the reviewers do not have explicit knowledge of the proposal teams.

Proposers should consult the "Guidelines for Anonymous Proposals" document in the "Other Documents" section on the NSPIRES of this program element for instructions on writing proposals appropriate for dual-anonymous peer review. The instructions here and in that document supersede the default instructions given in the *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation*. Proposers will also be required

to upload a separate "Expertise and Resources - Not Anonymized" document, which is not anonymized. The "Guidelines for Anonymous Proposals" document contains complete information on how to write this separate document.

In order to meet the objectives of dual-anonymous peer review, review panels will be instructed to evaluate the anonymized proposals based on their scientific merit, without initially taking into account the proposing team qualifications. As a final check, and only after the scientific evaluation is finalized for all proposals, the panel will be provided with the "Expertise and Resources - Not Anonymized" documents. The panel **may** ~~will~~ validate the qualifications of the team in order to allow the reviewers to assess the team capabilities required to execute a given proposed science investigation.

A summary of the key factors for PIs to keep in mind are:

- Proposals should eliminate language that identifies the proposers or institutions, as discussed in the Guidelines for Anonymous Proposals.
- PIs are required to upload a one-page "Expertise and Resources – Not Anonymized" PDF through ARK as a separate upload when submitting the **anonymized Scientific/Technical/Management section** ~~science justification.~~ This document must not be anonymized.
- NASA understands that dual-anonymous peer review represents a major shift in the evaluation of General Observer / General Investigator proposals, and as such there may be occasional slips in writing anonymized proposals. However, NASA reserves the right to return without review proposals that are particularly egregious in terms of the identification of the proposing team.

A summary of the key requirements for preparing anonymized Phase-1 proposals is provided in the table below. **Additional information may also be found on the web at: https://science.nasa.gov/researchers/dual-anonymous-peer-review**

Item	**Requirement**
Anonymization	Phase-1 proposals are anonymized. Phase-2 (cost) proposals are not anonymized.
Submission	Phase-1 proposals are submitted through ARK/RPS. Phase-2 (cost) proposals are submitted through NSPIRES.
References	References should be in the [1], [2] format.
Work plan	Include an anonymized one-paragraph work plan in the main body of the Phase-1 proposal.
Proposal length	No change.
Separate "Expertise and Resources - Not Anonymized" document	This document provides a list of all team members, their roles, expertise, and contributions to the work. The document should also discuss any specific resources that are key to completing the proposed work.

2.2.2. *Submission and Evaluation of Phase-1 NuSTAR GO Proposals*

Individuals submitting Phase-1 proposals to the Cycle 7 NuSTAR GO Program must adhere to the following proposal submission procedures:

- Proposers must submit their Phase-1 proposals (including the accompanying target forms) electronically through the ARK/RPS website at http://heasarc.gsfc.nasa.gov/ark/rps/. Instructions for submitting proposals via ARK/RPS are provided at the HEASARC NuSTAR web site: http://nustar.gsfc.nasa.gov/;
- Due to the nature of prospective investigations within the NuSTAR GO program, the Scientific/Technical/Management section of proposals is limited to four pages (five pages for LP proposals and proposals requesting joint NuSTAR/XMM-Newton, NuSTAR/**Neil** Gehrels Swift or NuSTAR/NICER observations), in lieu of the default 15 pages specified in the *NASA Guidebook for Proposers*. The requirement for a table of contents in the body of the proposal is waived. No supporting material (e.g., Curriculum Vitae, pending/current support) is required or allowed other than what is specified in the supplemental documentation concerning the dual-anonymous review procedure.
- The proposals should have margins of no less than 1” on US letter size paper (8.5” x 11”) and the text body font size should be no smaller than 15 characters per inch. Figure captions and references may be smaller but must be legible. Optional LaTeX and MS Word templates for the Scientific/Technical/Management section consistent with these requirements are provided at http://nustar.gsfc.nasa.gov;
- Proposals must not contain hyperlinks to additional material other than references to public information that do not identify the PI, Co-Is or their institutions; web pages with material specific to the proposal such as target lists **or stray light assessments** are not allowed.
- ~~The Science Justification~~ **The Scientific/Technical/Management section** and the "Expertise and Resources – Not Anonymized" documents must be uploaded to the RPS website as PDF files.
- Proposals not in compliance with these specifications may be returned without review.

In order to be included in the review of proposals for this cycle of the NuSTAR General Observer Program, all proposal materials must be submitted electronically by 4:30 p.m. Eastern Time on the Phase-1 due date provided in Tables 2 and 3 of ROSES.

Proposals will be evaluated by a science peer panel with respect to the criteria specified in Section VI.(a) of the *ROSES Summary of Solicitation*, where it is understood that the intrinsic merit of a proposal shall include the following factors:

- The extent to which the proposed investigation complements and enhances the anticipated science return from the NuSTAR mission;
- The suitability of using the NuSTAR observatory and associated data products for the proposed investigation, including the degree to which the investigation exploits the unique capabilities of NuSTAR;
- The feasibility of accomplishing the objectives of the proposed investigation with the requested observations, including the degree to which the proposal satisfies

NuSTAR observational constraints and the feasibility of the proposed analysis techniques;

- For joint observing proposals, the relevance and feasibility of the corresponding XMM-Newton, **Neil** Gehrels Swift or NICER observations;
- The degree to which the proposed observation(s) places demands upon mission resources;
- In the case of ToO proposals the justification of the trigger probabilities.

2.2.3 *Submission and Evaluation of Phase-2 proposals*

Subject to the availability of funding, eligible Phase-1 proposers with Category A, B or L observations will be contacted by the NuSTAR Program Scientist and invited to submit a Phase-2 (cost) proposal. Upon notification of selection of a Phase-1 proposal, proposers eligible for Phase-2 must follow the instructions for submitting a Phase-2 proposal given in the selection notification letter from the Phase-1 review. Phase-2 proposals must be submitted through the NASA NSPIRES electronic proposal website (http://nspires.nasaprs.com) by an Authorized Organizational Representative (AOR) of the proposing organization following the instructions in the *Summary of Solicitation* of this NRA. The cost proposal shall consist of a "Budget Details" section (maximum of two pages) and a "Budget Narrative" section (maximum of two pages).

NASA program personnel (as opposed to peer reviewers) will evaluate the Phase-2 cost proposals for cost reasonableness and will also compare the proposed cost to available funds as allowed by Section VI(a) of the *ROSES Summary of Solicitation.* Subject to the conditions stated above, proposers will be notified regarding the award amount for their Cycle 7 investigation(s) by NASA upon completion of the Phase-2 review process. Note that since the Phase-2 proposals will not be peer reviewed, the requirement to redact the budget information (per Section IV(b)(iii) of the *Summary of Solicitation*) is waived. All costs must be included in the proposal. Proposers should note that Phase-2 (cost) proposals should not be anonymized.

2.3 Supplemental Information

Further details concerning the proposal submission requirements and process can be found at the NuSTAR General Observer website (http://nustar.gsfc.nasa.gov/). This website provides instructions for completing the required proposal forms. A detailed description of the NuSTAR mission, including technical information relevant to the observatory, instruments, and observation feasibility can be found at http://nustar.caltech.edu/page/researchers. Answers to frequently asked questions can be found at http://heasarc.gsfc.nasa.gov/docs/nustar/nustar_faq.html.

3. Summary of Key Information

Expected program budget for Cycle 7 awards	~ $3.**75** ~~0~~ M
Expected number of new awards pending adequate proposals of merit	30-50
Maximum duration of awards	1 year (2 years for multi-year programs)

Due date for Notice of Intent to propose (NOI)	Option not available.
Due date for Phase-1 proposals	See Tables 2 and 3 of this ROSES NRA and Section 2.2.2.
Planning date for start of investigation	Funding will be awarded when the data are made available to the PI. NASA Center proposers should use October 1, 2021 (4 months after start of the Cycle 7 observing program) as a planning date for start of funding.
Page limit for Phase-1 proposals	Standard & ToO proposals: 4 pages. Large Program (LP) and Joint Observing Proposals: 5 pages. LaTeX and MS Word templates (available for download at http://nustar.gsfc.nasa.gov/) can be used for the proposals. No supporting material (e.g., pending/current support) will be considered for Phase-1 except what is specified in the Guidelines for Anonymous Reviews. Page limits include figures and references. This instruction supersedes the limits given in the *NASA Guidebook for Proposers*.
Relevance	This program is relevant to the Astrophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section 3 of the *NASA Guidebook for Proposers* and Section IV and Table 1 of the *ROSES Summary of Solicitation*.
Detailed instructions for the submission of Phase-1 proposals	See https://heasarc.gsfc.nasa.gov/docs/nustar/nustar_prop.html
Detailed instructions for the submission of Phase-2 proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of the *ROSES Summary of Solicitation*.

Submission medium	Electronic proposal submission is required in PDF format; no hard copy is required or permitted.
Web site for submission of Notice of Intent to propose (NOI)	Option not available.
Web site for submission of Phase-1 proposal and required forms	http://heasarc.gsfc.nasa.gov/ark/nustar/ (Help Desk available at: http://heasarc.gsfc.nasa.gov/ark/rps/help/)
Web site for submission of Phase-1 proposal via NSPIRES	Option not available.
Web site for submission of Phase-1 proposal via Grants.gov	Option not available.
Web site for submission of Phase-2 proposals	http://nspires.nasaprs.com; See Section 2.2.3
Programmatic information may be obtained from the NuSTAR Program Scientist	Hashima Hasan Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0692 Email: hhasan@nasa.gov
Technical questions concerning this program element may be directed to the NuSTAR General Observer Program Office	**Tod Strohmayer** NuSTAR Mission Scientist Code 662 Goddard Space Flight Center National Aeronautics and Space Administration Greenbelt, MD 20771-0001 Telephone: **(301) 286-1256** Email: **tod.e.strohmayer@nasa.gov** ~~Andrew Ptak~~ ~~Telephone: (301) 286-1154~~ ~~Email: andrew.ptak@nasa.gov~~

D.10 TESS GUEST INVESTIGATOR – Cycle 4

NOTICE: Amended October 23, 2020. In addition to small changes throughout, the following substantive edits were made: A new "Mini Proposal" category is available. These programs require minimal resources, up to 50 20-second cadence targets and 1,000 2-minute cadence targets per proposal may be requested. Proposals in this category are not eligible for funding. The observing sectors were updated in Section 1.1, Section 1.3 has been updated regarding postage stamp targets, source code sharing, and joint Fermi observations, and Section 2.2 has been updated regarding overlap with proposals to the Exoplanet Research Program.

Moreover, Cycle 4 also includes the following changes from the previous cycle:

- **TESS Cycle 4 observations will be collected between June 2021 and September 2022. Due to the extended length of the cycle compared to previous cycles, the total amount of funding available to U.S.-based PIs through this solicitation is anticipated to be $3.4M, of which up to $500,000 is available to support ground-based observing programs as in Cycle 3.**
- **Key Project proposals are no longer solicited.**

New text is in bold and deleted text is struck through. The Phase-1 due date has been delayed: Phase-1 proposals are due by 4:30 pm Eastern Time January 22, 2021 via ARK/RPS.

Cycle 4 proposals are solicited for targets in Northern Ecliptic Hemisphere fields and Ecliptic Plane fields. Beginning in Cycle 4, all Phase-1 proposals submitted to the TESS Guest Investigator Program will be evaluated following a dual-anonymous peer review process. Proposals must be accordingly prepared following the guidelines in Section 2.2.2 and in the associated "Guidelines for Anonymous Proposals" document.

1. Scope of Program

1.1 Overview

The **Transiting Exoplanet Survey Satellite (**TESS**)** Guest Investigator (GI) Program solicits proposals for the acquisition and analysis of new scientific data from the TESS mission, a NASA Explorer mission that was launched in April 2018 and began science operations in July 2018. Additionally, proposals that support the acquisition and analysis of scientific data from ground-based telescopes are solicited. Such ground-based measurements must directly support the analysis and/or interpretation of TESS scientific data.

The primary mission of TESS **is** ~~was~~ to monitor the brightness of nearby, bright F, G, K, and M stars in order to photometrically search for transiting planets smaller than Neptune. (See Ricker et al., 2015, *Journal of Astronomical Telescopes, Instruments, and Systems*, 1, 014003, for a detailed description). TESS's Extended Mission began in

July 2020. In both the prime and extended missions, TESS targets more than 200,000 stars spread over the celestial sphere with a photometric sensitivity sufficient to permit the detection of transiting planets with a radius less than 2.5 Earth radii. TESS's high-precision, continuous baseline photometric capability is also well suited to time domain astronomy, which includes studies of stellar variability and asteroseismology research, and analyses of both Galactic and extragalactic astrophysical sources.

The lead institution for TESS is the Massachusetts Institute of Technology (MIT), which hosts the Principal Investigator, Dr. George Ricker.

~~TESS will begin extended mission operations in July 2020.~~ Observations associated with the TESS GI Cycle 4 solicitation will be collected from **June** ~~July~~ 2021 until September 2022, covering observing sectors 40–5**5** ~~6~~.

There is no exclusive-use period associated with the data from TESS observations. All data will be made available through the Space Telescope Science Institute's Mikulski Archive for Space Telescopes (MAST) public archive once data processing and validation is complete.

Funding through the NASA TESS GI Program is available only to scientists at U.S. institutions who are identified as the Principal Investigators (PIs). No sub-awards will be made except in the case of Civil Servant Co-Is, who are eligible for direct sub-awards. U.S. based Co-Is on foreign-led proposals do not qualify for funding. Funding for accepted target proposals will be initiated only after the first data collected for the proposed investigation are uploaded to the MAST.

1.2 The TESS Mission

A detailed discussion of the TESS prime and extended missions and their scientific objectives can be found at https://tess.gsfc.nasa.gov. The TESS instrument consists of four wide field-of-view (FOV) cameras, each of which observes a 24x24 square degree field. The cameras are aligned with their fields adjacent, such that the instantaneous field-of-view is 24x96 square degrees.

During Cycle 4, TESS will continue its extended mission and will observe each sector continuously for two spacecraft orbits (2x approximately 14 days), with the boresight of the four-camera array pointed nearly **antisolar for non-ecliptic fields. Data products collected will include** ~~antisolar, obtaining~~ full-frame images (FFIs) every 10 minutes, 2-minute cadence sub-image data for ~**16,000** ~~15,000~~ pre-selected targets within the field, and 20-second cadence sub-images for approximately **600** ~~1000~~ targets awarded through the GI program. As with Cycle 2 Sectors 14–16 **and 24-26**, it may be necessary to off-point several sectors in Cycle 4 to avoid **excessive contamination by stray Earth- and moonlight from** ~~light from the Earth and Moon~~ entering Cameras 1 and 2.

Cycle 4 will observe fields in the Northern Ecliptic Hemisphere and the Ecliptic Plane. A total of **16** ~~17~~ sectors will be observed in Cycle 4. For the Ecliptic Plane fields the boresights of all cameras will be approximately at zero **degrees** ecliptic latitude. **The observing plan for Cycle 4 will be posted at https://tess.gsfc.nasa.gov once finalized.**

1.2.1 *Observing Modes and Data Products*

Data for specific targets are saved onboard and transmitted as "postage stamp" sub**-**images, with an area sufficiently large to accommodate the optimal aperture for the astrophysical target. Extended or very bright objects can be accommodated with more appropriately chosen sub**-**image pixels. Postage stamp observations are collected at either 2-minute or 20-second cadence. Additionally, the full 24x96 square degree field-of-view of all four TESS cameras is collected at 10-minute cadence.

The TESS data are processed with a data reduction pipeline based on software that was developed for the Kepler mission. This pipeline performs pixel-level calibration, background subtraction, aperture photometry, identification and removal of systematic errors, and the search for transit signals in the 2-minute cadence postage stamp data. The calibration corrects for bias level, smear, galactic cosmic rays, flat fielding, dark current, background, and instrument noise.

Data distribution and archival services ~~will be~~ **are** performed through the Mikulski Archive for Space Telescopes (MAST). Final data products available to GI observers include original and calibrated target pixel files, pipeline-produced light curves for each **20-second and** 2-minute cadence postage stamp target, and raw and calibrated images for the FFI data.

Data ~~will be~~ **are** archived in standard FITS formats for images and light curves. TESS light curves produced through the pipeline software are optimized for the detection of small exoplanets. Proposers should be aware that pipeline-generated light curves may not be optimal for all science programs and plan their analyses accordingly.

1.2.2 *Instrumentation and Technical Capabilities*

TESS has neither changeable filters nor dispersing elements. Photometry is taken through a broad bandpass ranging from 600 to ~~>~~1000 nm. There is no hard brightness limit for TESS. Additional details can be found in the Instrument Handbook here: https://archive.stsci.edu/tess/#section-b285b7ac-171e-40e2-a9a4-e813a661fa2d.

The TESS Input Catalog (TIC) is intended to contain most optically-persistent objects in the sky down to the limits of available photometric catalogs, to enable the selection of optimal targets for planet transit searches, and the calculation of flux contamination in the TESS sub**-**image for each target. The TIC has been publicly released (v8**.1**, as of October 20**20** ~~19~~; **this version** ~~these~~ will be superseded by revisions as available) and is searchable via MAST at http://archive.stsci.edu/tess/. The TIC is documented by Stassun et al. (2019; https://ui.adsabs.harvard.edu/abs/2019AJ....158..138S/abstract).

1.3 Permitted Guest Investigator Science

The primary purpose of the TESS GI Program is to enhance and maximize the science return from TESS. The program facilitates and supports investigations using postage stamp observations ~~with TESS~~, research undertaken with ~~the~~ FFIs, and ground-based supporting observations of TESS targets, including radial velocity measurements of TESS exoplanet host stars. Proposals may be a combination of postage stamp target requests, FFI analysis, and ground-based observing support. **If new observations of postage stamp targets are required, they must be included in the target list. No targets are guaranteed to be observed outside of the GI Program**.

The scientific justification of a GI proposal should focus on a compelling investigation that requires the collection of new TESS data or ground-based data that supports the analysis and/or interpretation of TESS data.

The proposed TESS Guest Investigation must clearly enhance the science return of the TESS mission. The proposal may include theoretical components, software development, and/or data simulation that strengthen~~s~~ the proposal, but at least 70% of the work effort should be focused on exploiting new TESS data products, except in the case of ground-based observing focused proposals. **Ground-based observing focused proposals may support the analysis of TESS data collected in Cycle 4 or TESS data already collected in Cycles 1-3.**

Proposed investigations in which the primary emphasis is theory/modeling or archival **analysis of TESS Cycle 1, Cycle 2, and/or Cycle 3 data** ~~(TESS Cycle 1 and/or Cycle 2) data analysis~~ will be non-compliant. The ROSES NASA Research Announcement provides alternative opportunities to exploit or support the TESS mission in these areas:

- Investigations for which the primary emphasis is theory and/or modeling may be proposed to the Astrophysics Theory Program (ATP; Program Element D.4), or the Exoplanet Research Program (XRP; Program Element E.3).
- Investigations for which the primary emphasis is analysis of archival data may be proposed to the Astrophysics Data Analysis Program (ADAP; Program Element D.2), or the Exoplanet Research Program (XRP; Program Element E.3).
- Investigations for which the primary emphasis is the collection and/or analysis of ground-based data may be proposed to the Exoplanet Research Program (XRP; Program Element E.3), or the NSF Astronomy and Astrophysics Research Grants Program (AAG). However, note that PIs are not permitted to submit proposals that are substantively similar to both this call and the XRP.

Proposals that are focused on ground-based observing programs must have a clear science driver and describe how the ground-based component is both feasible and required for analysis and/or interpretation of TESS data. Programs in this category that will collect observations from ground-based facilities contemporaneously with TESS observations are particularly encouraged. Proposals must describe how the funding would be used to support the collection or analysis of new data in support of TESS, including, for example, purchasing telescope time, instrument development, travel to observatories, support for students, etc. Funding awards of all sizes will be considered; the TESS GI Program is expected to award up to $500,000 to ground-based observing programs.

Proposals must clearly describe the plans to make any new software, higher level data products and/or supporting data publicly available. Software developed with TESS GI funds must add value to the TESS science community, be free**ly available**, and **have the source code openly accessible** ~~open source~~. Ground-based data collected with TESS GI funding support must be made publicly available in a timely fashion at either the NASA Exoplanet Science Institute (NExScI) ExoFOP service (https://exofop.ipac.caltech.edu) or as a MAST High-Level Science Product (http://archive.stsci.edu/hlsp/). Other data products created with TESS GI funding support should be archived as a MAST High-Level Science Product (http://archive.stsci.edu/hlsp/).

To foster correlative observations, TESS has established joint observing programs with the Hubble Space Telescope (HST)**, the Fermi Gamma-ray Space Telescope (Fermi),** and the Neil Gehrels Swift Observatory (Swift). Proposals for joint HST observations should be submitted through the HST GO Program**,** and the TESS targets will be recommended by that review. **Proposals for joint Fermi observations may be submitted through the Fermi GI Program, and the TESS targets will be recommended by that review. Funds for selected programs will be awarded from the Fermi project for joint investigations in this case (although the TESS GI Program reserves the right to award funds to joint Fermi-TESS proposals deemed to be of scientific merit).**

The TESS GI Program can also award Swift observations through a joint program with the Swift mission. Observing time under this program will be awarded only to proposals that require use of both observatories to meet the primary science goals. Up to 100 ks of total Swift time will be available through this program. TESS GI funding is available to successful U.S.-based investigators who request Swift observing time through the TESS GI process. No funds will be awarded from the Swift project for joint investigations proposed to this TESS Program element.

1.4 Target of Opportunity Observations

The TESS GI Program recognizes the category of Target of Opportunity (ToO) observations of rapidly evolving phenomena whose occurrence is not predictable at the time of the TESS proposal due date. Due to TESS mission constraints, ToO-triggered target definitions can only be uploaded to the spacecraft for the next observing sector. Details regarding the circumstances in which a ToO is triggered must be included in the scientific justification and on the target form. ToO proposals must also include an estimated probability for triggering the observations; the latter will be used in the accounting of total allocated targets. ToOs remain active during the cycle; ToOs not carried out during the cycle must be re-proposed to subsequent solicitations. ToO observations would commence after the spacecraft upload following a trigger. The impact to science of delays between trigger and data collection of several weeks should be addressed in proposals requesting ToO observations.

1.5 On-source Monitoring Times

The visibility tool on the TESS Science Support Center website **(http://tess.gsfc.nasa.gov/)** should be consulted to estimate the duration of visibility of targets to be proposed.

1.6 Target Lists

Proposals requesting postage stamp targets are required to submit a target list. Targets must be submitted electronically, at the same time as the science proposal, via the **Astrophysics Research Knowledgebase (ARK)** Remote Proposal System (RPS) **website**; https://heasarc.gsfc.nasa.gov/ark/rps/. A definition of each column and a detailed description of the example table can be found at the link to the table template at the TESS Science Support Center website (http://tess.gsfc.nasa.gov/). If a proposed target does not appear in the TIC, the information required to append the target to the TIC must be provided.

2. Programmatic Information

2.1 General Information

$3.4M ~~$3.0M~~ in Cycle 4 is anticipated to be available to U.S.-based PIs through this solicitation for the support of approximately 3**4** ~~6~~ Guest Investigations. The performance period of each award will be 1 year; PIs will be allowed to request a no-cost extension for one additional year as needed. The Cycle 4 GI Program will also include unfunded non-U.S.-based investigations of high merit, as determined by peer review. Additional Guest Investigation targets will be drawn from proposals **in the Mini category (see Section 2.2.1) and from proposals** that are not selected for funding, if target resources permit. Scientists participating in the TESS mission, including members of the Follow-up Team, are permitted to propose to the GI Program and are subject to the same program rules as the rest of the science community.

2.2 Proposal Submission and Evaluation

2.2.1 *Submission of Proposals to the TESS GI Program*

The TESS GI Program uses a two-phase proposal process. All proposal materials will be submitted electronically. A Phase-1 proposal shall comprise the science/technical justification; all proposals must include a one-paragraph work plan in the science/technical section **except for proposals in the Mini category**. This work plan must give details on how the proposed effort will be carried out, including the allocation of effort amongst investigators (expressed in terms of each participant's role in the investigation to preserve the anonymity of the document).

All proposals requesting funds must also provide upon submission a bottom-line budget number in the provided field of the Astrophysics Research Knowledgebase (ARK) RPS submission form; this number should not be included in the body of the proposal. Only proposers whose Phase-1 proposals are accepted will be invited to submit budget proposals in Phase-2. Proposal content must remain consistent between Phase-1 and Phase-2 proposals. It is not necessary for the PI of the Phase-2 proposal to be the science PI.

The Phase-1 peer review will be performed in a "dual-anonymous" manner, i.e., not only are proposers unaware of the identity of the members on the review panel, but the reviewers do not have explicit knowledge of the proposal teams (see Section 2.2.2).

There are three categories of investigations: **Mini,** Small, **and** Large~~, and Key Projects~~. **Mini proposals may request only a small number of targets and are not eligible for funding. A maximum of 1,000 2-minute cadence targets and up to 50 20-second cadence targets may be requested by any single Mini proposal submitted to Cycle 4. Requests for TOOs, joint programs with Swift and Fermi, and ground-based focused programs are not permitted in proposals submitted to the Mini category.**

Awards for the majority of investigations (i.e., focused analysis and/or relatively small numbers of targets) are expected to be capped at approximately **$70,000** ~~$50,000~~. Proposals requiring more complex analysis, specialized software development, or a large number of targets, may require funding substantially above the average award (i.e., up to **$250,000** ~~$200,000~~ range per award). ~~Key Projects are anticipated to be~~

~~large multi-year programs with very broad scopes (up to 27 months and up to $200,000 per year). We anticipate awarding at least one Key Project that proposes many tens of thousands of targets, subject to available slots for targets as well as funding. Key Projects and large~~ **Large** programs are expected to provide additional benefit to the science community beyond publishing scientific papers (e.g. software releases, value-added data products, etc.). Such proposals will need to provide a compelling justification for the higher funding level. Approximately **$2.9** ~~$2.5~~ million will be available to support standard Small~~,~~ **and** Large~~, and Key Projects~~ **programs**. **Investigations focused on the analysis of archival TESS data from Cycles 1, 2 and/or 3 are not compliant with this solicitation and should be submitted to the next ROSES Astrophysics Data Analysis Program (ADAP; D.2) or the Exoplanet Research Program (XRP; E.3).**

Another **~**$500,000 ~~is anticipated to~~ **will** be available to programs that focus on ground-based observing. Ground-based focused proposals should be identified in ARK/RPS as such and will be reviewed in a panel separately from other proposals submitted to the TESS GI Program. ~~All size programs are encouraged, and p~~ **P**roposers should identify their program as a Small or Large program, **Mini programs are not permitted in this category**. Proposers of ground-based TESS investigations may not submit ~~the same proposal, in part or in full,~~ to the ROSES Exoplanet Research Program (XRP; E.3) **a proposal that would violate the prohibition on duplicate proposals in Section 2 of D.1, the Astrophysics Research Program Overview**.

Mini proposals are limited to no more than 2 pages for the science/technical section. For Small proposals, the ~~The~~ science/technical section must not be more than 4 pages~~ for Small proposals~~. Large proposals ~~and Key Projects~~ are allocated an additional page within the science/technical section to describe the benefits that the program will provide to the science community.

The amount of the anticipated funding request must be entered into the box provided for this purpose on the **ARK/**RPS Cover Form. The detailed cost evaluation will be deferred until Phase-2. The funding amount requested in the Phase-2 cost proposal may not exceed the amount proposed in Phase-1.

The generic instructions for the submission of ROSES proposals are given in Table 1 of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers.* TESS GI Proposers should follow generic instructions, except where they are overridden by more specific guidance given in the *ROSES Summary of Solicitation* or in this Program Element (see for example Section I(g) of the *ROSES Summary of Solicitation*). Proposers to the TESS GI Program must adhere to the following proposal submission procedures:

- All Proposers must submit their Phase-1 proposals electronically through the Astrophysics Research Knowledgebase (ARK) Remote Proposal System (RPS) website at https://heasarc.gsfc.nasa.gov/ark/rps/. Instructions for doing so will be provided at the TESS Science Support Center web site (http://tess.gsfc.nasa.gov/);
- Target tables for all observation proposals are to be submitted through ARK/RPS;
- The Scientific/Technical/Management section of proposals is limited **to two pages for Mini programs,** four pages for Small programs and five pages for Large **programs** ~~and Key Projects~~, instead of the default 15 pages specified in the *NASA*

Guidebook for Proposers. The requirement for a table of contents in the body of the proposal is waived. **References are not included in the page limits.**

- No supporting material (e.g., Curriculum Vitae, pending/current support) is required or allowed other than what is specified in the supplemental documentation concerning the dual-anonymous review procedure.
- Optional Latex and MS Word templates for the Scientific/Technical/Management section will be provided on the TESS Science Support Center web site **(http://tess.gsfc.nasa.gov/)** ~~https://heasarc.gsfc.nasa.gov/docs/tess/~~;
- **For Small and Large programs,** the Scientific/Technical/Management section must include a **minimum of** one paragraph describing the work plan **(expressed in terms of each participant's role in the investigation to preserve the anonymity of the document)**. Investigators who are proposing to continue a program that was selected for funding in one or more previous cycles are no longer required to justify continuation of the program in their Phase-1 proposal. **Mini programs do not require a work plan.** ~~Instead, that justification will be requested as part of the Phase-2 proposals.~~

The Scientific/Technical/Management section must be uploaded to the ARK/RPS website as a PDF file. Proposals from non-U.S. institutions are acceptable and will only be considered on a no-exchange-of-funds basis. Non-U.S. proposals will be reviewed to the same standards as proposals from U.S. institutions and selected solely by NASA.

All proposal materials must be submitted electronically by 4:30 pm Eastern time on the due date for this program given in Tables 2 and 3 of ROSES to be included in the proposal review for this cycle of the TESS GI Program. Note that the 4:30 pm deadline supersedes the default deadline stated in the *Guidebook for Proposers* and in the *ROSES Summary of Solicitation.*

2.2.2 *Specific Instructions for Dual-Anonymous Peer Review Phase-1 Proposals*

The overarching objective of dual-anonymous peer review is to reduce unconscious bias in the evaluation of the merit of a proposal. Under this system, not only are proposers unaware of the identity of the members on the review panel, but the reviewers do not have explicit knowledge of the proposal teams.

Proposers should consult the "Guidelines for Anonymous Proposals" document in the "Other Documents" section on the NSPIRES of this program element for instructions on writing proposals appropriate for dual-anonymous peer review. The instructions here and in that document supersede the default instructions given in the *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation.* Proposers will also be required to upload a separate "Expertise and Resources - Not Anonymized" document, which is not anonymized. The "Guidelines for Anonymous Proposals" document contains complete information on how to write this separate document.

In order to meet the objectives of dual-anonymous peer review, review panels will be instructed to evaluate the anonymized proposals based on their scientific merit, without initially taking into account the proposing team qualifications. As a final check, and only after the scientific evaluation is finalized for all proposals, the panel will be provided with the "Expertise and Resources - Not Anonymized" documents. The panel will validate

the qualifications of the team in order to allow the reviewers to assess the team capabilities required to execute a given proposed science investigation.

A summary of the key factors for PIs to keep in mind are:

- Proposals should eliminate language that identifies the proposers or institutions, as discussed in the Guidelines for Anonymous Proposals.
- PIs are required to upload a one-page "Expertise and Resources – Not Anonymized" PDF through ARK as a separate upload when submitting the **anonymized Scientific/Technical/Management section** ~~science justification~~. This document must not be anonymized.
- NASA understands that dual-anonymous peer review represents a major shift in the evaluation of General Observer / General Investigator proposals, and as such there may be occasional slips in writing anonymized proposals. However, NASA reserves the right to return without review proposals that are particularly egregious in terms of the identification of the proposing team.

A summary of the key requirements for preparing anonymized Phase-1 proposals is provided in the table below. **Additional information may also be found on the web at: https://science.nasa.gov/researchers/dual-anonymous-peer-review.**

Table 1. Phase-1 Dual-Anonymous Peer Review Preparation

Item	Requirement
Anonymization	Phase-1 proposals are anonymized. Phase-2 (cost) proposals are not anonymized.
Submission	Phase-1 proposals are submitted through ARK/RPS. Phase-2 (cost) proposals are submitted through NSPIRES.
References	References should be in the [1], [2] format.
Work plan	Include an anonymized one-paragraph work plan in the main body of the Phase-1 proposal.
Proposal length	No change.
Separate "Expertise and Resources - Not Anonymized" document	This document provides a list of all team members, their roles, expertise, and contributions to the work. The document should also discuss any specific resources that are key to completing the proposed work.

2.2.3 *Evaluation of Phase-1 Proposals submitted to the TESS GI Program*

Proposals will be evaluated by a peer evaluation panel with respect to Relevance and Merit, as defined in Appendix D of the *NASA Guidebook for Proposers*. The evaluation of intrinsic merit of a proposal shall include:

- The suitability of using new TESS data products for the proposed investigation (not applicable for ground-based observing focused programs, although ground-based programs should make clear the need for ground-based data in order to analyze or interpret TESS data);
- The extent to which the investigation complements and enhances the anticipated science return from the TESS mission;

- The degree to which the proposed investigation places demands upon mission resources; and
- The degree to which the proposed investigation capitalizes on the unique capabilities of TESS.

Where appropriate, proposals should make clear why the proposed investigation cannot be performed using only archival TESS data.

2.2.4 *Submission and Evaluation of Phase-2 proposals*

Subject to the availability of funding, successful Phase-1 proposers will be contacted by the TESS Program Scientist and invited to submit a budget proposal in Phase-2. Upon notification of selection of a Phase-1 proposal, a proposer must respond as follows:

Follow the instructions for submitting a Phase-2 proposal given in the selection notification from the Phase-1 review. Phase-2 proposals must be submitted through the NASA NSPIRES electronic proposal website (https://nspires.nasaprs.com/) by an Authorized Organizational Representative (AOR) of the proposing organization. The budget proposal will consist of Budget Details (maximum of two pages) section and a Narrative section (maximum of two pages).

NASA program personnel will evaluate the Phase-2 cost proposals for cost reasonableness and compare the proposed cost to available funds and consistent with Section VI(a) of the *ROSES Summary of Solicitation.* Note that since the Phase-2 proposals will not be peer reviewed, the requirement to redact the budget information (per Section IV(b)(iii) of the *Summary of Solicitation*) is waived. All costs must be included in the proposal. Proposers should note that Phase-2 (cost) proposals should not be anonymized.

2.3 Supplemental Information

Further details concerning the proposal submission requirements and process can be found at http://tess.gsfc.nasa.gov/, the TESS Science Support Center website. This website provides a detailed mission description; technical information about the TESS mission, instrument, and observation feasibility; and instructions for completing the required proposal forms. The Web TESS Viewing Tool found at the TESS Science Support Center website (http://tess.gsfc.nasa.gov/) also provides the capability to see when user-provided TESS targets will be observed and to get estimated TESS magnitudes and photometric precisions for point sources.

3. Summary of Key Information

Expected program budget for first year of new awards	**$3.4M** ~~$3.0M~~ with $500,000 anticipated to be awarded to ground-based observing focused programs.
Number of new awards pending adequate proposals of merit	~**34** ~~36~~ (made up of approximately ~~1 Key Project~~, 6 large programs and 28 small programs).
Maximum duration of awards	**1 year.** ~~2 years (large and small programs), 27 months (Key Projects)~~

Due date for Phase-1 proposals	4:30 pm on the due date given in Tables 2 and 3 of ROSES.
Planning date for start of investigation	Cycle 4 observations are expected to start in June 2021. Funding will be released to the PI when the first data collected for the proposed investigation are uploaded to the MAST. The earliest such date is approximately August 2021.
Page limit for Phase-1 proposals	**2 pages for Mini programs,** 4 pages for Small programs and 5 pages for Large programs ~~and Key Projects~~. See Section 2.2.1 for details. See Section 2.2.2 for Guidelines for preparing proposals for Anonymous Reviews.
Relevance	This program is relevant to the Astrophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of Phase-2 proposals	Select proposers will be invited to submit a Phase-2 proposal via NSPIRES. See Section 2.2.4.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of Phase-1 proposal and required forms	https://heasarc.gsfc.nasa.gov/ark/rps/ (Help Desk available at http://heasarc.gsfc.nasa.gov/ark/rps/help/)
Web site for submission of Phase-2 proposals	http://nspires.nasaprs.com; See Section 2.2.4
Programmatic information may be obtained from the TESS Program Scientist	Douglas M. Hudgins Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0988 Email: Douglas.M.Hudgins@nasa.gov
Technical questions concerning this program element may be directed to the TESS Guest Investigator Program	Thomas Barclay Code 667 Goddard Space Flight Center National Aeronautics and Space Administration Greenbelt, MD 20771-0001 Email: thomas.barclay@nasa.gov

D.11 NICER GUEST OBSERVER – CYCLE 3

NOTICE: Amended August 17, 2020. This Amendment releases final text for this program element. The due date for Phase-1 proposals has changed; Phase-1 proposals are due by 4:30pm Eastern Time November 17, 2020 (via ARK/RPS). Major changes since the last cycle include:

- **Beginning in Cycle 3, all Phase-1 proposals submitted to the NICER Guest Observer Program will be evaluated following a dual-anonymous peer review process. Proposals must be prepared following the guidelines in Section 2.2.2 and in the associated "Guidelines for Anonymous Proposals" document.**
- **Clarification of language describing multi-year investigations and requests for joint NuSTAR time.**

1. Scope of Program

1.1 Overview

The Neutron Star Interior Composition Explorer (NICER) is an X-ray experiment on the International Space Station dedicated to high-resolution timing and spectroscopy of neutron stars and other rapidly variable X-ray sources in the 0.2-12 keV band. NASA is issuing this call for Cycle 3 of the NICER Guest Observer (GO) program. Proposals for observations with NICER addressing all areas of astrophysics are solicited, with 7 Ms of available time and a limited amount of funding available in Cycle 3.

Proposers also have the opportunity to request coordinated NuSTAR observations of their proposed NICER targets. A total of up to 400 ks of NuSTAR observing time is available within this Cycle.

Proposals will be submitted in two stages, with Phase-1 focusing on the science goals and observation parameters. Selected Phase-1 proposers will be invited to submit a budget for Phase 2. Proposers may request, and must justify, an exclusive-use period of up to 6 months for GO data in this Cycle; by default, data will be subject to the existing NICER data-release policy (validated data are made available in the public HEASARC archive within two weeks of acquisition), with no exclusive-use period.

1.2 The NICER Mission

NICER is a Principal Investigator (PI)-led NASA Mission of Opportunity in the Astrophysics Explorers Program. The PI institution is NASA's Goddard Space Flight Center, which is responsible for the overall direction of the program and the project management. Science partners include the Massachusetts Institute of Technology (MIT) Kavli Institute. The NICER Science and Mission Operations Center (SMOC) is located at NASA’s Goddard Space Flight Center. Proposers are reminded that Section III (c) of the *ROSES Summary of Solicitation* covers rules concerning foreign participation, as well as certain restrictions concerning the bilateral participation, collaboration, or coordination with China or any Chinese-owned entity.

NICER was launched aboard a SpaceX Falcon 9 rocket to the International Space Station (ISS) on June 3, 2017, and is installed externally on ISS, ExPRESS Logistics

Carrier 2, site 7 (starboard). It offers active pointing over nearly the full hemisphere about the zenith direction.

NICER was designed to perform high time-resolution and spectroscopic observations in the 0.2–12 keV energy range to study the physics of ultra-dense matter in the cores of neutron stars. It carries an X-ray Timing Instrument (XTI) that employs concentrator optics and detectors to register X-ray photon energies and times of arrival. The XTI is a non-imaging instrument that collects X-rays from within a single 6 arcmin (FWHM) field of view. NICER science data consist of photon energies and detection times.

NICER's XTI is an assembly of 56 X-ray concentrators (XRC) and detectors, of which 52 are functional on orbit. NICER's pointing system enables XTI to track and slew between targets over nearly 2π steradians. Each XRC collects photons over a large (~40 cm^2) effective geometric area from a ~30 $arcmin^2$ patch of sky, and focuses them onto small silicon drift detectors (SDDs). Together, this assemblage provides a photon counting capability with large effective area, high time resolution, moderate energy resolution, high throughput, and relatively low background.

SDDs offer energy resolution typical of silicon-based detectors, approaching the Fano limit. The XTI on-orbit performance is better than ~150 eV energy resolution at 6 keV and ~80 eV at 1 keV. The payload-level photon time-stamping uncertainty is less than 100 nsec RMS. NICER's event background is dominated below 2 keV by the diffuse cosmic X-ray background (0.3 cts/sec over the 31.5 $arcmin^2$ non-imaging field of view at high Galactic latitudes), and by unrejected particle background at higher energies (~0.1 cts/sec/keV across the NICER passband). Table 1 of this element directly below summarizes the most important NICER characteristics for proposal preparation.

Table 1: Key NICER Performance Parameters

Parameter	Value
Energy range	0.2–12 keV
Non-imaging angular resolution (HPD)	6.3 arcmin
Energy resolution at 1 keV	~ 80 eV
Energy resolution at 6 keV	~ 150 eV
Sensitivity (0.5–10 keV) (10^4 s, 5σ)	1×10^{-13} erg cm^{-2} s^{-1}
Background (0.25–10 keV)	~ 1 counts s^{-1} (typical)
Temporal resolution	< 100 ns RMS (absolute)
Target of opportunity response	Within 4 hours during regular business hours; otherwise, within 72 hours
Slew rate	1° s^{-1}
Minimum Sun angle	60º, for optimal XTI performance. Targets may be observed between 45º and 60º from the Sun, but with some degradation of spectral and timing performance.

Details of the NICER payload and instrument design can be found at the NICER documentation web page (https://heasarc.gsfc.nasa.gov/docs/nicer/nicer_docs.html)

and the NICER mission paper (Gendreau, K.C., et al. 2016, Proc. SPIE 9905, download PDF file). Simulated NICER count rates and spectra can be derived using the WebPIMMS and WebSPEC tools.

Please note that investigations making use of the Station Explorer for X-ray Timing and Navigation Technology (SEXTANT) algorithm are not supported by this call.

1.3 Available GO Time and Visibility Constraints

The expected total amount of observing time available for Cycle 3 of the NICER GO program is 7 Ms. Proposed NICER observations may span both Cycles 3 and 4 (March 1, 2021 – February 28, 2023), but requests for observations extending beyond the end of Cycle 3 in February 2022 must be scientifically justified. NICER observations that extend beyond September 30, 2022, will be contingent on mission extension via the Senior Review process. Proposals may only request joint NuSTAR observations during Cycle 3.

It is anticipated that approximately 50 GO observing programs will be selected for NICER Cycle 3, depending on the proposed exposure times. The remaining observing time will be used for multi-year GO observations from Cycle 2, legacy science, PI discretionary time, Targets of Opportunity (ToOs), unanticipated science not covered by the GO program, and calibration and background observations. A short-term schedule of planned NICER observations can be found at https://heasarc.gsfc.nasa.gov/docs/nicer/schedule/nicer_sts_current.html.

Accepted targets will be designated as Category A, B, or C. Assuming nominal operational efficiency, we anticipate that all Category A and B observations will be executed during Cycle 3. Category C observations will be completed on a best-effort basis.

Proposers should be aware that ISS structure, orbit inclination (51.6°) and altitude (approximately 250 miles), together with Sun/Moon/Earth avoidance criteria, impose significant target visibility constraints, allowing uninterrupted exposures of at most 2.4 ks per 92-minute ISS orbit, but typically half that amount. Guest observers should request total exposure times necessary for the proposed science goals, excluding observational efficiency factors (e.g., Earth occultations and South Atlantic Anomaly passages) in their calculations, unless there is a specific reason why the elapsed time of an observation is important.

Proposals are subject to the following limitations:

- Proposals requesting time-constrained observations must have designated Category A targets in order to guarantee scheduling (see Section 1.3.1).
- Proposals requesting coordinated observations with other space- or ground-based facilities will be considered time-constrained and subject to the restrictions described in Section 1.3.1.

1.3.1 *Time-Constrained Observations*

Time-constrained observations are defined as observations that must be performed within a certain time window. This includes, for example, orbit phase-constrained

requests and coordinated observing campaigns with ground-based or space-based facilities. Time-constrained observations are subject to the following limitations:

- Time-constrained targets must be designated as Category A to guarantee scheduling. Time-constrained observations in Categories B and C will be executed on a best-effort basis.
- NICER's flexibility affords a wide range of monitoring projects. Targets can be observed multiple times per day, week, month, etc. Proposed observing plans should use common sense in requesting closely-spaced observations, consistent with typical target visibilities of 1-2 ks in each of 16 orbits per day. The cadence of closely-spaced observations cannot be guaranteed.
- Proposers should take note of any constraints associated with NuSTAR monitoring; specifically, the minimum 20 ks NuSTAR exposure time requirement for each visit (see Section 1.3.3).

For coordinated and constrained observations, it is the proposer's responsibility to inform the NICER SMOC of the observing time windows at the earliest possible opportunity, preferably 1-2 weeks before observations start. Where observations involve coordination with other space-based observatories, the NICER SMOC will be responsible for communicating detailed schedule constraints with the relevant operations team.

1.3.2 *ToO Observations*

ToO proposals of both known and unknown targets (e.g., "the next black-hole transient") will be accepted through this NICER Cycle 3 call for proposals. Whether proposed as a GO project or not, ToO requests will be considered by the NICER project through a submission process found at https://heasarc.gsfc.nasa.gov/docs/nicer/.

1.3.3 *Joint NuSTAR observations*

Combined NICER and NuSTAR observations are a powerful diagnostic of high-energy sources, in the total energy range 0.2–79 keV. NuSTAR has made up to 400 ks available to NICER Cycle 3 proposers who want to take advantage of this opportunity. Proposals requesting NuSTAR coordinated observations must demonstrate the unique value of adding NuSTAR exposures for the proposed science and present a detailed feasibility case in its support. Joint observations with NuSTAR must be designated as Category A or B to be approved for observations in Cycle 3. Each target for which NuSTAR time is requested must also have an associated NICER time request.

The requested NuSTAR exposure time per observation (i.e., a single visit to a target) is constrained to a minimum of 20 ks and the time interval between successive visits must be $\geq$ 14 hours. Sources with fluxes $>10^{-11}$ ergs s^{-1} cm^{-2} within 5° of the target may cause increased nonuniform background gradients due to stray light. Users should check observations for potential stray light contributions using the tools available at http://nustar.caltech.edu/page/researchers. If a field is designated as heavily contaminated, proposers should submit a request for a feasibility analysis to nustar-help@srl.caltech.edu at least two business days prior to the proposal submission deadline.

NuSTAR observations of high count-rate targets (>50 cps/NuSTAR focal-plane module) require special planning and increased downlink capacity. High count-rate observations of duration >30 ks are difficult and can be accepted only if well motivated. High count-rate observations longer than 75 ks will be considered only if the total requested time is distributed in multiple observations, each with exposure time <75 ks and separated by more than 1 week.

Proposers should carefully review NuSTAR technical documentation available from the NuSTAR websites: http://nustar.caltech.edu and https://heasarc.gsfc.nasa.gov/docs/nustar/nustar_prop.html.

2. Programmatic Information

2.1 General Information

It is anticipated that limited funding will be available through this program element for the support of Guest Observations (see Section 3 table). Only proposals with Category A and B targets will be eligible for funding. Award funding will depend on the analysis complexity and total awarded observing time. NICER GO funding is open to all individuals who are identified as Principal Investigators and employed at U.S. institutions, including NICER science team members. Note that GO proposals that would support those who already receive NICER funding must clearly demonstrate that the proposed investigation is not redundant with their science team responsibilities.

Grant budgets will be invited as Phase-2 proposals in response to selected Phase-1 Cycle 3 proposals. It is anticipated that up to 50 GO grants will be awarded through this program. Proposals by non-U.S. PIs will not be eligible for funding. In addition, some U.S. PI-led proposals may be allocated observing time, but not be invited to submit grant budget requests. NASA does not anticipate awarding contracts in response to proposals submitted to this program element, because it would not be appropriate for the nature of the work solicited.

2.2 Proposal Submission and Evaluation

2.2.1 *Submission of Proposals to the NICER GO Program*

The NICER GO program uses a two-phase proposal process. A Phase-1 proposal shall comprise the science/technical justification. Only proposers whose Phase-1 proposals are accepted will be invited to submit budget proposals in Phase 2. The Phase-2 proposals must include a budget narrative describing, in sufficient detail, how the proposed funds will be used to achieve the goals outlined in the proposal. It is nominally expected that the PI of the Phase-1 proposal will serve as the Phase-2 proposal PI; however, for administrative purposes, an alternate individual from the Phase-1 PI's institution may serve as PI on the Phase-2 proposal. All proposal materials shall be submitted electronically.

The Phase-1 peer review will be executed in a "dual-anonymous" fashion, where not only are proposers unaware of the identity of review panel members, but the reviewers do not have explicit knowledge of the proposal teams (see Section 2.2.2).

Proposers to the NICER GO Program must adhere to the following proposal submission procedures:

- All Proposers must submit their Phase-1 proposals electronically through the ARK/RPS website at http://heasarc.gsfc.nasa.gov/ark/rps/;
- Target forms for all observation proposals are to be submitted through ARK/RPS;
- Due to the nature of prospective investigations within the NICER GO program, the Scientific/Technical/Management section of proposals is limited to four pages, instead of the default 15 pages specified in the *NASA Guidebook for Proposers*. The requirement for a table of contents in the body of the proposal is waived.
- No supporting material (e.g., Curriculum Vitae, pending/current support) is required or allowed other than what is specified in the supplemental documentation concerning the dual-anonymous review procedure.
- The Scientific/Technical/Management section must be uploaded to the ARK/RPS website as a single PDF file.
- Proposers are reminded that Section III (c) of the *ROSES Summary of Solicitation* covers rules concerning foreign participation, as well as certain restrictions concerning the bilateral participation, collaboration, or coordination with China or any Chinese-owned entity.

All proposal materials must be submitted electronically by 4:30 p.m. Eastern time on the due date for this program in order to be included in the proposal review for this cycle of the NICER GO program.

LaTeX and MS Word templates are available for download at https://heasarc.gsfc.nasa.gov/docs/nicer/ to aid in the preparation of Phase-1 proposals. No supporting material (e.g., CV, pending/current support) will be considered for Phase 1. Page limits include figures and references. These instructions supersede any given in the ROSES NRA and/or the *NASA Guidebook for Proposers*.

Proposers who are granted multi-year investigations will be requested to submit one-year budget proposals in both Cycle 3 and Cycle 4.

2.2.2 *Specific Instructions for Dual-Anonymous Peer Review Phase-1 Proposals*

The overarching objective of dual-anonymous peer review is to reduce unconscious bias in the evaluation of the merit of a proposal. Under this system, not only are proposers unaware of the identity of the members on the review panel, but the reviewers do not have explicit knowledge of the proposal teams.

Proposers should consult the "Guidelines for Anonymous Proposals" document in the "Other Documents" section on the NSPIRES page of this program element for instructions on writing proposals appropriate for dual-anonymous peer review. The instructions here and in that document supersede the default instructions given in the *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation.* Proposers will also be required to upload a separate "Expertise and Resources - Not Anonymized" document, which is not anonymized. The "Guidelines for Anonymous Proposals" document contains complete information on how to write this separate document.

In order to meet the objectives of dual-anonymous peer review, review panels will be instructed to evaluate the anonymized proposals based on their scientific merit, without initially taking into account the proposing team's qualifications. As a final check, and

only after the scientific evaluation is finalized for all proposals, the panel will be provided with the "Expertise and Resources - Not Anonymized" documents. The panel will validate the qualifications of the team in order to allow the reviewers to assess the team capabilities required to execute a given proposed science investigation.

A summary of the key factors for PIs to keep in mind are:

- Proposals should eliminate language that identifies the proposers or institutions, as discussed in the Guidelines for Anonymous Proposals.
- PIs are required to upload a one-page “Expertise and Resources – Not Anonymized” PDF through ARK as a separate upload when submitting the science justification. This document must not be anonymized.
- NASA understands that dual-anonymous peer review represents a major shift in the evaluation of Guest Observer / Guest Investigator proposals, and as such there may be occasional slips in writing anonymized proposals. However, NASA reserves the right to return without review proposals that are particularly egregious in terms of the identification of the proposing team.

A summary of the key requirements for preparing anonymized Phase-1 proposals is provided in the table below. Additional information may also be found on the web at: https://science.nasa.gov/researchers/dual-anonymous-peer-review.

Item	Requirement
Anonymization	Phase-1 proposals are anonymized. Phase-2 (cost) proposals are not anonymized.
Submission	Phase-1 proposals are submitted through ARK/RPS. Phase-2 (cost) proposals are submitted through NSPIRES.
References	References should be in the [1], [2] format.
Work plan	Include an anonymized one-paragraph work plan in the main body of the Phase-1 proposal.
Proposal length	No change.
Separate "Expertise and Resources - Not Anonymized" document	This document provides a list of all team members, their roles, expertise, and contributions to the work. The document should also discuss any specific resources that are key to completing the proposed work.

2.2.3 *Evaluation of Proposals submitted to the NICER GO Program*

Phase-1 proposals will be evaluated by a peer evaluation panel with respect to the Merit and Relevance criteria specified in Section VI(a) of the *ROSES Summary of Solicitation*, where it is understood that the merit of a proposal shall include the following factors:

- The suitability of using the NICER observatory and data products for the proposed investigation;
- The degree to which the proposed observations place demands upon NICER mission resources; and

- The degree to which the proposed observation capitalizes on the unique capabilities of NICER.

2.2.4 *Additional Proposal Constraints and Requirements*

GO proposals for targets with existing or planned NICER observations must justify why additional data are warranted. Proposers are strongly encouraged to familiarize themselves with the content of the NICER data archive; the onus is on the proposer to demonstrate that their proposed project does not significantly duplicate the goals of past or current NICER science investigations.

Proposers who wish to acquire coordinated NuSTAR exposures with their proposed NICER observations must demonstrate in the proposal the value of adding NuSTAR data, and present a detailed feasibility study of the combined observations. Proposers must check the appropriate box in the ARK/RPS submission form requesting coordinated NuSTAR time.

2.2.5 *Submission and Evaluation of Phase-2 Proposals*

Subject to the availability of funding, successful Phase-1 proposers will be contacted by the NICER Program Officer and invited to submit a cost proposal as their application for Phase-2. Upon notification of selection of a Phase-1 proposal, a proposer must respond by following the instructions for submitting a Phase-2 proposal given in the selection notification from the Phase-1 review. Phase-2 (cost) proposals must be submitted through NSPIRES by an Authorized Organizational Representative of the proposing institution according to the instructions in the *Summary of Solicitation* of this NRA. The cost proposal will consist of a Budget Details section (maximum of two pages) and a Narrative section (maximum of two pages) with a detailed justification of all proposed items for funding.

NASA program personnel (as opposed to peer reviewers) will evaluate the Phase-2 cost proposals for cost reasonableness and will also compare the proposed cost to available funds as allowed by Section VI(a) of the *ROSES Summary of Solicitation*. Subject to the conditions stated above, proposers will be notified regarding the award amount for their Cycle 3 investigation(s) by NASA upon completion of the Phase-2 review process.

Note that since the Phase-2 proposals will not be peer reviewed, the requirement to redact the budget information (per Section IV(b)(iii) of the *Summary of Solicitation*) is waived. All costs must be included in the proposal. Proposers should note that Phase-2 (cost) proposals should not be anonymized.

2.3 Supplemental Information

Further details concerning NICER, proposal requirements, and the submission process can be found at the NICER website (https://heasarc.gsfc.nasa.gov/docs/nicer/). NICER data are archived at the HEASARC (https://heasarc.gsfc.nasa.gov) in the standard (OGIP/HEASARC) high-energy FITS file formats. Supporting software, in the form of mission-specific FTOOLS (the NICERDAS package within HEASoft), is available through the HEASARC.

NuSTAR simulation tools and additional technical information may be found at https://heasarc.gsfc.nasa.gov/docs/nustar/nustar_prop.html.

3. Summary of Key Information

Expected total program budget for new awards.	~$1.5M. See Section 2.1.
Number of new awards pending adequate proposals of merit	~50. See Section 2.1.
Period of performance of the award	1 year
Due date for Notice of Intent to propose (NOI)	Option not available.
Due date for Phase-1 proposals	4:30 p.m. Eastern time on the date given in Tables 2 and 3 of this ROSES solicitation via ARK/RPS, see Section 2.2.1.
Planning date for start of investigation	Four months after Phase-1 proposal submission.
Page limit for Phase-1 proposals	4 pages. See Section 2.2.1 for details. See Section 2.2.2 for Guidelines for preparing proposals for Anonymous Reviews.
Relevance	This program is relevant to the Astrophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook and additional information in Section 2.2
Submission medium	Electronic proposal submission is required in PDF format; no hard copy is required or permitted.
Web site for submission of Notice of Intent to propose	Option not available.
Web site for submission of Phase-1 proposal and required forms	https://heasarc.gsfc.nasa.gov/ark/rps/ Phase-1 proposals may not be submitted via NSPIRES or grants.gov.
Programmatic information may be obtained from the NICER Program Officer	Daniel A. Evans Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-3882 Email: Daniel.A.Evans@nasa.gov

Technical questions concerning this program element may be directed to the NICER Guest Observer Program	Keith Gendreau, NICER PI Code 662 Goddard Space Flight Center National Aeronautics and Space Administration Greenbelt, MD 20771-0001 Telephone: (301) 286-6188 Email: Keith.C.Gendreau@nasa.gov

D.12 X-RAY IMAGING AND SPECTROSCOPY MISSION GUEST SCIENTIST PROGRAM

NOTICE: June 30, 2020. This program element, which was TBD, will not be solicited in ROSES this year. The XRISM Performance Verification phase targets are now expected to be selected and announced during the 2021 calendar year, so this Guest Scientist program will be solicited as an element of ROSES-2021.

1. Scope of Program

The Japan Aerospace Exploration Agency (JAXA) X-Ray Imaging and Spectroscopy Mission (XRISM), which is expected to launch in early 2022, will bring spectacular advances in our understanding of the high-energy universe. The objective of the XRISM Guest Scientist (XGS) program element of ROSES-2020 is to enhance the scientific return during the Performance Verification (PV) phase of XRISM by opening the opportunity to participate in the analysis of data collected on individual targets during the XRISM PV phase to U.S.-based scientists who are not members of the NASA-appointed instrument team. Following the selection of PV-phase targets, this ROSES-2020 element will be amended and clarified to list the PV-phase targets, provide a due date for proposals solicited through the XGS program, and describe the process and criteria used in their evaluation.

2. Point of Contact

Point of contact concerning this program	Valerie Connaughton XRISM Program Scientist Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1763 Email: valerie.connaughton@nasa.gov

D.13 ASTROPHYSICS EXPLORERS U.S. PARTICIPATING INVESTIGATORS

NOTICE: Amended June 3, 2020. This amendment presents the due dates for this program element. Notices of Intent (NOI) are mandatory. Proposals that are not preceded by an NOI will be returned without review. Mandatory NOIs are due August 3, 2020 and proposals are due September 15, 2020.

In lieu of a Data Management Plan, a Data Archiving Plan is required as an integral part of the Science/Technical/Management Section of the proposal and will be evaluated as part of merit (see Section 2.2).

1. Scope of Program

1.1 Introduction

This ROSES program element for Astrophysics Explorers U.S. Participating Investigators (APEX USPI) solicits proposals for Astrophysics Explorers investigations in which investigators participate as a Co-Investigator (Co-I) for an instrument, experiment, or technology demonstration that is being built and flown by a sponsor agency other than NASA. This is not the same as the solicitation for Partner Missions of Opportunity solicited in 2019 through the Program Element Appendix (PEA) O of the Third Stand-Alone Missions of Opportunity Notice (SALMON-3). Investigations requiring the provision of flight hardware are not solicited through this USPI program element. However, proposers should note that NASA does not plan to select both a Partner Mission of Opportunity and a USPI team for the same mission.

Proposals submitted in response to this program element must comply with the default requirements in the *ROSES Summary of Solicitation* except where superseded by D.1 *Astrophysics Research Program Overview* or this Astrophysics Explorers USPI program element. Proposals submitted in response to this program element should not comply with the requirements in the SALMON-3 AO.

There is no separate NASA budget for Explorers USPIs; all selections will be funded from the same Explorers future mission budget as Explorers mission and Mission of Opportunity selections.

1.2 Background

One of NASA's strategic objectives is to discover how the universe works, explore how it began and evolved, and search for life on planets around other stars. Further information on NASA's strategic goals may be found in the *NASA 2018 Strategic Plan*.

The NASA Science Mission Directorate (SMD) addresses this strategic objective by conducting astrophysics investigations designed to address the following science goals:

- Probe the origin and destiny of our universe, including the nature of black holes, dark energy, dark matter, and gravity;
- Explore the origin and evolution of the galaxies, stars, and planets that make our universe; and,
- Discover and study planets around other stars and explore whether they could harbor life.

Further information on the goals and objectives of NASA's astrophysics programs may be found in the *NASA 2018 Strategic Plan*, the SMD Science Plan and in *Enduring Quests Daring Visions, NASA Astrophysics in the Next Three Decades*.

1.3 Science and Program Objectives

NASA solicits proposals for Explorers USPI investigations that address any astrophysics objective as outlined in Section 1.2 of this program element. Investigations that address NASA goals in other areas, such as Earth science, planetary science, or heliophysics, are not solicited in this program element.

2. Programmatic Considerations

Notices of Intent (NOI) to propose are mandatory. Proposals that are not preceded by an NOI by the due date given in Section 3 will be returned without review.

2.1 Proposal Requirements and Constraints

2.1.1 *Type of Investigation*

A proposed investigation as a U.S. Participating Investigator on a non-NASA space mission may be as a Co-I for an instrument, experiment, or technology demonstration that is being built and flown by a sponsor agency other than NASA. The Co-I role may include, but is not limited to, instrument design, modeling and simulation of the instrument's operation and measurement performance, calibration of the instrument, scientific analysis and/or research of the data returned, and/or development of innovative data analysis techniques. A U.S. Participating Investigator may also serve as a member of a non-NASA space mission science or engineering team and participate in science team activities, such as mission planning, mission operations, data processing, data analysis, and data archiving.

Regardless of the nature of the U.S. Participating Investigator role, an investigation proposed under this category must be for a science investigation, must include some meaningful data analysis component and archiving of the data for use by the U.S. science community (see below), and must result in the publication of science results in the peer reviewed literature. All aspects of the investigation through publication must be within the proposed cost.

Proposed investigations must include plans for archiving data such as raw data, reduced data (Level 2), instrument calibration data, observation geometry ancillary data, and derived products at an appropriate NASA data archive. A Data Archiving Plan is a required element of the proposal and will be evaluated as part of Merit.

Investigations requiring the provision of flight hardware are not solicited through this USPI program element.

This program element solicits new investigations only, i.e., proposals to extend or directly supplement existing investigations already funded for approved space flight missions or other NASA-supported research programs are not appropriate for this program element. Furthermore, NASA does not plan to select both a USPI team and a Partner Mission of Opportunity for the same mission, whether selected through the Program Element Appendix (PEA) O of the Third Stand-Alone Missions of Opportunity Notice (SALMON-3) or any previous call for Missions of Opportunity.

A proposed investigation as a USPI on a non-NASA mission or instrument may take any form that clearly and demonstrably enhances the scientific output of the mission, is relevant to NASA's astrophysics goals and objectives and enables the U.S. astrophysics science community access to a highly valued scientific data set.

The proposed investigations can vary in duration, to include just the prime science mission phase, or to begin at the post confirmation development phase (e.g., for calibration analysis) through the prime mission operational phase, depending on the science requirements of the investigation. All investigations shall include adequate time for data analysis and archiving following the conclusion of the prime mission phase.

NASA expects that the mission sponsor will enter into an agreement with NASA to assure that data returned from at least those aspects of the mission in which NASA support is involved, if not the entire mission, will be made available to the U.S. research community in a timely way and deposited in an appropriate NASA data archive. NASA will seek to conclude an international agreement with the mission sponsor in advance of launch to ensure that this activity will be performed.

2.1.2 *Cost Constraints*

For individual investigators, the cost for selected proposals is expected to be on the order of $125K per selected investigation per year through the prime science mission phase, plus one year for additional data analysis and archiving for the baseline scientific investigation. For a team of investigators, the cost is expected to be on the order of $125K per investigator per year, up to a maximum combined team total of on the order of $1M per year, through the prime science mission phase, plus one year for additional data analysis and archiving.

NASA reserves the right to make no selection if there are no proposals of appropriate merit.

2.1.3 *Duration of Award and Cover Page Budgets*

Proposals should be for the entire duration of the proposed investigation. This may be no more than through the prime science mission, plus one year for additional data archiving for the baseline scientific investigation. The budget justification in the body of the proposal should cover this entire period.

Note that ROSES-2020 requires redaction of salary and indirect rate information from the proposal document, and requires a "Total Budget" file to be uploaded separately from the proposal document. In addition, since proposers can only enter the first five years of budget into the cover page of the NSPIRES web interface, proposers must submit a high-level budget for all fiscal years as part of the "Total Budget" file.

2.1.4 *Technical Requirements and Constraints*

In addition to the requirements given in ROSES, all proposed investigations must also demonstrate: (1) their formal relationship with the sponsoring agency's mission (e.g., selected participant, invited participant, or proposed participant); (2) the status of the mission within the sponsoring agency (i.e., Preliminary Study (Pre-Phase A); Concept Study and Technology Development (Phase A); Preliminary Design and Technology Completion (Phase B); Final Design and Fabrication (Phase C); System Assembly,

Integration and Test, and Launch (Phase D); Operations and Sustainment (Phase E)), including the level of commitment that the sponsoring agency has made to complete development; (3) a description of the type and the characteristics of the data from this investigation, as well as any ancillary science data, that will be archived as part of this investigation; the status of any data-sharing discussions with the mission team; and a description of the arrangements and resources included in the proposal to ensure the timely delivery of the necessary data in the required format; and (4) a detailed explanation of how the U.S. astrophysics science community benefits from this participation.

Proposers should note that NASA does not plan to select both a Partner Mission of Opportunity and a USPI team for the same mission. In addition, the proposal must provide supporting documentation for item (2) above, and for the NASA commitment for U.S. participation via the USPI opportunity being required by the sponsoring organization prior to December 2023.

2.2 Proposal Evaluation Factors

All proposals with be evaluated for Intrinsic Merit, Cost, and Relevance, as defined in Appendix D of the *NASA Guidebook for Proposers* and consistent with Section VI(a) of the *ROSES Summary of Solicitation*. Relevance will be assessed relative to the Astrophysics questions and goals in the NASA Science Plan. In addition, the evaluation of "intrinsic merit" includes the following factors:

- Compelling nature and scientific priority of the proposed investigation's science goals and objectives. This factor includes the clarity of the goals and objectives; how well the goals and objectives reflect astrophysics program priorities; the potential scientific impact of the investigation on astrophysics science objectives; and the potential for fundamental progress, as well as filling gaps in our knowledge relative to the current state of the art.
- Programmatic value of the proposed investigation. This factor includes the unique value of the investigation to make scientific progress in the context of other ongoing and planned missions; the relationship to the other elements of NASA's science programs; and how well the investigation may synergistically support ongoing or planned missions by NASA and other agencies.
- Likelihood of scientific success. This factor includes how well the anticipated measurements support the goals and objectives of the USPI investigation; the adequacy of the anticipated data to complete the investigation and meet the goals and objectives; and the appropriateness of the investigation requirements for guiding development and ensuring scientific success.
- Merit of the instruments and mission design for addressing the USPI investigation's science goals and objectives. This factor includes the degree to which the proposed mission will address the goals and objectives; the appropriateness of the selected instruments and mission design for addressing the goals and objectives; the degree to which the proposed instruments and mission can provide the necessary data; and the sufficiency of the data gathered to complete the scientific investigation.
- Merit of the data analysis, data availability, and data archiving plan. This factor includes the merit of plans for data analysis and data archiving to meet the goals

and objectives; to result in the publication of science discoveries in the professional literature; and to preserve data and analysis of value to the science community. Considerations in this factor include assessment of planning and evidence of plans for well-documented, high-level data products and software usable to the entire science community; assessment of adequate resources for physical interpretation of data; reporting scientific results in refereed journals; and assessment of the proposed plan for the timely release of the data to the public domain for enlarging its science impact.

- Probability of science team success. This factor will be evaluated by assessing the experience, expertise, and organizational structure of the science team. The role of each Co-Investigator will be evaluated for necessary contributions to the proposed investigation; the inclusion of Co-Is who do not have a well-defined and appropriate role may be cause for downgrading of the proposal.

2.3 Award Management

Awards will likely be executed directly from NASA Headquarters, although NASA reserves the right to implement them through a NASA Center in order to facilitate coordination with related flight projects that the Center may be carrying out.

3. Summary of Key Information

Expected program budget for first year of new awards	See Section 2.1.2
Number of new awards pending adequate proposals of merit	Up to two awards.
Maximum duration of awards	Through the end of the Prime Mission plus one year for data analysis and archiving.
Due date for required Notice of Intent to propose (NOI)	See Tables 2 and 3 of this ROSES NRA
Due date for proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	No earlier than 6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Table 1 of ROSES
Relevance	This program is relevant to the Astrophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*
General requirements for content of proposals	See D.1 *Astrophysics Research Program Overview* and Section IV and Table 1 of *the ROSES Summary of Solicitation*

Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ and Section IV(b) of *the ROSES Summary of Solicitation*
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-APEXUSPI
Point of contact concerning this program	Linda S. Sparke Astrophysics Explorers Program Scientist Mail Stop 3U23 NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-3775 Email: linda.s.sparke@nasa.gov

D.14 THEORETICAL AND COMPUTATIONAL ASTROPHYSICS NETWORKS

NOTICE: Amended April 3, 2020. Proposals to this program element are now due June 23, 2020.

1. Scope of Program

The *New Worlds, New Horizons* report of the Astro2010 Decadal Survey (http://www.nap.edu/catalog.php?record_id=12951) observed that key challenges in theoretical astrophysics "are of a scale and complexity that require sustained, multi-institutional collaborations" but that there was "no mechanism to support these coordinated efforts at the needed level in the U.S." To address these issues, the Theoretical and Computational Astrophysics Networks (TCAN) program was established with the following goals:

- To support coordinated efforts in fundamental theory and computational techniques in order to make groundbreaking advances in astrophysics;
- To strengthen theoretical and computational astrophysics in the U.S. by uniting researchers in collaborative networks that cross institutional and geographical divides; and,
- To advance the training of the future workforce of theoretical and computational scientists.

In ROSES-2020, NASA solicits proposals for new TCAN networks. The period of performance for TCAN investigations will be three years. The TCAN program will support research networks with three or more nodes at distinct institutions. A network is a combination of nodes and connections. A node is a group of researchers at an existing institution, along with the local resources (e.g., computational, educational, communications) that sustain them. A connection is a significant exchange of expertise or capabilities between nodes (e.g., exchange of personnel, web-based training, sharing of access to resources). Multiple connections between nodes, that enable an integrated and focused collaborative effort, constitute a network.

Proposals submitted to the TCAN program must:

- Be directly relevant to space astrophysics goals by facilitating the interpretation of data from space astrophysics missions or by leading to predictions that can be tested with space astrophysics observations;
- Address fundamental issues in theoretical and computational astrophysics, and display a depth and breadth of concept qualitatively beyond those typical of the Astrophysics Theory Program (ATP);
- Consist predominantly of theoretical astrophysics studies and/or the development of theoretical astrophysics models *and* a significant computational component that involves more than just incremental enhancement of existing codes.

TCAN proposals may address theoretical topics in any of the areas of astrophysics included in the ATP, which are:

1 Exoplanet Astrophysics (e.g., circumstellar disks, exoplanet atmospheres, planet formation);

2 Stellar Astrophysics (e.g., astrochemistry, asteroseismology, brown dwarfs, convection, stellar evolution, stellar mass loss);
3 Collapsed Objects and X-ray Astrophysics (e.g., black-hole binaries, cataclysmic variables, neutron stars, X-ray binaries, white dwarfs);
4 Supernovae and Gamma Ray Bursts;
5 Star Formation, Interstellar Medium, Cosmic Rays, and Galactic Structure (e.g., dark clouds, diffuse galactic emission, HII regions, interstellar dust, planetary nebulae, protostars, star-forming clouds, stellar clusters, supernova remnants);
6 Galaxies (e.g., accretion disks and jets from active galactic nuclei (AGNs), circumgalactic medium, interacting galaxies, quiescent galaxies, starburst galaxies);
7 Galaxy Formation (e.g., evolution of galaxies and AGN, population studies);
8 Large Scale Cosmic Structure and Dark Matter (e.g., clusters of galaxies, diffuse photon backgrounds, intracluster medium, lensing studies);
9 Dark Energy and the Cosmic Microwave Background (e.g., dark energy models, theoretical cosmology, theoretical studies of cosmological observation techniques);
10 Gravitational Astronomy (e.g., computation of gravitational radiation waveforms, gravitational wave sources); and
11 Other Astrophysics Theory.

Proposers should note, however, that the mix of proposals in a TCAN panel is likely to cover a broader range of topics than a typical ATP panel, and should prepare their proposals accordingly. TCAN proposals satisfying the requirements listed above may involve development of data analysis methods for astrophysics missions and may incidentally include actual data analysis as a test of the theory or the method.

Proposals to the TCAN program may not:

- Consist primarily of data reduction or data analysis (such proposals should be directed to the mission-specific programs or the Astrophysics Data Analysis Program (ADAP) described in Program Element D.2 in this solicitation);
- Propose theoretical work pertaining to atomic and molecular astrophysics and other topics directly related to Laboratory Astrophysics (these should be proposed to the Astrophysics Research and Analysis (APRA) program element described in Program Element D.3);
- Address theoretical topics that are predominantly unrelated to the needs of NASA's space astrophysics programs (such proposals should be directed to other appropriate Federal agencies);
- Deal strictly or predominantly with Solar System objects or solar-terrestrial interaction studies, including solar energetic particles (see Appendices B and C for appropriate programs);
- Propose to develop new data analysis methods for future space missions (these proposals should be submitted to the APRA program element described in Program Element D.3); or
- Primarily aim at studying new mission concepts,

Each proposed TCAN investigation must have a single, clear scientific focus, and be led by a single Principal Investigator (PI), with a Co-I at each of the other nodes designated

as the organizational lead at that node. An individual may serve as PI or as an organizational lead on no more than one proposal in response to this solicitation. One proposal should be submitted for each proposed TCAN network; individual proposals for constituent nodes are not required. Group proposals in which several researchers submit an omnibus proposal consisting of related, but separate, investigations under a designated PI, are not solicited for TCAN, and will be considered unresponsive to this program element. For each funded network, one award will be made to the PI organization, with the other node organizations funded through subawards from the PI organization (except in cases of nodes located at Government laboratories). Networks will be required to submit annual progress reports, and to participate in a videoconference review with NASA Program Officers between years 2 and 3 (a pdf version of the materials from this presentation will constitute the year-2 progress report.)

2. Additional Solicitation Specific Review Criteria

A peer evaluation panel will review all proposals with respect to the criteria specified in Appendix D of the *NASA Guidebook for Proposers*, where it is understood that the intrinsic merit of a proposal shall include the following factors:

- The appropriateness of the roles of the participating nodes and the effectiveness of the connections between nodes in establishing the proposed project as a network for realizing the goals of the proposed investigation;
- The functionality and effectiveness of management structures and procedures for allocating responsibilities, reaching decisions, monitoring progress, correcting errors, resolving conflicts, and assessing results;
- The practicality and efficacy of plans for evaluating the success of the network;
- The appropriateness of plans to publicly release software developed as part of the project, and the practicality and efficacy of plans for the support and maintenance of that software (see Section 1.1 of of D.1, The Astrophysics Research Program Overview);
- The effectiveness of network activities in contributing to the training and development of the future scientific workforce.

3. Availability of High-End Computational Resources

Those investigators requiring access to high-performance computing should refer to the *Summary of Solicitation*, Section I(d), "NASA-provided High-End Computing (HEC) Resources." This section describes the procedure that proposers to the TCAN program must follow to apply for computing time at either of the two NASA computing facilities: the Goddard Space Flight Center's Computational and Information Sciences and Technology Office and the Ames Research Center's Advanced Supercomputing Division. Because of the current high demand on NASA computing facilities, TCAN proposers may instead request support for the purchase of computing equipment or computing time from non-NASA providers of high-performance computing systems and services. In this case, the budget narrative should include a comparison between the cost of the proposed computing solution and that set out for NASA systems at https://www.hec.nasa.gov/user/policies/sbus.html. TCAN proposers requesting support for non-NASA computing may not also request NASA HEC resources, and vice versa. All computing resource requests will be evaluated under the "cost reasonableness"

criterion by the science peer review panels (see Section VI(a) of the *Summary of Solicitation*.)

4. Summary of Key Information

Expected program budget for first year of new awards	~ $1M to $1.5M
Number of new awards pending adequate proposals of merit	2 - 3
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 of this ROSES NRA
Due date for proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	No earlier than 6 months after the proposal due date, but no later than Oct 1, 2021.
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Table 1 of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the Astrophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	Please see *ROSES Summary of Solicitation* Section I(g) Order of Precedence and the NASA Guidebook for Proposers
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-TCAN
Point of contact concerning this program	Evan Scannapieco Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-3730 Email: HQ-ATP@mail.nasa.gov

D.15 LISA PREPARATORY SCIENCE

NOTICE: Amended April 7, 2020. This Amendment adds this program element to ROSES-2020. Mandatory NOIs are due September 15, 2020, and proposals are due December 15, 2020.

This program requires a Notice of Intent (NOI). Proposals that are not preceded by the mandatory NOI may be returned without review. No feedback will be provided in response to the NOI. PIs must provide the names of their co-investigators and collaborators on the NOI for review planning purposes.

1. Scope of Program

1.1 Overview

NASA is partnering with the European Space Agency (ESA) on the ESA-led Laser Interferometer Space Antenna (LISA) gravitational wave observatory planned for launch in the early 2030s. LISA will detect gravitational waves in the milli-Hz band, opening a new window to study the Universe. LISA will measure gravitational radiation from a variety of astrophysical sources including the mergers of massive black holes, the capture of stellar-remnant black holes by galactic center black holes, close compact binaries in our own galaxy, and other potential sources. More information about the LISA mission can be found at https://lisa.nasa.gov.

NASA's specific contributions to LISA are the subject of ongoing discussions with ESA, but are expected to include elements of the instrument, elements of the spacecraft, and aspects of science data analysis and science interpretation, including potential Guest Investigator activities. While the development of hardware and ground-segment infrastructure is supported by NASA through the NASA LISA Study Office (NLSO) at NASA's Goddard Space Flight Center, this ROSES element concerns the support of U.S.-based investigators for developing tools and techniques for the analysis and interpretation of LISA data.

1.2 Program Objectives

The LISA Preparatory Science (LPS) program has been created to provide support for U.S. investigators to conduct activities that contribute to furthering the eventual science yield of LISA. It is not intended as a vehicle for funding specific U.S. contributions to the LISA instrument or science ground segment, or to develop concepts for other missions outside of LISA. Proposals to the LPS program may request support to:

- Perform high-fidelity simulations of the expected waveforms for LISA sources and assessing their impact on LISA's science return;
- Develop data analysis and statistical techniques useful for the extraction of scientific measurements from LISA data (e.g., parameter estimators, etc.);
- Refine and expand on LISA's capabilities to conduct specific astrophysical investigations and evaluate LISA’s potential contributions in the context of the broader astrophysical landscape;

- Conduct astrophysics investigations that demonstrably prepare for the analysis and interpretation of the LISA data.

Note that the NLSO is responsible for NASA's direct contributions to both the instrument and science ground segment. More information on the current activities of the NLSO can be found at https://lisa.nasa.gov/teamActivities.html. Proposers must ensure that the proposed investigations do not duplicate these activities. Proposals also must not duplicate previously funded LPS projects; for a list and brief description of prior LPS projects see https://lisa.nasa.gov/LPSprogram.html.

Proposals to the LPS program may not:

- Address topics that are predominantly theoretical in nature. Such proposals may be directed to the mission-specific programs or the Astrophysics Theory Program (ATP) described in Program Element D.4 of ROSES-2020;
- Consist primarily of data reduction or analysis of archival data other than that in direct support of LISA-centric investigations. Such proposals may be directed, as appropriate, to the mission-specific programs or the Astrophysics Data Analysis Program (ADAP) described in Program Element D.2 of ROSES-2020;
- Consist primarily of new astronomical observations. Such proposals may be directed to the mission-specific Guest Observer programs;
- Propose to develop technologies or experimental concepts for LISA;
- Request support for organizing and/or hosting scientific meetings. Such proposals may be directed to the Topical Workshops, Symposia, and Conferences (TWSC) program described in Program Element E.2 of ROSES-2020; or
- Request support for substantial computing facilities or resources.

1.3. Availability of High-End Computational Resources

Those investigators whose research requires high-performance computing should refer to the *ROSES Summary of Solicitation*, Section I(d), "NASA-provided High-End Computing Resources." This section describes the opportunity for the successful procedure that proposers must follow to apply for computing time on either of two NASA computing facilities at the Goddard Space Flight Center's Computational and Information Sciences and Technology Office or at the Ames Research Center's Advanced Supercomputing Division.

2. Programmatic Information

2.1 Eligibility

All U.S. Organizations are eligible to receive funding via this program element. Participants from non-U.S. institutions are eligible on a no-exchange-of-funds basis. Proposals from U.S. organizations with participants affiliated with non-U.S. institutions who have a significant role on a proposal must include a letter from their government agency or funding/sponsoring institution in their country indicating that they have the support to allocate the time promised to carry out the project.

One may not be funded twice for the same work. The LPS program is not intended to fund activities that should be supported by the NLSO. Those who will already be receiving NASA funding for LISA-related activities during the proposed period of performance (i.e., from the NASA LISA Study Office for the LISA Core Teams), may not participate on proposals submitted to this program element as funded or unfunded PIs or Co-Is, but may be collaborators. Questions regarding eligibility may be directed to the point of contact in Section 4.

2.2 Proposal Guidelines

Proposals must have a clear, single focus. All individuals participating in the proposed investigation should be included as Co-Investigators and Collaborators.

Investigators may submit more than one proposal if the research program of each proposal is significantly distinct and if the implied work does not over commit the personnel involved. The proposals must state clearly what the overlap is in the proposed work and why funding of both proposals is warranted and desirable.

Proposers of previously funded LPS projects must provide a status report on the funded activity and explain the relationship of the newly proposed project to the previously funded one. If the proposed project overlaps with a previous LPS proposal, the proposers must provide a justification of why additional funding and time is needed.

NASA does not anticipate awarding contracts in response to proposals submitted to this program element because it would not be appropriate for the nature of the work solicited.

Proposals must address items above. Any questions may be addressed to the point-of-contact dentified in Section 4 at least two weeks before the proposal due date. The anonymized questions and the answers will be collected by the Program Officer and posted on the NSPIRES page for this program element under "Other documents".

2.3 Additional Requirements

In addition to the default required proposal elements (as outlined in Table 1 of the *Summary of Solicitation*), including the new requirement regarding the data management plan (DMP) described in Section 1.1 of The Astrophysics Research Program Overview, Program Element D.1 of ROSES-2020, proposals for this program element must include the following in the Scientific/Technical/Management section:

- A brief description of how the goals of the proposed project relate and enhance the LISA science goals;
- A description of how the proposed project complements and augments other currently funded LISA science projects of the PI and CoIs, if any;
- A description of how the proposed project complements and/or augments activities of the NASA LISA Study Office and prior funded LPS investigations, if applicable (see https://lisa.nasa.gov/).

2.4 Mandatory Notice of Intent

To facilitate the early recruitment of a conflict-free review panel, a Notice of Intent (NOI) to propose is required for all submissions to this Program Element. Proposals that are

not preceded by an NOI will be returned without review. The proposers are strongly encouraged to finalize their team's composition before submitting the NOIs. The NOIs will be used to recruit non-conflicted reviewers, and any later changes to the Team composition would hinder this effort. The PI is strongly encouraged to list the names of all their Co-Investigators and Collaborators on the NOI. If additions to the Team composition are made after the submission of the NOI, the proposers must inform thomas.hams-1@nasa.gov as soon as possible, but no fewer than four weeks in advance of the proposal due date.

The period of performance of investigations for this research element is restricted to a maximum of three (3) years. Projects of three-year duration must be well justified, shorter duration projects are allowed.

2.5 Proposal Evaluation and Awards

The default evaluation process is described in Section VI(a) of the *ROSES Summary of Solicitation* and the three basic criteria, defined in Appendix D of the *NASA Guidebook for Proposers*, are Relevance, Merit, and Cost. For this program element the evaluation of Merit will include:

a. How well the investigation goals relate to or advance the LISA science requirements, as outlined in the LISA mission proposal (available at https://lisa.nasa.gov/documentsReference.html);
b. The merit of a plan for disseminating the results of the research project to the broader community;
c. If development of analysis tools is being proposed, the availability and usefulness of the tools developed under the award for the astronomy and astrophysical scientific community at large for engaging in LISA science, and the timeline for their release. Note that software, whether a stand-alone program, an enhancement to existing code, or a module that interfaces with existing codes, created as part of an LPS award, should be made publicly available when it is practical and feasible to do so, and when there is scientific utility in doing so.

In addition, as part of the evaluation of relevance, the peer review panel will assess:

d. The extent to which the proposed project overlaps or duplicates LISA efforts ongoing in the NASA LISA Study Office or prior funded LPS invstigations as described at https://lisa.nasa.gov/teamActivities.html;
e. The extent to which the proposed project overlaps or duplicates funded LPS projects, past or ongoing, as listed at https://lisa.nasa.gov/LPSprogram.html.

For items d) and e), please contact thomas.hams-1@nasa.gov when in doubt.

3. Reporting

For each year of the investigation period, the PI shall prepare a standard annual progress report (See SARA web page for more information), and submit it at least 60 days before the anniversary of the start date. The title and abstract of the funded LPS proposal, at a minimum, will be made available on https://lisa.nasa.gov.

NASA HQ may organize a special session for LISA Preparatory Science at a future meeting or science conference. If such a session is organized, the PIs or designated

team members of the selected proposals shall give an oral or poster presentation with the results of their LPS projects. Proposers should plan for at least one domestic trip in their proposed budgets to attend a future NASA HQ organized LISA Preparatory Science special session.

4. Summary of Key Information

Expected program budget for first year of new awards	~$1M
Number of new awards pending adequate proposals of merit	~4-6
Maximum duration of awards	3 years; shorter-term proposals are encouraged
Due date for mandatory Notice of Intent to propose (NOI)	See Tables 2 and 3 of this ROSES NRA
Due date for proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	October 1, 2021
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Table 1 of ROSES and the *NASA Guidebook for Proposers.*
Relevance	This program is relevant to the Astrophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	Please see *Section I(g)* Order of Precedence and Table 1 of the ROSES *Summary of Solicitation* and the *NASA Guidebook for Proposers.*
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-LPS
Point of contact concerning this program	Thomas Hams Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-5162 Email: thomas.hams-1@nasa.gov

D.16 ASTROPHYSICS PIONEERS

NOTICE: Amended September 17, 2020. This Amendment delays the proposal due date for this program element to give more time for proposers displaced by fires in the west. Proposals are now due October 8, 2020.

Amended July 2, 2020. This Amendment releases the final text for this program element. Mandatory Notices of Intent are due August 13, 2020 and ~~proposals are due October 1, 2020~~.

The text has been revised in response to community comments. Changes include: Section 3.1, Orbital projects are now allowed to 'bring your own ride' within the PI cost cap and commercial reusable sub-orbital launch vehicles are included as an option. Clarification on including budget for orbital communications included. Section 3.2, multiple flights allowed and 'keep alive' funding level requested. Section 4.1, role of existing Program Offices clarified. Section 4.3, decision authority for milestone reviews clarified. Section 5.2, maximum duration of projects clarified. Section 5.3, required cost information and size of project team clarified. Section 5.4, Data Management plan and archiving requirements clarified. Section 6, initial budget period clarified. Section 8.2 on early career team members clarified. Section 8.4 request for reviewer names added. In addition, there are numerous small changes and clarifications throughout the text, so please read this final text carefully.

1. Scope of Program

This program element solicits proposals for "Pioneers", Astrophysics space and sub-orbital science investigations that are greater in cost, scope and capability than what is possible within the Astrophysics Research and Analysis (APRA) program (D.3 of ROSES-2020) but are smaller in cost than what is possible within the Astrophysics Explorers Mission of Opportunity (MO) program (e.g., PEA O of SALMON-3 for the 2019 opportunity). Investigations are solicited using platforms that include CubeSats (including constellations), SmallSats, Major Balloon Missions, and International Space Station (ISS)-attached payloads. Technology development and maturation within the proposed project is allowed, but the primary review criterion for selection is the merit of the proposed science investigation.

All proposed investigations must be responsive to NASA's science goals in Astrophysics, as described in the 2020 NASA Science Mission Directorate Science Plan and the 2018 NASA Strategic Plan.

2. Background

Small satellites (SmallSats) have been suggested (in the Space Studies Board report Achieving Science Goals with CubeSats) as a means to execute scientific missions at far lower cost and complexity than typical space science missions; CubeSats are a type of SmallSats. There are frequent launch opportunities for CubeSats in standard form

factors as secondary payloads. NASA has previously developed Astrophysics 6U CubeSat missions for low-Earth orbit operations through the APRA program. Frequent launch opportunities are also available for SmallSats as secondary payloads using standard interfaces such as the Evolved Expendable Launch Vehicle Secondary Payload Adapter (ESPA) and the ESPA Grande.

NASA is developing capabilities for long(er) duration balloon flights including flights from mid-latitudes. Several test flights of zero-pressure balloons have recently been carried out, including shared-risk science payloads. These capabilities offer the opportunity for multi-month-long exposures including substantial night-time observing.

NASA has determined that there may be payload opportunities for small, suborbital-class astrophysics investigations that utilize the ISS. Proposals seeking use of the ISS must take advantage of the Station's unique capabilities. Available external attach points include both zenith and nadir pointing locations.

3. Categories of Proposals

3.1 SmallSats and CubeSats, including CubeSat Constellations

Proposers to this program element may propose CubeSats in form factors from 1U to 27U, CubeSat constellations, as well as ESPA or ESPA Grande mounted SmallSats over a variety of form factors. It is expected that CubeSats larger than 12U will be dispensed from an ESPA ring.

NASA will cover all launch and launch vehicle integration costs for spaceflight launches via NASA's CubeSat Launch Initiative (CSLI) or SMD's rideshare program, including the cost of an ESPA ring and integration of such, outside of the PI-managed cost. The SMD rideshare program allows launch opportunities as secondary payloads on ESPA or ESPA Grande secondary adapters launched with SMD missions on SMD-purchased launch vehicles. NASA will also cover the costs of suborbital launches using commercial suborbital reusable launch vehicle services through the Flight Opportunities Program of NASA's Science and Technology Mission Directorate (STMD) outside of the PI-managed cost. If so desired, the PI may 'bring their own ride' and elect to use commercial launch providers, including Venture Class launch vehicles, but the costs of doing so must be included within the PI-managed cost.

Information on small satellite platform technologies is available through the NASA Small Spacecraft Virtual Institute (S3VI) or the NASA Small Satellite Technology Program (SSTP) websites. Basic information on CubeSat testing, mechanical, electrical, etc. standards, can be found at these sites and in the "CubeSats 101" pdf file, available under "Other Documents" on the NSPIRES page of this program element. Due to the rapidly emerging commercial SmallSat market, it is expected that a suitable spacecraft bus, or components for the bus, will be available from a variety of sources; examples are available in the on line NASA State of the Art (SoA) report or the NASA SmallSat Parts On Orbit Now (SPOON) database.

Proposers requiring a secondary launch opportunity must include in the appendix to their proposal a completed version of the rideshare accommodation worksheet based

on the template available under "Other Documents" on the NSPIRES page of this program element. After the evaluation of proposals, but prior to the selection decision, NASA will perform an accommodation study of selectable rideshare investigation proposals to assess the extent to which the proposed investigation is compatible with expected future rideshare opportunities. A proposed investigation compatible with common launch opportunities (see Section 7.2) is more likely to be selected than one with less common or less flexible accommodation and orbit requirements.

In case the requested launch configuration is not available immediately after the payload is completed, proposals should indicate a minimum 'keep alive' funding level that would allow the payload to be stored until the requested launch is available. Keep alive funding will be limited to at most 2 years and shall not be included in the PI-managed cost. Excessive keep alive costs or a low likelihood of achieving the required orbit via rideshare may be a reason for non-selection.

SmallSat projects may use the full range of up/down-link options available, including the NASA Near Earth Network (NEN), TDRSS, and/or commercial providers, but must include the cost of these communications within the PI-managed cost.

Orbital missions must meet orbital debris requirements and the project team will assist NASA in verifying compliance. Detailed requirements and guidelines for limiting the generation of orbital debris and for implementing the U. S. Government Orbital Debris Mitigation Standard Practices are provided in NASA Standard (NASA-STD) 8719.14B, Process for Limiting Orbital Debris,(which superseded NASA Safety Standard (NSS) 1740.14), and NASA-Handbook (NHBK) 8719.14, Handbook for Limiting Orbital Debris. This compliance will be evaluated as part of the Concept Study Report review (see Section 4.3 below).

Note that depending upon the nature of the proposed investigation, one or more proposal appendices must be included. These appendices should be included at the end of the single PDF file that makes up the uploaded proposal document, but they do not count against the science-management-technical section page limit. Proposers are urged to be familiar with the rideshare documents available under "Other Documents" on the NSPIRES page of this program element.

For further information on CSLI, please contact:

Samantha Fonder
Launch Services Program Executive
Phone: 321-607-2286
Email: Samantha.fonder@nasa.gov

John Guidi
Chief Technologist for Human Exploration and Operations
Phone: 202-358-1644
Email: john.guidi@nasa.gov

For information on the SMD rideshare program, please contact:

Alicia Mendoza-Hill
Phone: 321-432-4916
Email: Alicia.mendoza-hill@nasa.gov

3.2 Major Balloon Payloads

Proposers to this program element may propose major balloon payloads. NASA will provide the appropriate balloon launch vehicle for major balloon missions via NASA's scientific balloon program outside of the PI-managed cost.

Investigators proposing Pioneers balloon payloads are required to contact the Balloon Program Office (BPO) to obtain technical information related to BPO balloon capabilities, services, and the latest planned campaign schedules. A BPO Feasibility Letter must be included in the appendix of a Pioneers balloon proposal. All unique requirements that an investigation may have on the BPO must be listed in the BPO feasibility Letter. Payloads for remote balloon campaigns, e.g., McMurdo, Antarctica, or Wanaka, New Zealand, are required to have a CONUS test flight prior to deployment to the remote campaign. Alternatively, proposers can provide a test plan for a relevant thermal-vacuum test of the complete payload. The BPO concurrence on an environmental test has to be included in the Feasibility Letter. The cost for environmental tests are the responsibility of the proposer within the PI-managed cost.

Information on the capabilities of current available balloon vehicles is available at http://sites.wff.nasa.gov/code820/ and at http://www.csbf.nasa.gov/balloons.html. Proposers are encouraged to consider these capabilities in designing their investigations, but the BPO has the final authority in the choice of which vehicles to be used. The current funded mission model of the BPO supports two U.S. balloon campaigns and two non-U.S. balloon campaigns per year. Projects may propose for multiple flights within the maximum 5-year duration of a Pioneers project.

The nominal U.S. launch sites for scientific balloons are Fort Sumner, New Mexico, and at the Columbia Scientific Balloon Facility in Palestine, Texas. The BPO also conducts launches from established non-U.S. launch sites at McMurdo, Antarctica; Wanaka, New Zealand; as well as Alice Springs, Australia; and Kiruna, Sweden (Esrange); subject to science community requirements and the availability of BPO operations funding to conduct the campaign. Launches from McMurdo, Antarctica, are typically conventional zero-pressure balloons with payload recovery on the continent. Flight durations vary, but the average flight duration is approximately 20 days and the longest flight is 55 days. In addition, the McMurdo site can support a super-pressure balloon launch extending the mission duration by allowing the balloon payload to leave the continent. Launches from Wanaka, New Zealand are exclusively on the super-pressure balloon platform, allowing for mid-latitude, southern-hemisphere observations, including nighttime flight operations. Flight durations on the super-pressure platform are expected to last between 30-60 days with a future goal of 100 days. Since the super-pressure payloads spend an appreciable duration over the water and a payload recovery cannot be guaranteed, proposers must provide a plan to transmit all data during flight and are

required to accept the risk of losing the payload at the end of the flight. There is no similar requirement for zero-pressure balloon flights from Sweden.

In case the requested launch configuration is not available immediately after the payload is completed, proposals should indicate a minimum 'keep alive' funding level that would allow the payload to be stored until the requested launch is available. Keep alive funding will be limited to at most 2 years and shall not be included in the PI-managed cost. Excessive keep alive costs may be a reason for non-selection.

Proposers needing investigation unique engineering, flight support systems, and/or technical support services from NASA, such as the Wallops Arc-Second Pointing System (WASP), should contact the BPO directly for an estimate of the Government Furnished Equipment (GFE) cost of the desired support.

Details on NASA's scientific balloon program may be found in the *ROSES-2020 Summary of Solicitation*, Section V(c)(ii).

Questions concerning balloons may be addressed to:

Debora Fairbrother
Balloon Program Office
Code 820
GSFC/Wallops Flight Facility
National Aeronautics and Space Administration
Wallops Island, VA 23337
Telephone: (757) 824-1717
Email: debora.a.fairbrother@nasa.gov

3.3 International Space Station Attached Payloads

Proposers to this program element may propose payloads for the ISS. Information on opportunities and constraints for ISS attached payloads may be found at http://www.nasa.gov/mission_pages/station/research/research_information.html. NASA will provide launch services to the ISS for ISS-attached payloads via NASA's Commercial Resupply Services (CRS) program, outside of the PI-managed cost.

Details on ISS-attached experiments may be found in the *ROSES-2020 Summary of Solicitation*, Section V(c)(iv). Pay particular attention to the additional requirements for proposals for the ISS that are described in that section, including the requirement for a letter of feasibility from the ISS Research Integration Office. Note that the issuance of the ISS letter of feasibility can take several weeks; therefore, proposers are urged to contact the ISS Research Integration Office as early as possible for such a request.

For further information, please see the *ROSES-2020 Summary of Solicitation*, Section V(c)(iv). For ISS Program accommodation support please contact both of these points of contact from the ISS Program's Research Office:

Name	email	Telephone
Steve Huning	steven.w.huning@nasa.gov	(281) 244-8043
Pete Hasbrook	Pete.Hasbrook@nasa.gov	(281) 483-0768

4. Pioneers Management Process

Selected projects will be managed as research projects, not space flight projects. As such the standard NASA mission classification scheme of class A, B, C, D does not apply to Pioneers project. Management requirements for research projects are fully documented in NASA Procedural Requirements document NPR7120.8A, but key items are listed below.

4.1 Management Oversight

While selected projects will be managed as research projects, they will be subject to additional oversight beyond what is typical of APRA suborbital-class projects. That oversight will include monthly reporting. The NASA Special Projects and Small Satellite Project Office (S3PO) at Wallops Flight Facility (WFF) will act as a program office and provide high level oversight of Pioneers projects, including guidance at monthly reporting, and possible engineering support if requested by the project PI. The S3PO will provide this oversight for all projects including balloons, ISS attached payloads, and suborbital programs, acting as a liaison between the project and other NASA program offices (for example, the BPO).

4.2 Program and Project Management

NASA considers Pioneers investigations to be research and technology projects, not space flight projects, just like all other ROSES investigations. Programmatic oversight for Pioneers projects will be provided by the S3PO at WFF, while the PI provides project management. Issuance of an award is the beginning of formulation. At the end of each project year, the PI will submit an annual report, with the final report serving to document project closeout, unless otherwise documented in the Project Plan.

4.3 Gate Reviews

Within 6 months following selection, Pioneers projects are required to deliver to NASA a Concept Study Report (CSR), which shall include a Project Plan, comprising an agreement between the PI and NASA on implementation approach, resources, cost, reviews, schedule, and other plans. Gate reviews (as listed below) will be conducted by the S3PO per the draft schedule contained in the CSR. Following each gate review, a milestone review will be held by the Astrophysics Division, NASA HQ. Decision Authority for these milestone reviews is the Director, Astrophysics Division, NASA HQ. The first gate review is the Systems Requirements Review (SRR), which must be passed in order to proceed; one of the deliverables required at SRR is the CSR with the Project Plan. Subsequent gate reviews will include a Preliminary Design Review (PDR) and/or Critical Design Review (CDR), and Flight Readiness Review (FRR) per the schedule agreed to in the Project Plan.

4.4 Cost and Continuation Assessment

Should a project be over budget or behind schedule at any Gate Review, a Cost and Continuation Assessment will be performed to determine whether the project should continue and, if continuation is approved, how the project can increase its probability of success within its approved cost and schedule.

5. Proposal Requirements

5.1 Mandatory Notices of Intent (NOI)

To facilitate the early recruitment of a qualified, diverse and conflict-free review panel, an NOI is required for all submissions to this program element. Proposals that are not preceded by an NOI may be returned without review. Submission of an NOI does not obligate the proposer to submit a full proposal later.

After NOI submission, the initially listed PI may request to reassign the PI role only to listed Co-Is. To make changes in the proposal team between submission of the NOI and the proposal, the PI must inform the NASA point of contact identified in the summary table of key information and cc sara@nasa.gov at least three weeks in advance of the proposal due date. Addition of funded investigators within three weeks of the proposal deadline will require explicit permission from the NASA point of contact.

5.2 General Requirements

Investigations must be PI-led and responsive to the NASA science goals in Astrophysics, as described in the 2020 NASA Science Mission Directorate Science Plan and the NASA 2018 Strategic Plan. All proposed investigations must be more capable than the missions that are solicited within the Astrophysics Research and Analysis (APRA) program (D.3 of ROSES-2020).

PI-managed cost (from initiation to data archiving) allowed under this program are limited to $20M in real year dollars over five years (not including NASA-provided launch). Pioneers takes advantage of the SMD rideshare program and CSLI launches; therefore, NASA will provide these launch services outside of the PI-managed cost for all categories of missions. Suborbital launches using commercial suborbital reusable launch vehicle services through the Flight Opportunities Program of NASA's Science and Technology Mission Directorate (STMD) are also allowed and costs are outside of the PI-managed cost. In addition, the PI may 'bring their own ride' and elect to use commercial launch providers, including Venture Class launch vehicles, but the costs of doing so must be included within the PI-managed cost.

Awards are expected to cover all aspects of the proposed investigation, typically including payload development and construction, instrument integration and calibration, support for the team through launch, flight operations, publication of results, and data collection/analysis/dissemination/archiving. The PI institution is expected to fund participating co-Investigators via subawards, except where the Co-I is at a Government laboratory, including the Jet Propulsion Laboratory.

Pioneers is designed to incentivize quick projects. Maximum duration of awards is five years. Proposers are encouraged to be flight ready within three to four years of the beginning of funding, and all projects must complete their prime mission within five years of the beginning of funding. It is anticipated that spacecraft bus and launch availability will allow some SmallSat programs to be flight ready more rapidly. The prime mission includes completion of the science objectives proposed, archiving of data and publication of results.

Projects may request a waiver from the requirement to finish the prime mission within 5 years by giving sufficient justification within the proposal. Funding for extended mission operations may be requested via a subsequent proposal to this program.

5.3 Proposal Content Requirements

The Scientific/Technical/Management section of Pioneers proposals may be at most 30 pages long and should otherwise follow the form outlined in Table 1 of ROSES and the *NASA Guidebook for Proposers*. If they differ, ROSES takes precedence.

The proposal shall clearly define its science goals and objectives, shall demonstrate how the science objectives map into high-level science requirements, and shall show how the science requirements subsequently map into the measurement and instrument performance requirements and, as relevant, into the platform performance requirements. The proposal shall include a Science Traceability Matrix (STM) per the example in the Other Documents section of this program element's webpage. Each proposal shall clearly state the requirements for a successful science program, for the performance of the instrument, for the performance of the platform, the prime mission lifetime for operations, and the range of satellite orbits or balloon flights acceptable or required for deployment. Proposals shall clearly state the desired and acceptable orbits and operational constraints (e.g., duty cycle or observational cadence) and describe the relative scientific merits of each possible orbit (per the rideshare worksheet on the Other Documents section of this program element's webpage, if applicable). The proposal shall include a preliminary cost estimate for the entire (up to 5 year) project, either bottoms up or parametric, in sufficient detail to convince the reviewing team that the cost estimate is reasonable. The cost estimate shall include sufficient reserves to ensure a probability of success on budget commensurate with sub-orbital class projects and shall identify the largest risks to the cost estimate. The proposal may include a flight heritage section if appropriate.

Proposals shall designate all Co-Investigators (Co-Is), describe the role of each Co-I in the development of the investigation, and justify the necessary nature of the role. The proposal shall identify the Project Manager, which given the size of Pioneers project is likely to be somebody other than the PI, but it is allowed that the PI takes on this role. While excessively large teams of Co-Investigators and Collaborators are discouraged, it is expected that Pioneers teams may be larger than APRA sub-orbital teams but smaller than Explorer teams. Non-U.S. based researches are allowed as team members on a non-exchange of funds basis, please see the *ROSES Summary of Solicitation*, Section IV(d), for details.

The proposal shall outline what trades will be studied during the initial 6 months formulation phase leading to the CSR. In order to assist with these trades, the team may work with any of the NASA design offices identified below. Mission design will be a critical part of this formulation phase, during which the team will make trades, explore feasibility, and refine the mission concept. Proposals should include team members to conduct mission design and/or provide a statement that arrangements have been made to partner with an appropriate NASA mission design team.

Since some science teams may lack access to the necessary mission design capability, NASA field centers can provide study teams access to mission design assistance if needed. It is up to the proposing team to engage one of the field center contacts below to determine availability to support the team and to request the cost associated with the support required. The negotiated cost is to be included in the proposal as a separate line item. If you are at a NASA center and using your local design center, this cost should be included along with other costs in the main part of your budget. If you are not at a NASA Center, please include this cost in Section F ("Other Direct Costs") of the budget pages, line 8 or 9, labeled with the name of the center facility, e.g., Ames Research Center - Mission Design Center". These funds will be sent directly to the center and proposers may not charge overhead on this portion of the award. Note that participation by a design center does not necessarily mean that the NASA center must continue support once the CSR has been delivered; it is up to the PI teams to work out what support is needed to successfully bring the mission to completion.

Ames Research Center - Mission Design Center
http://www.nasa.gov/centers/ames/engineering/divisions/missiondesign/
Sally Cahill, sally.a.cahill@nasa.gov, 650-604-6571.

Goddard Space Flight Center's Wallops Flight Facility – Mission Planning Lab
https://sites.wff.nasa.gov/mpl/index.html
Benjamin Cervantes, benjamin.w.cervantes@nasa.gov,757-824-1526.

Jet Propulsion Laboratory, Innovation Foundry and Team Xc
http://jplfoundry.jpl.nasa.gov/
http://www.jpl.nasa.gov/cubesat/teamxc.php
Keith Grogan, keith.grogan@jpl.nasa.gov, 818-354-2617.

Marshall Space Flight Center - Advanced Concepts Office
https://www.nasa.gov/centers/marshall/advancedconcepts.html
Rachel Mccauley rachel.j.mccauley@nasa.gov, 256-975-5400.

5.4 Data Management and Archiving Requirements

A discussion of the plans for project management and for reduction, analysis and archiving of the data (a Data Management Plan (DMP) as described in the *ROSES Summary of Solicitation*), consistent with Pioneers data management and archiving requirements, must be included in the proposal. Per the *ROSES Summary of Solicitation* the DMP is separate from the main body of the proposal and does not count against the page limit, but proposers may wish to include information on the DMP in the main body if appropriate.

The investigation team shall make mission data fully available to the public through a NASA-approved astrophysics data archive (High Energy Astrophysics Science Archive Research Center (HEASARC), Mikulski Archive for Space Telescopes (MAST), or Infrared Science Archive (IRSA)), in readily usable form, in the minimum time necessary, but, barring exceptional circumstances, within six months following the end of the prime mission. The PI shall be responsible for collecting the scientific,

engineering, and ancillary information necessary to validate and calibrate the data prior to delivery to the archive.

Archival data products shall include low-level (raw) data, high-level (processed) data, and derived data products such as maps, ancillary data, calibration data (ground and in-flight, and intercalibration as needed), documentation, related software, and/or other tools or parameters that are necessary to interpret the data. Data which is required to carry out the science objectives but is obtained by other facilities must be included in the archive. The PI shall be responsible for generating data products that are documented, validated, and calibrated in physical units that are usable by the scientific community at large.

For exceptionally complex data sets (for example, CMB polarization maps) it may be allowable to initially archive the raw data within six months of completion of the prime mission. Such an exception must be justified within the data management plan and plans for archiving the high-level data must also be described.

5.5 Proposal Appendix Requirements

Proposals requiring a NASA provided secondary launch opportunity for a Pioneers CubeSat or SmallSat project must fill out the rideshare accommodation worksheet posted on the Other Documents section of this program element's webpage and include it in the proposal appendix.

Proposals for Pioneers balloon payloads must include a BPO Feasibility Letter in the proposal appendix.

Proposals for ISS-attached Pioneers payloads must include a letter of feasibility from the ISS Research Integration Office in the proposal appendix.

6. Concept Study Report Requirements

The planned up-to-five-year duration of the award shall include an initial formulation phase lasting 6 months during which science and performance trades shall be made in order to optimize the mission design. This phase shall conclude with the delivery of a Concept Study Report (CSR) to NASA, which will be reviewed by NASA in order to determine if continuation of the program into development is warranted. The submitted budget must be for the full up-to-five year duration, but must include a period of limited funding (see Section 9) covering the interval up until the decision on continuation is received, which will be within 3 months of receipt of the CSR, followed by the budget for the implementation of the full project.

The CSR shall include a Project Plan, comprising an agreement on implementation approach, resources, cost, reviews, schedule, and other plans, in order to be approved to proceed from the formulation phase to implementation phase. This should include sufficient information to allow a Systems Requirements Review (SRR) to be conducted. The CSR shall identify what changes in performance and implementation were made from the original proposal, i.e., what trades have been made. For Pioneers projects requiring a secondary launch, an updated launch accommodation worksheet must be

included in the CSR. Please see the Other Documents section of this program element's webpage for an outline of the suggested contents of the CSR.

The CSR must include sufficient information for NASA to perform a uniform cost analysis on all submissions; please see the required contents listed on the Other Documents section of this program element's webpage. This may include a Master Equipment List (MEL) in abbreviated form.

Should review of the CSR reveal significant challenges (in, for example, cost, schedule or technology maturity), the project may be terminated or continued with a revised baseline.

7. Programmatic Information

7.1 Award Duration and Type

Awards will be for a maximum duration of 5 years and extramural awards will be in the form of Cooperative Agreements or Contracts. Deliverables as outlined in this document will be specified in the award documentation.

7.1.1 *Description of NASA Contribution*

It is anticipated that most awards to non-governmental organizations will be in the form of cooperative agreements (as opposed to grants) since SMD will be substantially involved after selection and intends to maintain an essential degree of oversight of the selected project(s) throughout the project lifecycle (e.g., see Section 4.1). Information on each suborbital-class platform provided as Government furnished equipment (GFE) and/or Government services by NASA is shown in Sections 3.1-3.3 and 7.2. Proposers should contact the referenced suborbital-class platform point of contact when developing their proposals to best understand the capabilities and limitations of each platform, their associated technical and integration services, how to schedule a flight/launch, and to ensure their proposed investigations are feasible from a vehicle perspective.

Award conditions will provide for effective control of integrated spacecraft with payload to transfer to NASA upon delivery to the launch site for integration into the launch vehicle. This will allow use of the NASA National Telecommunications and Information Administration (NTIA) process to obtain RF usage authorization from the FCC.

The Pioneers program's planning budget can accommodate two or more selection(s) within this solicitation's cost cap with a typical (combined) funding profile over a nominal five-year development period including launch. Proposers should request a funding profile that is appropriate for their investigation. However, NASA cannot guarantee that every proposed funding profile can be accommodated within the Pioneers program budget. The inability of NASA to accommodate the requested funding profile may be a reason for non-selection of a proposal. Final funding profiles for all selected investigations will be negotiated between the Pioneers program and the selected investigation teams.

7.2 Launch for Secondary Payloads (CubeSats and SmallSats)

All launch costs and spacecraft integration costs for secondary payloads will be covered by NASA and managed by NASA's Launch Services Program. Proposers should plan that launch for CubeSats will be via the CubeSat Launch Initiative (CSLI) and launch for larger payloads via the SMD rideshare program for secondary payloads launched on an ESPA ring with SMD missions. Through CSLI, NASA has begun regularly providing launch opportunities for CubeSats as secondary payloads on U.S. Government missions. The CubeSat Launch Initiative is managed by the NASA Human Exploration and Operations Mission Directorate.

Payloads are expected to adhere to ESPA or ESPA-grande standards, or containerized CubeSat standards for smaller spacecraft. Please see the information on the Other Documents section of this appendix's webpage for details.

Because of the availability of frequent launch opportunities, it is anticipated that the majority of the selections will be for investigations that would be delivered to moderately inclined low Earth orbit (LEO) at 400km-600km, geosynchronous transfer orbit (GTO), or Sun-synchronous orbit (SSO); other orbits (including low inclination LEO and cis-lunar) are allowed provided the case is made that launch opportunities as a secondary payload with an SMD primary mission could reasonably be expected. More details on the NASA rideshare program can be found in the Rideshare Users Guide (RUG) available on the Other Documents section of this program element's webpage. See also the SmallSat Virtual Institute (S3VI) Launch Portal for information on currently planned SMD launches which may have the capacity for rideshare payloads.

7.3 Cross-Waivers of Liability

Awards made in response to proposals to this program element will include the Cross-Waiver of Liability cited in Section 5.10.1 (and given in full in Appendix E) of the *NASA Grant and Cooperative Agreement Manual*: 5.a Cross-Waiver of Liability for International Space Station Activities and 5.b Cross-Waiver of Liability for Science or Space Exploration Activities Unrelated to the International Space Station. Cross-waivers will require the recipient to extend the correct cross-waiver terms and conditions to their subcontractors at any tier and related entities, ensuring those subcontractors and related entities also waive all claims against any entity or person defined in the provision for damages arising out of Protected Space Operations. This cross-waiver is intended to be broadly construed, and NASA extends it to its related entities as set forth in the provision. The language in the cross waiver is required by the international agreements NASA has with its international partners for the exploration of space.

8. Evaluation Considerations and Criteria

8.1 Evaluation Criteria

All proposals will be evaluated for Intrinsic Merit, Cost, and Relevance, as defined in Appendix D of the *NASA Guidebook for Proposers* and consistent with Section VI(a) of the *ROSES Summary of Solicitation*. While scientific merit is the primary factor in the Intrinsic Merit evaluation criterion, Pioneers projects also offer the opportunity for

advancing the technology readiness levels of future space flight detectors and supporting technologies and preparing future leaders of NASA space flight missions, such as early-career researchers and students. For Pioneers proposals, specific factors that will be considered when evaluating a proposal's intrinsic merit are primarily the scientific merit and secondarily the degree to which it advances the technology readiness level of a detector or supporting technology (see Section 8.3), and the degree to which it advances the readiness of early-career researchers or graduate students to assume leadership roles on future NASA space flight missions (see Section 8.2). As a rough guide, science merit will form ~50% of the evaluation, technical feasibility and, if applicable, merit and feasibility of technology development ~25%, and advancing early career researchers ~25%.

8.2 Early Career Team Members

Specific factors that will be considered when evaluating a proposal's intrinsic merit include the degree to which it advances the readiness of early-career researchers or students to assume roles in advancing NASA's strategic objectives. Brief details of the educational goals and training of the participants should be included in the main Science-Management-Technical section of proposal. The participation of graduate and undergraduate students, postdocs, and other early career team members is strongly encouraged, especially if the project can be concluded within the nominal tenure of student training or postdoctoral appointments. This participation is not limited to scientific staff but extends to all staff needed to carry out the proposed project. Early Career is defined as less than 10 years since receipt of the most advanced degree. It is allowed that the entire team be early career, but the mix of personnel, regardless of career stage, should be appropriate to carry out the proposed work.

8.3 Technology Development

While the emphasis in Pioneers is on astrophysics science investigations, the development of Pioneers projects does enable technology development. When proposing to carry out such development, it is recommended that the proposal should demonstrate that TRL 6 on all systems can be achieved by the end of the 6 month formulation stage and that all technologies will be flight ready by the time of delivery of the integrated mission for launch. A properly formulated technology development plan is consistent with the goals of Pioneers, and it could be a strength of a proposal.

8.4 Request for Reviewer Names

Proposers are strongly encouraged to provide names and contact information of up to five experts qualified to review their proposal. These experts must not be from the institutions of the PI or Co-Is or stand to benefit financially from the selection (or otherwise) of the proposal. This information should be included in the "program specific data question" in the Notice of Intent or emailed to the relevant Program Officer listed below.

9. Summary of Key Information

Maximum funding per investigation	$20M PI cost, over life cycle (real year dollars).

Expected annual program budget for new awards	$600K for the formulation phase (until three months after CSR delivery) $2.0M - $5M thereafter.
Number of new awards pending sufficient meritorious proposals	NASA intends to select 2 or 3 proposals, and pending sufficient budget, to continue each of those that pass the gate into implementation
Maximum duration of awards	5 years
Due date for mandatory NOI to propose	See Tables 2 and 3 of this ROSES NRA
Due date for proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	No sooner than February 1, 2021
Launch readiness date	No later than five years from the project start (when initial funding starts).
Page limit for the central Science-Management-Technical section of proposal	30 pages
Relevance	This program is relevant to the Astrophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See D.1 The Astrophysics Research Program Overview and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of the *ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of electronic proposals via NSPIRES	https://nspires.nasaprs.com/ (help desk available at 202-479-9376 or nspires-help@nasaprs.com)
Web site for submission of electronic proposals via Grants.gov	https://www.grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)

Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-PIONEERS
Points of contact, both of whom share the following postal address: Astrophysics Division NASA Headquarters Washington, DC 20546-0001	Main Point of Contact: Michael Garcia Telephone: (202) 358-1053 Email: michael.r.garcia@nasa.gov POC concerning Data Archive issues: Hashima Hasan Telephone: (202) 358-0692 Email: hashima.hasan@nasa.gov

D.17 EXTREME PRECISION RADIAL VELOCITY FOUNDATION SCIENCE

NOTICE: Amended October 9, 2020. This amendment presents a new opportunity in program element D.17 Extreme Precision Radial Velocity Foundation Science.

Proposals to this program will be submitted by a two-step process in which the Notice of Intent is replaced by a mandatory Step-1 proposal that must be submitted by an organization Authorized Organizational Representative. Only proposers who submit a Step-1 proposal are eligible to submit a Step-2 (full) proposal. See Section 3 of this program element. Step-1 Proposals are due December 17, 2020 and Step-2 proposals are due January 28, 2021

1. Background and Motivation

In 2017, NASA asked the National Academies of Sciences, Engineering, and Medicine to convene an ad hoc committee to survey the status of the field of exoplanet science and recommend a strategy for advancing the field. The report from that study, published in 2018, articulates both the key scientific questions facing the field as well as near-, medium-, and far-term measurement capabilities and technologies required to address them. This *Exoplanet Science Strategy*, or simply the ESS, covers a broad landscape from understanding the formation and evolution of planetary systems and characterizing their architectures, compositions, and environments to identifying potentially habitable environments, distinguishing between the signatures of life and those of nonbiological processes, and searching for signatures of extant life beyond our solar system.

Among the most important characteristics of planetary systems discussed in the ESS is planet mass. Indeed, the ESS makes the strong statement:

> "Mass is the most fundamental property of a planet, and knowledge of a planet's mass (along with a knowledge of its radius) is essential to understand its bulk composition and to interpret spectroscopic features in its atmosphere. If scientists seek to study Earth-like planets orbiting Sun-like stars, they need to push mass measurements to the sensitivity required for such worlds."
>
> *Exoplanet Science Strategy, National Academies Press (2018)*

In view of the central importance of determining planet masses to the field of exoplanet science, and consistent with the overarching goal of exoplanet science to characterize potentially habitable, Earth-like exoplanets and search for life, the ESS recommends that, "NASA and NSF […] establish a strategic initiative in extremely precise radial velocities (EPRVs) to develop methods and facilities for measuring the masses of temperate terrestrial planets orbiting Sun-like stars."

In response to this recommendation, in 2019 NASA and NSF convened an Extreme Precision Radial Velocity (EPRV) Working Group to develop a scientific and technological framework for implementing such an EPRV initiative. While the final report from the EPRV Working Group will not be available until Fall 2020, a presentation summarizing the group's vision for an EPRV initiative has been delivered to the agencies and is available through the NASA Exoplanet Exploration Program web page at https://exoplanets.nasa.gov/exep/NNExplore/EPRV/. The recommended framework

for the EPRV initiative involves a multifaceted approach that combines scientific research, advancement of measurement technologies, and the development of advanced observational platforms. Although full implementation of a joint NASA-NSF initiative to advance EPRV measurement capabilities must await the release of the 2020 Decadal Survey of Astronomy and Astrophysics and will be subject to its priorities, the Astrophysics Division has allocated a limited pool of funding in FY21 to support a pilot set of competitively-selected two-year investigations that address key challenges identified by the EPRV Working Group. This ROSES element is established to solicit proposals for such investigations.

2. Solicited Investigations

This ROSES program element solicits proposals for two-year investigations that fall within the scientific and technical scope of the program as described in Section 2.1 below. Because of the limited funding available for this pilot program, the scope of this proposal opportunity is necessarily limited and should not be construed as representative of the full range of activities and investments that will be required to reach EPRV measurement precisions at the level necessary to detect Earth-mass, rocky planets in the habitable zones of sunlike stars (~a few cm/sec). The scope of this solicitation has been chosen to focus on science and data analysis techniques that were identified as high value by the EPRV Working Group, and which have the prospect of yielding significant advances in EPRV measurement precisions within the context of a focused, two-year effort. Should this pilot program be continued in future years, it is anticipated that the scope would be broadened significantly in accordance with the architecture described by the EPRV Working Group.

2.1. Scope of the Program: Stellar (Radial Velocity) Variability and Advanced Data Analytics.

Stellar variability results from the effects of the complex combination of phenomena that shape the surface of a star - e.g., convection, granulation, surface oscillations, flares, spots, faculae, plage, etc. These phenomena are active over a wide range of spatial and temporal scales and together create a performance plateau at measurement precisions of ~1 m/s for most stars. This variability represents what is currently the most significant barrier to achieving the ~1 cm/s precisions needed to measure the masses of Earth-mass planets around Sun-like stars. A new wave of EPRV instruments (including the NASA-funded NEID spectrometer, built as part of the NASA-NSF EXoPLanet Observational Research, or NN-EXPLORE, partnership) are now coming on-sky and offer the prospect of penetrating the meter-per-second limitation. It is expected that observations with this new level of instrumentation will provide data sets for deep investigation into stellar variability and other noise sources. Among instrument teams, a common set of standard star targets is being negotiated to open the opportunity for cooperative/simultaneous observations. Further, many of the new instruments will operate with solar feeds, collecting abundant solar data for Sun-as-a-star investigations.

The central question of this effort is: "Can stellar variability be understood well enough to mitigate its limitation on radial velocity precision?" To answer that question, this ROSES element solicits investigations that will advance tools, techniques, and understanding to enable the extraction of small Keplerian radial velocity signals buried

deeply within complex time-series stellar spectra. Specifically, we seek investigations in the following areas:

- Studies of how stellar (including solar) surface phenomena (convection, granulation, supergranulation, various flows, oscillations, magnetic fields, spots, faculae, plage) impact the radial velocity time series measurements of disk-integrated spectra and how those impacts vary over magnetic cycles.
- Investigations leading to the development of models, tools, and techniques that can be applied to disk-integrated spectra of stars to mitigate stellar radial velocity variability.
- Analyses of disk-integrated precision radial velocity observations of the Sun and benchmark (standard) stars, along with cross comparisons and simultaneous observations from different radial velocity instruments, designed to evaluate the effectiveness of mitigation strategies for stellar radial velocity variability and instrument systematics.
- Development of advanced statistical methodologies to analyze complex radial velocity datasets to enable detection of small planets and precisely measure their masses.

Proposed investigations may involve theory, observation, analysis of archival data, or a combination these approaches.

2.2. Exclusions and Requirements

This ROSES element is not intended to solicit proposals for the development of radial velocity instrumentation or for the advancement of measurement or calibration technologies that enable high precision radial velocity measurements. Such work may be within scope under future solicitations if this program is extended and if sufficient funding is available.

Data Management Plan - Proposals to this program element must include an explicit data management plan (DMP). The DMP is to be placed in a special section of the proposal, not exceed two pages in length entitled "Data Management Plan" immediately following the references and citations for the S/T/M portion of the proposal. The two-page DMP section does not count against the 15-page limit of the S/T/M section. Formatting requirements for DMPs are the same as for the S/T/M section.

The sufficiency of the DMP will be evaluated as part of the Merit evaluation of the proposal. The DMP should contain the following elements, as appropriate to the project:

- A description of data sources, types, volume, formats, and (where relevant) standards;
- A description of the schedule for data archiving and sharing;
- A description of the intended repositories for archived data, including mechanisms for public access and distribution;
- A discussion of how the plan enables long-term preservation of data;
- A discussion of roles and responsibilities of team members in accomplishing the DMP.

It is anticipated that many of the data products of the research solicited here (including, but not limited to, raw and high-level data products, and software) will be appropriate for

curation as part of the NASA Exoplanet Archive (NEA) and/or the associated Exoplanet Follow-up Observing Program (ExoFOP) system. Proposers planning to take advantage of these repositories should include any associated costs in the budget of their investigation and should include a letter of acknowledgement from the NEA/ExoFOP in their proposal.

Organization and formatting of the proposal must conform to the requirements described in the 2020 *NASA Guidebook for Proposers* and the *ROSES-2020 Summary of Solicitation*. There is no minimum requirement for fonts used within figures and tables but all text in figures and tables should be legible to reviewers and illegible content may be cited as a weakness of any proposal. Proposals that do not conform to the page limits and formatting requirements described or referenced in this solicitation will be subject to penalty up to and including decline without review.

3. Proposal Preparation and Submission

To facilitate the early recruitment of conflict-free review panelists and to ensure that proposal concepts are compliant with the scope of the solicited program this program element will use a two-step proposal submission process (see Section IV.(b)vii of the ROSES *Summary of Solicitation*). Under the two-step process, a Step-1 proposal is required and must be submitted electronically by an AOR prior to the separate Step-1 deadline. No budget is required for the Step-1 proposal. Only proposers who submit a Step-1 proposal will be eligible to submit a full, Step-2 proposal. Such Step-2 proposals must address the same broad scientific goals described in the Step-1 proposal. The PI cannot be changed between the Step-1 and Step-2 proposals, and proposers who want to make changes to the proposing team must inform the point of contact identified in the summary table of key information (Section 4) and cc sara@nasa.gov at least two weeks in advance of the Step-2 proposal deadline date. Addition of funded investigators to the proposing team within two weeks of the Step-2 proposal deadline is subject to the explicit approval of the NASA point of contact. Submission of a Step-1 proposal does not obligate the proposer to submit a Step-2 (full) proposal later.

The Scientific/Technical/Management (S/T/M) section of a Step-1 proposal is restricted to the 4000-character text box on the NSPIRES web interface cover pages. Step-1 proposals must address the following topics:

- The goals and objectives of the proposed work;
- The approach and methodology to be used to address the goals and/or objectives; and
- The reason(s) why the work proposed is within the scope of this program element.

Following the submission of a Step-1 proposal, most proposers will be notified through NSPIRES that the Step-1 proposal has been designated as "encouraged" or "discouraged," at which point the proposer will be able to create a Step-2 proposal. No evaluation of intrinsic merit will be performed on Step-1 proposals. The perceived relevance of the proposed work to the particular program element will be the main factor in deciding whether submission of a Step-2 proposal will be encouraged. Please note that the Step-2 proposal evaluation is independent of the Step-1 designation i.e.,

reviewers of a Step-2 proposal do not know whether a proposal was encouraged or discouraged at Step-1.

In rare cases, for example, when the Step-1 proposal is not compliant with the requirements outlined above, or the proposed work cannot be funded because of NASA, Science Mission Directorate, or Astrophysics Division policy, a Step-1 proposal may be declined by the selection official. In such a case, a Step-2 proposal cannot be submitted.

Table 1 of the *ROSES-2020 Summary of Solicitation* provides a checklist of required information to be included in full proposals. Proposers should refer to that guidance for the preparation of their Step-2 proposals.

4. Summary of Key Information

Expected total program budget for lifecycle of new awards	$1.75 M in FY21 funds.
Number of investigator awards pending adequate proposals of merit	4 - 7 awards
Maximum duration of awards	Awards should be for a duration of 2 years.
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 of this ROSES NRA.
Due date for proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	May 1, 2021
Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of the *ROSES Summary of Solicitation*.
Relevance	This program is relevant to Strategic Goal 1 and Strategic Objective 1.1 in NASA's 2018 *Strategic Plan*. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted.

Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-EPRV
Point of contact concerning this program	Douglas Hudgins Exoplanet Exploration Program Scientist Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: 202-358-0988 Email: douglas.m.hudgins@nasa.gov

APPENDIX E: CROSS-DIVISION RESEARCH

E.1 CROSS-DIVISION RESEARCH OVERVIEW

1. Introduction

The Science Mission Directorate (SMD) sponsors program elements that apply across more than one of its four science research areas as defined in Section I of the *ROSES Summary of Solicitation*. Such cross-division program elements are listed here in Appendix E of the ROSES NASA Research Announcement (NRA). At the time of the initial release of this NRA, there are seven such programs, see below. Unless otherwise noted in the individual program elements, no contracts will be issued in response to proposals submitted to program elements in Appendix E, as it does not seem appropriate for the nature of the work currently solicited.

2. Data Management Plans

Most proposals to ROSES require a data management plan (DMP) or an explanation of why one is not necessary given the nature of the work proposed. There is considerable variation in how the program elements in Appendix E handle this, but for those program elements that require a DMP, its sufficiency will be evaluated as part of Merit and thus may have a bearing on whether or not the proposal is selected. The kinds of proposals that require a data management plan are described in the NASA Plan for increasing access to results of Federally funded research and in the SARA Frequently Asked Questions (FAQs) for ROSES. Proposers to E.2 Topical Workshops, Symposia, and Conferences (TWSC) will not be asked for a data management plan, because those are not research proposals. However, any peer reviewed publications that come out of awards from E.2 (such as conference proceedings) must still meet the requirement that the data behind figures and tables be available electronically at the time of publication, ideally in supplementary material with the article. Proposals to E.3 The Exoplanets Research Program, must include the DMP in the 15-page Science/Technical/ Management section of the proposal. Proposals to E.4 Habitable Worlds and any other elements that don't specify otherwise, must follow the ROSES default and include the DMP in a special section, not to exceed two pages in length, immediately following the References and Citations section for the Scientific/Technical/Management portion of the proposal. Please refer to those program elements for details. FINESST should refer to the text of that program element for requirements particular to that program element focused on graduate student research.

The DMP must cover any data needed to validate the scientific conclusions of peer-reviewed publications, particularly data underlying figures, maps, and tables. It also needs to cover any other data and software that would enable future research or the replication/reproduction of published results.

"Data" does not include preliminary and other unpublished data, data in prepublication documents, private communications, or certain other types of information that have been specifically exempted from the DMP requirement.

In the case of a project that would produce no data, as defined above, or only data specifically exempted, the DMP must state that no data preservation or data sharing is

needed, but must also explain why. In a case where no appropriate archive exists for a particular data set, the DMP should discuss alternative methods for making the data publicly available.

The DMP must contain the following elements, as appropriate to the project, in adequate detail for review:

- A description of data types, volume, formats, and (where relevant) standards;
- A description of the schedule for data archiving and sharing;
- A description of the intended repositories for archived data, including mechanisms for public access and distribution;
- A discussion of how the plan enables long-term preservation of data;
- A discussion of roles and responsibilities of team members in accomplishing the DMP. If funds are required for data management activities, these should be covered in the normal budget and budget justification sections of the proposal.

Software, whether a stand-alone program, an enhancement to existing code, or a module that interfaces with existing codes, created as part of a ROSES award, should be made publicly available when it is practical and feasible to do so, and when there is scientific utility in doing so. Stand-alone code that is not straightforward to implement, or whose utility is significantly outweighed by the costs to share it, is not expected to be made available. This expectation extends to three types of software, defined as follows:

Short Name	Name	Description	Examples
Libraries	Libraries and toolkits	Generic tools implementing well-known algorithms, providing statistical analysis or visualization, and so on, that are incorporated in other software categories.	Numerical Recipes, NumPy, general FFTs, LAPACK, scikit-learn, AstroPy, GDAL
Analysis software	Analysis, post-processing, or visualization software	Generalized software (not low-level libraries) used to manipulate measurements or model results to visualize or gain understanding.	Stand-alone image processing, topology analysis, vector-field analysis, satellite analysis tools, and so on
Frameworks	Modeling frameworks	Multicomponent software systems that incorporate a variety of models and couple them together in a complex way.	Community Earth System Model (CESM) is a collection of coupled models including atmospheric, oceanographic, sea ice, land surface, and other models

SMD expects that the source code, with associated documentation sufficient to enable use of the code, will be made publicly available as Open Source Software (OSS) under an appropriately permissive license (e.g., Apache-2, BSD-3-Clause, GPL). This includes all software developed with SMD funding used in the production of data products, as

well as software developed to discover, access, visualize, and transform NASA data. OSS is defined as software that can be accessed, used, modified, and shared by anyone. Awardees will not be required to continue maintenance of their software beyond the submission of the software to an appropriate repository.

3. Program Elements

The Topical Workshops, Symposia, and Conferences (TWSC) program element E.2 solicits proposals for topical workshops, symposia, conferences, and other scientific/technical meetings that advance the goals and objectives of the Astrophysics, Earth Science, Heliophysics, and Planetary Science Divisions. This program has no fixed due date or budget; proposals may be submitted at any time but are dependent on the availability of funds in the specific program or focus area. Thus, before submitting, potential proposers to TWSC are strongly urged to contact an appropriate SMD Program Officer(s) (at http://science.nasa.gov/researchers/sara/program-officers-list/) to investigate the availability of funds. This program element now allows proposals for events on astrophysics topics.

The Exoplanets Research Program (XRP) program element E.3 solicits basic research proposals to advance our knowledge and understanding of exoplanetary systems. Its objectives are the detection and characterization of planets and planetary systems outside of our Solar System, including the determination of their compositions, dynamics, energetics, and chemical behaviors. Research supported by this call may include observations, theoretical studies, and modeling. Observational proposals focused on detecting, validating, or characterizing potentially habitable planets and supporting the detection of biosignatures using current or future space telescopes also fall within the scope of the XRP.

The Habitable Worlds (HW) program element E.4 solicits basic research proposals about processes and conditions that create and maintain potentially habitable environments. This Program includes aspects of research relevant to the Heliophysics and Planetary Science Divisions. A common goal of these programs is to identify the characteristics and the distribution of potentially habitable environments in the Solar System and beyond. HW will be evaluating proposals using a dual-anonymous peer review process in which, not only are proposers unaware of the identity of the reviewers, but the reviewers are not given the identity of the proposers until after the evaluation of Merit. Proposals to HW must be prepared consistent with special instructions described in Sections IV(b)i and VI(b) of the ROSES-2020 *Summary of Solicitation* and in the text of E.4 HW.

Future Investigators in NASA Earth and Space Science and Technology (E.5) solicits proposals from accredited U.S. universities and other eligible organizations for graduate student-designed and performed research projects that contribute to SMD's science, technology and exploration goals. There must be a Principal Investigator (PI) at the submitting institution who will serve as the research mentor and the graduate student is listed on the proposal as a student participant.

The SMD Science Activation Program Integration proposal element (E.6) seeks to further enable NASA science experts and content into the learning environment more effectively and efficiently with learners of all ages. Competitively selected teams from

across the Nation work in partnership with each other and with NASA to connect NASA science experts, real content, and experiences with community leaders to do science in ways that activate participation and promote understanding.

The Open Source Software Tools, Libraries, and Frameworks program (E.7) seeks proposals for the improvement and sustainment of high-value, open source tools, frameworks, and libraries that have made significant impacts to the SMD science community.

Supplemental Open Source Software Awards are used to encourage the conversion of legacy software into modern code to be released under a generally-accepted, open source license (e.g., Apache-2, BSD-2-clause, GPL). Proposals for such supplements to add a software component to their "parent" award may be submitted either within 90 days of the selection of the parent award or no fewer than 90 days in advance of the yearly anniversary date of the parent award. See program element E.8.

Any other cross-division programs that are defined during the calendar year will be issued as amendments to ROSES, typically 90 days in advance of their established Proposal Due Dates.

E.2 TOPICAL WORKSHOPS, SYMPOSIA, AND CONFERENCES

NOTICE: Amended September 10, 2020. TWSC proposals continue to be accepted on a rolling basis; however, the final due date is extended to April 14, 2021.

Two entirely new sections have been added: 3.4 "Additional Information on Proposals to the Biological and Physical Sciences Division" and 4.4.3 "Videoconferencing, Access Innovations and Similar Purchases". The content under Section 3.3 "Additional Information on Proposals to the Planetary Science Division" (original section title) is deleted and replaced with a similar restriction applicable to all Divisions. In 4.6 "Antidiscrimination, Diversity and Inclusion" adds accessibility by persons with disabilities resource references.

New text has been added in bold and deleted language has been struck through in the following sections: 1. "Introduction and Funding Opportunity Description"; 3. "Relevance to SMD's Goals and Objectives" 3.3 "Additional Information on Proposals to the Planetary Science and Heliophysics Divisions"; 4.2.1 "Limitations on Participants and Events Conducted Within and Outside the United States, ; 4.4.1 "Geographic Location"; 4.3.1 "Non-U.S. and U.S. Sources"; 4.3.3 "Technology and Data"; 4.4.2 "Facilities"; 4.4.5 "Award Duration"; 4.7 "Within NASA, Inter-Agency and NASA-as Primary Sponsor Awards"; 5. "Other Factors"; and 7. Summary of Key Information.

February 14, 2020 Potential proposers must identify an SMD program officer in a technical area related to the topic of the prospective event from: http://science.nasa.gov/researchers/sara/program-officers-list/. Only individuals who are listed on this web page are authorized to accept a TWSC proposal for review, but they are not obligated to do so. Until at least one of the listed NASA SMD Program Officer confirms relevancy and/or availability of funds, do not prepare or submit a proposal.

1. Introduction and Funding Opportunity Description

The Topical Workshops, Symposia, and conferences (TWSC) is a program element in Research Opportunities in Space and Earth Sciences (ROSES). ROSES, an "omnibus" solicitation, provides common guidelines and information in its *Summary of Solicitation*. **Proposals submitted fewer than 90 days prior to the requested start date for the period of performance, i.e. when NASA funds will be needed to support the event, may be returned as noncompliant unless authorized prior to submission by the reviewing program.**

Through TWSC, the Science Mission Directorate (SMD) solicits proposals from eligible organizations for events, **including asynchronous and virtual workshops, etc**., that contribute to SMD's science, technology and exploration research goals. Proposal

submission requires designation of at least one reviewing division. However, proposals that are relevant to more than one division are welcome.

TWSC awards are grants made under the authority of 2 CFR 200. If necessary, as described in Section 3.4 of the Grant and Cooperative Agreement Manual (GCAM) "Determining Whether to Issue a Grant or Cooperative Agreement", NASA may choose to issue cooperative agreements. TWSC proposals align to 2 CFR § 200.432 *Conferences*, which includes meetings, retreats, seminars, symposiums, workshops or events with a primary purpose to disseminate technical information beyond SMD. Requesting support for ground transportation, meals or other sustenance may be allowable only when 1) reasonable and necessary to complete or deliver the event and 2) justified with evidence.

A TWSC proposal must describe any travel, logistics, accessibility, and health and safety considerations, including the security of proposed technologies provided to participants. If the proposing organization is the host of a TWSC event, then a PI shall describe in the proposal consultations within your organization about its safety policies and risk mitigation procedures in the case of a local or national public health or another type of emergency. When a PI's institution is not the primary host organizing the event, then describe any consultations with the organizers regarding any safety policies/procedures, travel flexibilities, alternate dates, plans for virtual participation, etc.

The scope of this program element across SMD is described in Section 2. Section 3 describes how proposals submitted in response to this program element must convincingly connect the proposed content of the event to specific goals, e.g., in SMD program elements or the *NASA Science Plan***.** Section 4 describes principles and constraints for proposals submitted in response to this program element.

2. Scope of Program

This program element solicits proposals for topical workshops, symposia, conferences, and other scientific/technical meetings (herein referred to as "events") that advance the goals and objectives of one or more of the following SMD Divisions: Astrophysics, **Biological and Physical Sciences,** Earth Science, Heliophysics, and Planetary Science.

~~As long as there is an interested SMD program/funder, proposals that contribute to SMD's cross-divisional science, technology and exploration goals also are solicited.~~ **Proposals that contribute to SMD's cross-divisional science, technology, and exploration goals also are solicited**. Proposals are not limited to traditional, e.g., in-person, meetings. Proposals for multiple related events should be well justified.

This program element is directed at, and strictly limited to, scientific and technical events of interest to SMD, not general education or public outreach conferences. Moreover, this program element does not support any type of research projects; course development; and/or scholarships or fellowships. Please note that travel or logistical support for students to participate in the proposed event is not a scholarship or fellowship **and may be included in proposals**.

Where other ROSES program elements specifically solicit for events, proposals must be submitted in response to those program elements instead of this one.

If an event-related proposal is not eligible for TWSC, other ROSES elements, or for SMD's other broad agency announcements, then **the prospective proposers should ask** ~~have~~ the interested NASA funding program point of contact **to** consult with TWSC's overall POC listed in Section 6 regarding potential alternatives.

3. Relevance to SMD's Goals and Objectives

Proposals submitted in response to this program element must demonstrate the relevance of the event to SMD by showing how the scientific/technical area(s) to be covered will advance high-level SMD goals and objectives, and specific outcomes identified in ROSES program elements, SMD roadmaps, other SMD program documents, such as the *NASA Science Plan*, findings in decadal surveys, or the reports of NASA advisory bodies or groups relevant to NASA. The *NASA Science Plan* ***Science 2020-2024: A Vision for Scientific Excellence***, **the** *NASA 2018 Strategic Plan*, and other documents, may be found at https://science.nasa.gov/about-us/science-strategy/.

Proposers that choose to demonstrate relevance by reference to ROSES elements are not limited to those solicited in the current ROSES. Some program element calls do not appear annually, but research in that area continues and TWSC proposals may still be possible. Proposed events may be limited to dissemination of the relevant science itself, or **of the** data analysis that leads to science, and may (or not) include a focus on technologies, methods, and capabilities. Events that focus on code development, data compression algorithms, higher order data products, model intercomparisons, the enhancement and/or application of new equipment to make pertinent measurements, etc. are welcome. All proposers must state from what source, e.g., ROSES program element, roadmap, decadal survey, etc., the claim of SMD relevance derives.

3.1 Additional Information on Earth Science Relevance

Proposals for workshops, symposia, conferences, or scientific/technical meetings in Earth Science should be carried out in support of NASA Science Questions and Goals from the ~~*2014 SMD Science Plan*~~ **newest Science Plan entitled** ***Science 2020-2024: A Vision for Scientific Excellence***.

NASA's Earth science research is conducted in four major areas: research and analysis, satellite missions, applied sciences, and enabling capabilities (e.g., data and information systems, high-end computing, airborne science, and technology development). Proposals for events under any of these four Earth science areas will be considered under this program element. NASA Earth Science's research and analysis programs emphasize interdisciplinary topics and interagency collaboration and coordination through the U.S. Global Change Research Program (http://www.globalchange.gov/). NASA's applied sciences area supports efforts to discover and demonstrate innovative and practical uses of NASA Earth science observations and research through applications projects carried out in partnership with end user organizations (http://AppliedSciences.nasa.gov/). NASA's enabling capabilities area supports efforts that engage the broader Earth science community to encourage partnerships and collaborations among data providers, users, and information

technology experts to improve data and data system interoperability (https://earthdata.nasa.gov/earth-science-data-systems-program/policies). Thus, events proposed to address the goals of NASA Earth Science research must, in many cases, involve substantial participation by interagency partners and/or end user organizations, and such participation will be considered as a positive factor in establishing relevance to NASA.

3.2 Additional Information on Proposals to the Astrophysics Division

Selection decisions regarding TWSC proposals submitted to the Astrophysics Division will be driven by the degree to which the proposal meets the following:

1. The topic and scope of the meeting must be compelling and timely, and the scientific program should promote the scientific benefits that conferences provide and the scientific priorities of NASA' Astrophysics Division (APD).
2. In general, it is not sufficient that a proposed event be scientifically compelling; the event should also support the strategic interests of the division as reflected in APD's investments in missions and projects and described in the Astrophysics Research Program Overview (ROSES-2020, Appendix D.1) and associated documents. The relevance to APD's strategic interests should be explicit and clearly demonstrated.
3. While proposals under which APD would be the only source of funding support for an event are allowed (i.e. the meeting will not happen in the absence of that sponsorship), APD will also accept proposals for events that involve funding contributions from multiple sources. In such instances, the proposal should identify the specific element or elements of the event that will be enabled or substantially enhanced by APD funding. Such elements may include (but are not limited to) professional development/training of students and/or early career scientists, **development** ~~cultivation~~ of a diverse and inclusive astrophysics science community, and support for participation by members of the community who would not otherwise be able to do so (either in-person or virtually).

3.3 Additional Information on Proposals to the Planetary Science **and Heliophysics** Division**s**

~~The Planetary Science Division will return without review proposals submitted fewer than 90 days prior to the requested start date for the period of performance, i.e., when NASA funds will be needed to support the event~~. **Neither the Planetary Science Division (PSD) nor Heliophysics Division have additional information**. **PSD has not canceled its fewer than 90 days rule, it is replaced by a similar restriction applicable to all Divisions located in Section 1 "Introduction and Funding Opportunity Description".**

3.4 Additional Information on Proposals to the Biological and Physical Sciences Division

NASA's Space Biology and Physical Sciences researchers support the NASA 2018 Strategic Plan goal to "Expand Human Knowledge Through New Scientific Discoveries" and "Objective 1.2: Understand Responses of Physical and Biological Systems to Spaceflight" by investigating a wide range of systems in

spaceflight and analog environments. NASA's Space Biology and Physical Sciences research priorities were 1) set out in the 2011 National Research Council Report "*Recapturing a Future for Space Exploration: Life and Physical Sciences Research for a New Era*", and 2) further defined by the 2018 National Research Council Report "*A Midterm Assessment of Implementation of the Decadal Survey on Life and Physical Sciences Research at NASA*".

Effective late July 2020, SMD established a Biological and Physical Sciences (BPS) Division to advance the biological and physical sciences through space-based research, and study the behavior and adaptation of physical processes, living organisms, and ecosystems to environments beyond Earth, to enable space exploration and pioneer scientific discovery. Prior to the July 2020 transfer, the Human Exploration and Operations Mission Directorate operated the BPS programs.

The Space Biology Research (SBR) program focuses on the effects of short and long duration spaceflight environment exposure on the biology of cells, microorganisms, plants, and animals. The SBR program's goals include: 1) to use microgravity and other space environment characteristics to enhance understanding of the adaptation and function of basic biological processes in spaceflight, 2) to develop scientific and technological knowledge that will contribute to a safe, productive human presence in space during exploration, and 3) to apply the knowledge and technologies gained to improve a) our nation's competitiveness and b) the quality of life on Earth.

SBR experiments use the International Space Station (ISS), ground-based microgravity analog systems, and non-ISS platforms to discover how the spaceflight environment impacts microorganisms, plants, and animals throughout their entire life cycle. SBR seeks to understand biological responses through the continuum of gravity, from microgravity through hypergravity. SBR limits its research program areas to omics and GeneLab, i.e., systems biology, plant biology, microbiology, developmental, reproductive, and evolutionary biology, cell and molecular biology, and animal biology.

The Physical Sciences Research (PSR) program conducts experiments in space, on Earth-based reduced-gravity platforms, and in other ground-based facilities, and conducts analysis, computational and theoretical investigations, to advance scientific knowledge in the disciplines of physical science, and to understand the effects of the space environment on physical and biological systems critical to space exploration. PSR limits its research support to biophysics, combustion science, complex fluids, dusty plasmas, fluid physics, materials science, and quantum science and technology. The National Academies reports, such as *Microgravity Research in Support of Technologies for the Human Exploration and Development of Space and Planetary Bodies* (2000), *Assessment of Directions in Microgravity and Physical Sciences Research at NASA* (2003), and *Review of NASA Plans for the International Space Station* (2006) guide these PSR programs.

Proposals for workshops, symposia, conferences, or other technical meetings should demonstrate clear relevance to the mission of the Biological and Physical

Sciences (BPS) Division. Proposals for workshops, particularly those related to the current Decadal survey being conducted by the National Academies, are welcome.

4. Program Principles and Proposal Constraints

4.1 Allowable Focus of Proposals

The goal of any proposed event must be to bring together existing or potential members of scientific communities relevant to NASA in order to enable science that addresses strategic goals and objectives (see Section I of the *ROSES Summary of Solicitation*), of the Science Mission Directorate (SMD) in order to:

A. Encourage and facilitate the use of mission data;
B. Increase the efficiency of investigators through advanced scientific/technical training;
C. Increase the efficiency of investigators through the open exchange of ideas, ~~and~~ **or,**
D. Expose investigators to new subject areas.

TWSC proposals must be written so that the overall objective of any proposed activity is clearly focused on one or more of the enabling activities specified by letters A through D and may include other types of science enabling approaches not listed. It is acceptable to have a goal of developing an output that is a prerequisite to achieving a target laid out in a ROSES program element, roadmap, decadal survey, etc., and to pay for the support for person time and/or logistics as an expense on the way to accomplishing that goal. A proposal with a stated goal of simply paying for logistics, however, would not be considered responsive to this program element.

4.2 Competition and Criteria for Selecting Event Participants

SMD principles **articulated in the NASA Science Strategy or Plan for the Science Mission Directorate entitled *Science 2020-2024: A Vision for Scientific Excellence*** include the use of competition to increase the effectiveness of awarded funds. Although SMD may provide only a fraction of the total funds required for an event, SMD expects participants to be identified through competition; exceptions require adequate justification. When funds are requested for the costs of participants to attend an event, then SMD expects the selection of participants will be based on an open call for abstracts or **other type** of application subject to an appropriate, criteria-based review process **that the proposal's narrative describes**. **A proposal's narrative also should describe, what, if any, recruitment strategies and review criteria may be used to ensure an open, collaborative, diverse and inclusive NASA science culture**.

SMD acknowledges the appropriateness of considering other factors beyond the scientific or technical merit or an abstract or application, such as but not limited to, geographic, institutional and/or career-stage types of diversity. As stated in Section III (a) of the *ROSES Summary of Solicitation*, NASA recognizes and supports the benefits of having diverse and inclusive scientific, engineering, and technology communities and fully expects that such values will be reflected in the composition of all proposal teams as well as peer review panels (science, engineering, and technology), science definition

teams, and mission and instrument teams. This also applies to, for example, speakers at a NASA-funded event.

SMD reminds proposers that as a condition of receipt of NASA funding, the awarded institution acknowledges and agrees to comply (and require any subgrantees, contractors, successors, transferees, and assignees to comply) with applicable provisions of national laws and policies prohibiting discrimination. TWSC organizers share these Federal civil rights obligations. For more information visit: https://missionstem.nasa.gov/compliance-requirements-nasa-grantees.html.

There may be reasons to select some or all participants without competition in order to attain the stated scientific or technical or other aim of the event. In such cases, **a thorough justification for invitational versus competitive participant selection must be** provide**d** in the proposal ~~a thorough justification for invitational versus competitive participant selection~~.

4.2.1 *Limitations on Participants and Events Conducted* ***Within and Outside the United States****~~, in Designated Countries~~*

Because conditions can change rapidly in any country at any time for a variety of reasons and disrupt the proposed or awarded TWSC support, proposals for events planned outside the U.S. must, at a minimum, demonstrate consultation of the State Department Travel Advisories website. For TWSC events in the U.S. for the duration of the Coronavirus Disease 2019 (COVID-19) pandemic, proposers making requests for travel support must consult and address the Centers for Disease Control (CDC) Considerations for Travelers - Coronavirus in the U.S. website as well as any applicable state, county or municipal laws or executive orders. The CDC also provides international travel information at https://www.cdc.gov/coronavirus/2019-ncov/travelers/index.html.

A proposal that requests to include any NASA civil servant as an in-person, on-site attendee or speaker, must address the "NASA Framework for Return to On-Site Work (as of 11 June 2020 or later)" that summarizes the limitations on all travel to or from NASA centers and justify why there is no non-travel option. NASA Contractor employees also may be subject to similar limitations and they will consult their management regarding potential travel to a TWSC event.

If the subject of the proposed event falls under **the** International Traffic in Arms Regulations (ITAR) or **the** Export Administration Regulations (EAR), then only a U.S. person may be proposed as the PI.

Most events that include participants from only U.S. and People's Republic of China organizations may be considered bilateral activities and thus ineligible for funding **from NASA** because of **legal** prohibitions ~~in Appropriation Acts~~. See also Section III.c of the *ROSES Summary of Solicitation* regarding NASA funding any work that involves the bilateral participation, collaboration, or coordination with China or any Chinese-owned company or entity, whether funded or performed under a no exchange of funds arrangement.

Proposals for events outside the United States in "Designated Countries" that also are "State Sponsors of Terrorism" will be subject to additional levels of review by the Office

of International and Interagency Relations (OIIR) that may result in a proposal being denied. NASA's "Designated Country (DC) List" is hosted on the NASA Export Control website at https://www.nasa.gov/oiir/export-control. The relevant part of the list is Column II, i.e., Countries determined by the Department of State to support Terrorism. The DC list is updated regularly; therefore, please consult the website to ensure use of the most up-to-date list.

Regarding participant support costs for non-U.S. persons, including travel and short-term visa costs, these costs may be proposed as a direct cost when **such costs qualify as** ~~part of~~ **"R**ecruiting costs**"**~~. See~~ **per** 2 CFR 200.463. Short-term travel and visa costs (as opposed to longer-term, immigration visas) are generally allowable expenses that may be proposed as a direct cost.

Since short-term visas are issued for a specific period and purpose, they may be identified as directly connected to participation on a TWSC award. For these costs to be directly charged to a TWSC award; however, the budget narrative must demonstrate that a non-U.S. person(s):

(1) Is critical and necessary for the conduct of the TWSC event;
(2) Is allowable under the applicable cost principles;
(3) Is consistent with the non-Federal entity's cost accounting practices and non-Federal entity policy; and
(4) Meets the definition of "direct cost" as described in the applicable cost principles. **For additional information see Subpart E - Cost Principles in 2 CFR 200**

The proposal narrative also should provide sufficient explanation for how non-U.S. participant support is relevant to SMD in accordance with Section 3 herein.

4.3 Availability of Funding

This program element has no dedicated budget, thus selected proposals will be funded by the relevant SMD Division. The number of proposals selected depends on the number and quality of proposals submitted and on the availability of funds from a relevant SMD program. Before submitting, potential proposers are to contact an appropriate SMD Program Officer(s) to investigate the availability of funds. Until at least one NASA HQ SMD Program Officer confirms relevancy and~~/or~~ availability of funds, please do not prepare or submit a proposal. Not every person working at NASA Headquarters, the Jet Propulsion Laboratory (JPL) or a NASA Center is a SMD program officer. Contact information for SMD Program Officers is available at http://science.nasa.gov/researchers/sara/program-officers-list/.

4.3.1 *Non-U.S. and U.S. Sources*

Subject to the Section 4.2.1"Limitations on Participants and Events Conducted **Within and Outside the United States**", the direct purchase of supplies and/or services that do not constitute research, e.g., key note speakers, facilitators, software licenses, etc. from non-U.S. and U.S. sources, including associated travel and related support, as a subaward by the U.S. award recipients is permitted. **For information on the required documentation for consultants, see 2 CFR § 200.459 Professional service costs.** This ROSES program element does not fund foreign or domestic research projects.

4.3.2 *Pass-Through Awards and Connections with Professional Networks or Societies and Research Platforms*

This program element does not allow for the award of pass-through funds, e.g., mini-grants, prizes, etc. to any individuals or organizations for research or educational activities, e.g., K-12 education teacher professional development. Criteria-based or competitively based travel awards and recognition awards associated with a TWSC event, e.g., best student poster/paper, etc. are permitted, when justified in the proposal and budget as a type of purchase per 4.3.1 or as a participant support cost.

Proposals to support special events, e.g., landmark anniversaries in a society/profession association, etc. are welcome. Proposers also may plan events designed to increase the efficiency of investigators through advanced scientific/technical training that coincide or extend an annual or other meeting of a professional association, scientific society, etc.

TWSC is not a source of multi-year funding for sustaining content platforms, communities of practice, or other networks/professional societies infrastructure. To request infrastructure support that is not limited to meetings or events, contact the appropriate program manager in SMD at NASA Headquarters to inquire about the availability of other opportunities, such as invitation-only proposals.

4.3.3 *Technology and Data*

Proposals that involve traditional and non-traditional meetings, e.g., hackathons, in order to plan to develop new or emerging technologies/research agendas or that feature existing SMD data and technologies/research are ~~both~~ welcome.

If technology, data, etc. are required to support the purpose of the proposal, then the purchase and/or modification of existing products is permissible. ~~However,~~ **With the exception of hackathons and similar innovative meetings**, the acquisition, ~~or~~ creation, or ~~sustainability~~ **maintenance** of new technologies, data, etc., may not be the main purpose of the proposal. TWSC proposals normally do not have a data management plans nor propose to create new or enhanced technologies. Proposals that need a data management plan and/or would generate a patent are probably research or development projects and not TWSC events.

4.4 Constraints on Logistics

The logistics of the event must be described well enough for SMD to ensure it will achieve the stated purpose(s). This includes and is not limited to the size, location, duration, scheduling, and cost of the event for both sponsors and attendees. No venue shall be proposed that discriminates on the grounds of race, color, age, ethnicity, religion, pregnancy, sexual orientation, gender identity, sex, marital status, disability, or status as a U.S. Veteran.

The funding request, whether a small grant to subsidize student participation or full sponsorship of a large symposium, must be commensurate with (a) NASA's stewardship roles for the subject science and the benefiting science community, (b) the importance of the event to SMD in attaining its goals and objectives, and (c) NASA’s responsibility to manage federal, i.e., taxpayer, funds and their expectations.

4.4.1 *Geographic Location*

Proposers are encouraged to choose a U.S. location, e.g., one of the 50 states, the District of Columbia, a U.S. territory, etc. ~~Proposers are discouraged from choosing a non-U.S. location~~. The proposal should explain why a non-U.S. location is justified. **For instance, when a meeting has sponsors from multiple nations, include in the proposal or the budget narrative a description of the choice of location and its impact on potential participation.**

4.4.2 *Facilities*

NASA encourages using facilities that are appropriate to the proposed event, e.g., an academic facility, a public or private conference center, a retreat facility, etc. NASA discourages proposing to use entertainment, recreation, sporting, or luxury venues. Proposals should explain any **such** unusual facilities choice. **Facilities or venues shall provide equal and integrated access for individuals with disabilities. For example, when access is not apparent, events may have to identify or add signage that enables participants with disabilities to navigate the accessible routes to a venue's restrooms, meeting rooms, etc.**

4.4.3 *Videoconferencing, Access Innovations and Similar Purchases*

Proposers may request to purchase and distribute the necessary equipment and/or contract with a service provider for videoconferencing, augmented reality, telepresence robots, communications software/licenses, etc. to replace or reduce participant travel to events and to produce agendas and proceedings. Explain the importance of these purchases/services and how they relate to the success, accessibility and safety considerations for the event in proposal's narrative. For these types of requests, in addition to explaining the role in the event, note whether total cost is over $5,000 in the budget. When over $5,000 provide a short, clear budget justification, e.g., a lease versus purchase analysis, etc. For example, document non-availability of a lease option by naming at least three leasing sources contacted with dates.

Communications and other technology often provide access innovations; however, some internet, media and technology choices create access challenges for participants who need language, audio, visual or other supports. The following federal guidance lacks the effect of law, except when incorporated into a federal contract, but TWSC provides these references to encourage proposers to consider and explain in the proposal equal access plans.

- **Guide to the Section 508 Standards** (June 2001)
  This link explains requirements in the original Section 508 Standards (2000) for electronic and information technology in the federal sector.
- **Guidance on the Telecommunications Act Section 255 Guidelines (April 1999) This link explains accessibility requirements for telecommunications products and services covered by Section 255 of the Communications Act.**

4.5 Award Duration

Most awards from this program element have a performance period of 12 months. Under certain circumstances, and if properly justified, it is permissible to propose multiple events that span across a longer performance period. For example, a pair of meetings before and after fieldwork, targets of opportunity (oil spills, comet ~~appears~~ **apparitions**, etc.) or another large project, **e.g. recurring, even annual, meetings that may or may not change topics or themes**, **that** make sense to plan and propose together. Otherwise, proposers should plan on a single event.

SMD is deeply concerned for the health and safety of people involved in NASA research dissemination activities funded via TWSC. NASA will do our part to help awardees 1) to continue to disseminate technical information; 2) to develop and to sustain future leaders, particularly graduate students, postdocs and early career researchers in the United States, and 3) to create a more collaborative, diverse and inclusive NASA science culture via TWSC. Therefore, should funded-TWSC projects be disrupted and require a performance period extension and/or to change scope, SMD program managers will be flexible and will ask the NASA Shared Services Center to be as accommodating as Federal Grant Policy Regulations permit.

4.6 Antidiscrimination, Diversity and Inclusion

Everyone related to NASA science, including awardees associated with this program element, should report harassment claims in accordance with the NASA Policy Statement on Antidiscrimination in NASA Conducted or Funded Program, Activities, and Institutions signed by Administrator Bridenstine at https://missionstem.nasa.gov/docs/Bridenstine_Title_IX_Policy_Statement_TAGGED.pdf. For detailed guidance related to filing a harassment complaint to NASA visit https://missionstem.nasa.gov/filing-a-complaint.html.

NASA's MissionSTEM Web site is available to assist programs and activities that receive NASA funding to meet their obligations under equal opportunity laws and augments the Agency's ongoing civil rights compliance reviews of NASA grant recipients. MissionSTEM hosts video and other media on topics such as diversity and inclusion leadership; implicit bias in STEM environments; etc.

An event's diversity and inclusion policies and practices should make clear that everyone is welcome within NASA Science and strive to create an environment that is free of harassment and discrimination. Organizers of events must have a specific policy**,** code of conduct or meeting ground rules provided in advance and available during the event for all participants.

In the proposal include a brief overview of the meeting conduct principles or policies and identify a responsible person(s). Selected examples of such meeting rules include:

- American Geophysical Union (AGU) Meetings Code of Conduct at https://www.agu.org/Plan-for-a-Meeting/AGUMeetings/Meetings-Resources/Meetings-code-of-conduct
- **Lunar and Planetary Science Conference** (LPSC) Statement on Harassment at https://www.hou.usra.edu/meetings/lpsc2018/#harassment

- American Astronomical Society (AAS) Anti-Harassment policy (which applies to all AAS and Division of Planetary Science meetings) at https://aas.org/policies/anti-harassment-policy-aas-division-meetings-activities.
- Ecological Society of America at https://esa.org/louisville/about/code-of-conduct/

Additionally, proposers should consult and collaborate with an Accessibility Resource Center or equivalent organization, prior to proposal submission to help ensure awareness of disability as a facet of diversity in order to advance access for the event and in recruiting. If not covered in the code of conduct or event principles, the proposal should identify where to address feedback or concerns related to the accessibility. If the TWSC proposal is a contribution to a third party's event, the proposal should explain how the third-party addresses accessibility.

See also the U.S. Access Board website for research, guidelines and standards resources at https://www.access-board.gov/.

4.7 Within NASA, Inter-Agency and NASA-as Primary Sponsor Awards

NASA leadership has developed agency-wide, Return to On-Site Work guidance that takes into account guidelines provided by the White House and the Offices of Personnel Management and Management and Budget, and calls for a methodical and flexible return to on-site work, including reducing in-person meetings and large or small in-person gatherings that are TWSC eligible. **Proposals for TWSC events at NASA must adequately address and account for the most current NASA Coronavirus Response and other relevant Operating Status Information available at: https://nasapeople.nasa.gov/.**

There are NASA Procedural Requirements documents (NPRs) that will be important when planning an event involving a NASA Center or Facility. For example, NPR 9770.1 Subject: *NASA Conference Approval and Reporting* and NPR 9710.1 Subject: *General Travel Requirements* provide the financial management requirements for conference planning, approval, attendance, and reporting for NASA. These NPRs specify in section P.2 *Applicability* that these NPRs are applicable to recipients of grants and cooperative agreements only to the extent specified or referenced in the award. Therefore, these NPRs while applicable to intra-NASA funding transfers, normally will not apply to most TWSC grants, ~~and~~ cooperative agreements, **and inter-agency transfer agreements**.

If the proposer anticipates that the resulting award will not be a grant or cooperative agreement (i.e., if the proposing institution is a Government laboratory, including the Jet Propulsion Laboratory **or a Federal Agency**) and the result of the award is that NASA will be the primary sponsor of a conference then the proposal must clearly state this fact, because NASA must provide detailed reports for NASA-sponsored conferences. In addition, there are other constraints set by Office of Management and Budget (OMB) policy memorandum, statute and federal regulations that limit options for NASA-sponsored conferences.

5. Other Factors

The amount that NASA can spend on TWSC is limited. Support from this program element is exclusively for scientific/technical subjects, see Sections 1 and 2.

This program element cannot result in the award of a contract, only a grant, cooperative agreement, an interagency agreement, or internal funding, i.e., an intra-agency transfer from Headquarters to a NASA Center or Facility or JPL.

Letters of affirmation from the relevant stakeholder community are permitted for proposals to this program.

Not all proposals to this program element are peer reviewed. Depending on the availability of appropriately knowledgeable SMD staff and the size of the request, some submissions may be reviewed only by program managers at NASA Headquarters.

Events that are proposed in response to this program element should have a public purpose and/or benefit, i.e., the proposer's event is primarily for its own purposes and NASA is supporting only with financial assistance. Thus, NASA may not direct a recipient in arranging the event or in providing other services for NASA's benefit. The proposed event must be run by the recipient, not by NASA. NASA projects that would satisfy a NASA requirement or provide a crucial deliverable (such as a decadal survey) through an event cannot be supported through this call. Events sponsored or initiated by NASA primarily to meet a specific NASA need or obtain information for the direct benefit of NASA must be supported by means of a contract and may not be proposed in response to this program element.

No NSPIRES ~~cover page~~ question on data management plans is posed for proposals to this program element. However, if appropriate, then proposers may present one or NASA may require one.

In order to route a proposal to the appropriate SMD personnel, proposers provide on the NSPIRES cover page the name of a NASA Headquarters point of contact and identify the relevant science program(s).

6. Proposal Alignment and Risks Guide or Checklist

This two-part guide or checklist is designed to help proposers 1) align proposals to the TWSC solicitation and 2) ensure the proposal disclosed and addresses risks, if any, that could prevent review or selection.

Part 1: Proposal Alignment Considerations

1. Is the proposal event-focused, e.g., topical workshops, symposia, conferences, other scientific/technical meetings or similar activity, i.e., events do not have to be exclusively in person or face-to-face (F2F)? Events may combine F2F with virtual or be entirely virtual, etc. See Section 4.3.3 "Technology and Data" and **Section 4.4.3 "Videoconferencing, Access Innovations and Similar Purchases".**
2. Does the proposal explain how the proposed event(s) advance(s) the goals/objectives of the funding SMD Division(s)?
3. Regarding its relevance to SMD, does the proposal 1) advance high-level SMD goals/objectives and/or 2) address specific, existing or anticipated, outcomes identified in the NASA Science Plan ***Science 2020-2024: A Vision for Scientific Excellence***, NASA's most current Strategic Plan, another ROSES program element(s), or other SMD documents, e.g., roadmaps, decadal survey findings, reports of NASA advisory bodies or other groups relevant to NASA, etc.?

4. Does the proposal briefly explain/acknowledge open recruitment of participants, e.g., identify review members or types of review processes or review criteria, provide a recruitment URL, etc.? If the proposal is for an invitation-only participant selection, has a justification or explanation been provided? See Section 4.2 "Competition and Criteria for Selecting Event Participants".
5. Does the proposal include a brief overview of the event's conduct principles/policies and does it identify a responsible person(s), i.e., makes clear that the proposed event's environment is **safe**, **accessible**, inclusive, diverse, and free of harassment and discrimination. See Section 4.6 "Antidiscrimination, Diversity and Inclusion" **and Section 1. "Introduction and Funding Opportunity Description**". Organizers of events must have a specific policy, code of conduct or meeting ground rules provided in advance and available during the event for all participants. **Does the proposal describe, any travel flexibilities, venue accessibility challenges, and participant health and safety strategies?**
6. Will the event occur at a NASA Center or Facility? If so, does the proposal reference/acknowledge the NASA Procedural Requirements documents or NPRs? NPR 9770.1 Subject: *NASA Conference Approval and Reporting* and NPR 9710.1 Subject: *General Travel Requirements* provide the financial management requirements for conference planning, approval, attendance, and reporting for NASA. See Section 4.7 "Within NASA, Inter-Agency and NASA-as Primary Sponsor Awards." NOTE: These NPRs normally are applicable only to intra-NASA funding transfers only and not to grants/cooperative agreements.
7. Is there explanation of how the proposed event(s) have a public purpose and/or benefit, i.e., the proposer's event primarily for its own purposes? What are the expected public benefits?

Part 2: Proposal Risk Considerations

NOTE: In most cases, there will be nothing to say about risks.

1. Does the event include only participants from the U.S. and the People's Republic of China or occur in China? If yes, does the proposal discuss the details?
2. Does the proposal request funds for events organized by or held in a "Designated Country" (DC)? Check the "Designated Country List" on the NASA Export Control website. See 4.2.1 "Limitations on Participants and Events Conducted in Designated Countries".
3. Is the proposed event hosted at an entertainment, recreation, sporting or luxury venue? Ensure the proposal explains any unusual venue/facility.
4. Does the proposed event(s) 1) occur in a non-U.S. location, e.g., not one of the 50 states, the District of Columbia, a U.S. territory, etc. *and* 2) does not occur in China or a DC? If so, ensure the proposal explains why it is non-U.S., e.g. the nature of the science is multi-national; it is not the U.S.'s turn, etc.
5. Does proposal need a data management plan and/or likely will generate a patent? See Section 4.3.3 "Technology and Data".
6. Is the proposal a request for of multi-year funding for sustaining research, content platforms, communities of practice, or other networks/professional societies infrastructure, and/or continuing or one-time only fellowships?

Please note, that compliance with this TWSC checklist does not mean that a proposal will be selected or awarded.

7. Summary of Key Information

Expected annual program budget for new awards	No dedicated budget; selected proposals will be funded by the relevant SMD program.
Number of new awards pending adequate proposals of merit	The number of proposals selected will be dependent on the number and quality of proposals submitted and on the availability of funds from the relevant SMD program.
Maximum duration of awards	Typically, 1 year, but see section 4.5
Due date for Notice of Intent to propose (NOI)	No Notices of Intent are requested for this program element.
Due date for proposals	Proposals may be submitted at any time until 11:59 pm Eastern time on ~~March 29~~ **April 14**, 2021
Planning date for start of investigation	**Typically, no earlier than** 6 months after **the proposal submission date** ~~receipt~~**.**
Page limit for the central Science/Technical/Management section of proposal	5 pp; see also Table 1 in the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*.
Relevance	See section 3. Proposals that are relevant to this program element are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	Please see ROSES *Summary of Solicitation* Section I(g) Order of Precedence, Table 1, and the *NASA Guidebook for Proposers*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-TWSC
Funding Points of Contact	https://science.nasa.gov/researchers/sara/program-officers-list

Coordinating point of contact concerning this program	Mary F. Sladek Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0861 Email: mary.f.sladek@nasa.gov

E.3 EXOPLANETS RESEARCH

NOTICE: May 5, 2020. Some of the points of contact for this program element have changed, see Section 4.

Amended March 20, 2020. In order to streamline the process for organizations still adapting to the COVID-19 emergency, this program is changing from Step-1 proposals (which must be submitted by an AOR) to Mandatory Notices of Intent (NOIs - which can be submitted by the PI). NOIs are due on the original Step-1 due date of March 27, 2020. Proposers who have already submitted a Step-1 proposal need not take any additional action. Proposers who have a Step-1 proposal in process may still submit the Step-1 by the due date or may submit an NOI instead. Note that any Step-1 proposal submitted between the date of this amendment and the due date will be marked as late by NSPIRES, but please ignore that; as long as it is submitted by the due date, it will be considered on time.

Proposals to this program will be taken by a two-step process in which the Notice of Intent is replaced by a required Step-1 proposal submitted by an organization Authorized Organizational Representative. No PDF upload is required or permitted for Step-1 proposals. Step-1 proposers must provide information in the Proposal Summary text box on the NSPIRES cover pages and provide the list of team members. Only proposers who submit a Step-1 proposal are eligible to submit a Step-2 (full) proposal.

A Data Management Plan is required as part of the 15-page S/T/M section and will be evaluated as part of Merit, see Section 3.3 for details.

1. Scope of Program

The Exoplanets Research Program (XRP) element solicits basic research proposals to conduct scientific investigations focused on exoplanets and exoplanetary systems. Broad objectives of this program include, but are not limited to: the detection and characterization of exoplanetary systems; characterization of individual exoplanets, through their composition, dynamics, energetics, chemical behavior, etc.; and the origins of exoplanets.

This program element is cross-divisional, and jointly managed by the four science divisions within the Science Mission Directorate: Astrophysics, Planetary Science, Heliophysics, and Earth Science. Proposed investigations that combine multiple scientific disciplines or cross traditional Divisional science boundaries are encouraged. This call supports observational, laboratory, modeling, and theoretical studies that focus on improving our understanding of exoplanetary systems. Proposed investigations should have significant impact on the study of exoplanets through collection and analysis of new data, analysis of archival data, collection and interpretation of laboratory data, or development of an observationally-testable prediction or theory.

Proposed investigations should do one or more of the following:

- Detect exoplanets and/or confirm exoplanet candidates;
- Observationally characterize exoplanets, their atmospheres, or specific host star properties that directly impact our understanding of the exoplanetary system;
- Explore the chemical and physical processes of exoplanets (including the state and evolution of their surfaces, interiors, and atmospheres);
- Improve understanding of the origins of exoplanetary systems.

Investigations with laboratory, theoretical, or modeling components must clearly describe how results will either be tested by observational data or how they will improve interpretation of existing data and/or be tested by observational data.

All XRP proposals will be evaluated, in part, on their significance to and impact on the advancement of exoplanet science. Proposals that have a near-term impact (within 5 years) are particularly encouraged. All proposals must include plans for scientific data analysis, public archiving of data (see Section 3.3), and for publication of results.

All XRP proposals will be evaluated, in part, on how the proposed studies will support past and current NASA missions and/or how they will facilitate the formulation and development of future NASA missions and strategic exoplanet programs. Proposals must demonstrate relevance to NASA by describing the benefit for NASA missions, with specific past, current, or future missions or programs identified. Proposers are encouraged to familiarize themselves with the Exoplanet Program's Science Plan and Science Gap List, that may be downloaded from (the lower right hand corner of) https://exoplanets.nasa.gov/exep/science-overview. However, the identification of novel science investigations beyond these plans and gaps is thoroughly encouraged.

2. Programmatic Information

2.1 Scope Clarifications

Ground-based observations are supported by XRP and may be made at any ground-based facility, public or private, including those supported by NASA. If new observations are to be made, the facility and all instrumentation specific to the investigation must be in scientific operation at the time of submission of the proposal, and the proposal must state whether or not observing time to support the proposed investigation has been awarded. Proposals must provide evidence of current instrument performance and data quality.

Observational proposals focused on detecting, validating, or characterizing potentially habitable planets fall within the scope of the XRP. Observational proposals focused on supporting the detection of biosignatures using current or future space telescopes also fall within the scope of the XRP.

Exoplanet investigations with a primary focus on analysis of data from a NASA public domain archive (including the Kepler and TESS missions) are in the scope of this program element. Such proposals should no longer be submitted to ADAP (Appendix D.2). To understand the permissible scope of archival data analysis within the XRP, proposers should follow the scope laid out in D.2 ADAP with one addendum: there are

no restrictions within the XRP on the fractions of archival, theory, modeling, or ground-based observing elements conducted within an investigation.

Proposed investigations of stellar objects or brown dwarfs are in scope of the XRP, but only if proposals demonstrate convincingly that the main focus of the research is to advance exoplanet science.

Observational, archival, theoretical, and modeling proposals focused upon the detection of technosignatures are in scope of the XRP.

For programs that have potential scope issues, consultation with an XRP Program Officer is encouraged before the Step-1 proposal deadline.

2.2 Exclusions

The Exoplanet Research Program is intended to encompass the majority of research investigations where exoplanets are the primary focus. However, there remains some overlap with other ROSES program elements resulting in the following exclusions:

Studies of the formation of planetary systems that are focused on increased understanding of our own Solar System, should be submitted to Emerging Worlds (program element C.2).

Theoretical or laboratory investigations focused on the studies of defining, understanding, or characterizing biosignatures generally fall in the scope of the Exobiology Program (C.5). Theoretical or laboratory investigations focused on the environmental conditions needed for life generally fall in the scope of the Habitable Worlds Program (E.4). For programs that have overlap between these areas, consultation with an XRP, Habitable Worlds, and/or Exobiology Program Officer is encouraged.

Proposed investigations containing major work elements of collecting and analyzing data from currently operating or future space missions that have Guest Investigator programs (e.g. TESS, Hubble, Webb, etc.) will not be considered for grant funding through XRP. Such investigations should respond directly to the Guest Investigator programs of the relevant missions.

Investigations with the primary objective of maintaining and operating observing facilities, or installing, developing, commissioning, or determining the integrated performance of instrumentation are not solicited in this program.

Proposals that are substantively identical to proposals submitted to another program element within ROSES will not be accepted for review in XRP.

2.3 Facilities Available to Proposers

Those investigators whose research requires high-performance computing should refer to the *ROSES Summary of Solicitation*, Section I(d), "NASA-provided High-End Computing Resources" under "Announcement Documents" on the NSPIRES page for this program. This section describes the opportunity for successful proposers to XRP to apply for computing time on either of two NASA computing facilities at the Goddard Space Flight Center’s Computational and Information Sciences and Technology Office or at the Ames Research Center’s Advanced Supercomputing Division.

2.4 Early Career Programs

This program element will participate in the Planetary Science Early Career Award (ECA; see program element C.19), with the aim of supporting research and professional development of outstanding early-career scientists.

Details of the Planetary Science Early Career Award (ECA) program are given in program element C.19. The aim of the ECA program is to support research and professional development of outstanding early-career scientists, and to help stimulate research careers in areas supported by the Planetary Science Division. XRP is an ECA-participating ROSES program element. Proposals from eligible PIs, or Science PIs if applicable, selected from XRP this year may become the 'parent award' for future ECA proposals. See program element C.19 for details.

2.5 Duration of Awards

We anticipate that most proposals will seek three years of funding. Proposals for fewer than three years are encouraged for projects that can be completed on shorter timescales. Four-year proposals are allowed but must clearly justify the need for the longer duration; this justification will be considered as part of the evaluation process.

2.6 Selecting Officials

Selections from XRP will be jointly made by appointed Selection Officials of all four Divisions within the Science Mission Directorate.

2.7 Research Coordination Networks

PIs of proposals selected for funding from this program element are eligible to become members of the Steering Committees of the Research Coordination Networks (RCNs) provided that the proposed investigation is aligned with the goals of an RCN. For more information, see: https://astrobiology.nasa.gov/news/astrobiology-program-faqs/. Relevance to an RCN is not an evaluation criterion for proposals to this program element, and eligibility for participation in an RCN does not indicate that additional research funding will be provided. The currently active RCNs are:

- NExSS: a research coordination network that brings together scientists from many disciplines to investigate the diversity of exoplanets and to learn how their history, geology, and climate interact to create the conditions for life. (For more information see https://nexss.info/)
- NfoLD: a research coordination network that brings together scientists from many disciplines to investigate life detection research, including biosignature creation and preservation, as well as related technology development. (For more information see https://nfold.org)

3. The Two-Step Submission Process

To facilitate the early recruitment of conflict-free peer review panels, and to ensure proposals are submitted to the appropriate program, XRP will use a two-step proposal submission process (see Section IV.(b)vii of the *ROSES Summary of Solicitation*).

A Step-1 proposal is required and must be submitted electronically by the PI's Authorized Organizational Representative (AOR). No budget is required. Only

proposers who submit a Step-1 proposal are eligible to submit a Step-2 proposal. Full (Step-2) proposals must broadly contain the same scientific goals proposed in the Step-1 proposal. The Step-1 proposal title and PI cannot be adjusted. To add funded investigators between the Step-1 and Step-2 proposals, proposers must write to the point(s) of contact below and cc sara@nasa.gov at least four weeks in advance of the Step-2 due date. Submission of the Step-1 proposal does not obligate the proposer to submit a Step-2 (full) proposal later.

3.1 Step-1 Proposal

Proposers should refer to the "Instructions for Submitting a Step-1 Proposal" under "Other Documents" on the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) web page for this program. The Step-1 proposal should identify the PI and team members on the proposal. The Scientific-Technical-Management section of the Step-1 proposal is restricted to the 4,000-character text box on the NSPIRES web interface cover pages and should include a description of the science goals and objectives to be addressed by the proposal, a brief description of the methodology to be used to address the science goals and objectives, and the relevance of the proposed research to this call. The Step-1 proposal may be used to determine whether the proposal was submitted to the correct program element. No evaluation of intrinsic merit will be done on Step-1 proposals.

The proposal is entered directly into a text field in NSPIRES, and no attachment is required or permitted. NSPIRES will notify proposers whether their Step-1 proposal is encouraged or not, at which point they will be able to create Step-2 proposals.

3.2 Step-2 Proposal

Proposers should refer to the document entitled "How to submit a Step-2 proposal" under "Other Documents" on the NSPIRES page for this program. The process for preparation and submission of the Step-2 (full) proposals is essentially identical to that associated with any other ROSES proposal. This is a reminder that all proposals submitted to ROSES must strictly conform to the formatting rules in Section IV of the *Summary of Solicitation* and the *NASA Guidebook for Proposers*. Those that violate any of the rules may be rejected without review.

3.3 Data Management Plans and Archiving

Note that this is a new requirement for ROSES 2020.

To broaden access to the results of NASA-funded research, proposals submitted to this program element must include a data management plan (DMP) that covers any data needed to validate the scientific conclusions of peer-reviewed publications (particularly data underlying figures, maps, and tables) and any other data and software that would enable future research or the replication/reproduction of published results. If the proposed work would not produce data suitable for deposition in a stable long-term public archive, then that must be explicitly justified in the proposal.

Data management plans must be included in the 15-page Science/Technical/ Management section of the proposal and will be evaluated as part of Merit.

A DMP should answer these types of questions:

1. What data types, volumes, formats, and (e.g., where relevant) data standards?
2. Where does the project intend to make these data available?
3. When will these data be made available?
4. Who will do archiving and what experience do they have with this kind of data, archive, etc.?

Software, whether a stand-alone program, an enhancement to existing code, or a module that interfaces with existing codes, created as part of a NASA award, should be made publicly available when it is practical and feasible to do so, and when there is scientific utility in doing so. Stand-alone code that is not straightforward to implement, or whose utility is significantly outweighed by the costs to share it, is not expected to be made available. NASA expects that the source code, with associated documentation sufficient to enable use of the code, will be made publicly available in the NASA GitHub (https://github.com/nasa), or another NASA-supported archive (e.g., for mission-specific code, when appropriate), or an appropriate community-recognized depository (for instance, the homepage of the code base for which a module was developed). Archiving software in a public repository does not require the proposer to maintain the code. Awards that derive from proposals that include plans to post code in GitHub will contain a Rights in Data clause reflecting this expectation.

For proposals that use non-mission data (e.g., laboratory results, Earth-based observations) that are not publicly available (in any publicly accessible archive, in the literature, etc.), the project is expected to make the data available following the Data Management Plan guidelines.

"Data" does not include preliminary and other unpublished data, data in prepublication documents, private communications, or certain other types of information that have been specifically exempted from the DMP requirement.

In the case of a project that would produce no data, as defined above, or only data specifically exempted, the DMP should state that no data preservation or data sharing is needed and must also explain why. In a case where no appropriate archive exists for a particular data set, the DMP should discuss alternative methods for making the data publicly available.

DMPs will be reviewed as part of the overall NASA research proposal review process. Proposals that do not address each of these items in their DMP, even if determined to be selected or selectable for funding, may not be funded until an adequate DMP is submitted. Funded researchers, research institutions, and NASA centers are responsible for ensuring and demonstrating compliance with the DMPs approved as part of their awards. Awardees who do not fulfill the intent of their DMPs may have continuing funds withheld and this may be considered in the evaluation of future proposals.

4. Summary of Key Information

Expected program budget for first year of new awards	~$ 4 M
Number of new awards pending adequate proposals of merit	~25
Maximum duration of awards	3 years; 4 years if well-justified (see Section 2.4)
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	January 1, 2021
Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of ROSES and the *NASA Guidebook for Proposers*.
Relevance	This program is relevant to the questions and goals of the Science Mission Directorate as described in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	Please see *ROSES Summary of Solicitation* Section I(g) Order of Precedence and the *NASA Guidebook for Proposers*.
Submission medium	Electronic proposal submission is required; no hard copy is required. See also Section IV in the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*.
Web site for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-XRP
Points of contact concerning this program, all of whom share the following postal address: Science Mission Directorate NASA Headquarters Washington, DC 20546-0001	Richard Eckman Earth Science Division Telephone: (202) 358-2567 Email: richard.s.eckman@nasa.gov Galen Fowler Heliophysics Division Telephone: (202) 358-0039 Email: galen.fowler@nasa.gov Continued…

	Douglas Hudgins Astrophysics Division Telephone: (202) 358-0988 Email: douglas.m.hudgins@nasa.gov **[Added May 5, 2020]** **Pam Marcum** **Astrophysics Division** **Email: pamela.m.marcum@nasa.gov** **[Changed May 5, 2020]** **Doris Daou** Planetary Science Division Telephone: (202) 358-**1686** Email: **doris.daou-1@nasa.gov**

E.4 HABITABLE WORLDS

NOTICE: Amended October 19, 2020. The scope of this program element has been updated to include transient environments. Please refer to the bullet list of target bodies in Section 1. The main point of contact has changed. New text is in bold. The proposal due dates remain unchanged.

Amended July 6, 2020. This program element will not be solicited next year in ROSES-2021. It is still solicited this year and it is anticipated that it will be solicited every year after 2021. The due dates remain unchanged: Step-1 proposals are due 11/17/2020 and Step-2 proposals are due 01/15/2021.

Clarified June 25, 2020. The summary table of the key requirements for anonymized proposals, reproduced from the "Guidelines for Anonymous Proposals" in Section 3.3 has been modified to indicate that not just the budget justification but also the (redacted) budget numbers should be included in the anonymized proposal. New text is in bold.

March 2, 2020. Section 2.2 has been corrected to indicate that proposals on the formation of complex organic molecules in space and their delivery to planetary surfaces should be submitted to C.5 Exobiology, not C.2 Emerging Worlds. New Text is in bold and deleted text is struck through.

Proposals to this program continue to be taken by a two-step process in which the Notice of Intent is replaced by a required Step-1 proposal submitted by an organization Authorized Organizational Representative. See Section 3 for details.

Step-2 proposals submitted to this program will be evaluated using a dual-anonymous review process. Proposals must be prepared according to the guidelines in Section 3.3 and in the associated "Guidelines for Anonymous Proposals" document under other documents on the NSPIRES page for this program element.

A separate Relevance Statement is required for proposals to this program element, see section 2.1 for details.

1. Scope of Program **[Amended October 19, 2020]**

The goal of the Habitable Worlds program is to use knowledge of the history of the Earth and the life upon it as a guide for determining the processes and conditions that create and maintain habitable environments **(including transient environments)** and to search for ancient and contemporary habitable environments and explore the possibility of extant life beyond the Earth.

NASA's Habitable Worlds Program includes elements of the Astrobiology Program, the Mars Exploration Program, the Outer Planets Program, **the Planetary Protection Research Program** (all in the Planetary Science Division) and Living With a Star in Heliophysics. A common goal of these programs is to identify the characteristics and the

distribution of potentially habitable environments in the Solar System and beyond. This research is conducted in the context of NASA's ongoing exploration of our stellar neighborhood and the identification of biosignatures for *in situ* and remote sensing applications. For further information on the science scope of Astrobiology, please refer to the Astrobiology roadmap, which can be found on the Astrobiology web page http://astrobiology.nasa.gov/. Information on the habitability-related goals of the Mars Exploration Program can be found in the "*Mars Science Goals, Objectives, Investigations and Priorities: 2010*" document, available on the Mars Exploration Program Analysis Group web page (http://mepag.jpl.nasa.gov). For the Outer Planets Program, refer to the document "*Scientific Goals and Pathways for Exploration of the Outer Solar System*," found on the Outer Planets Assessment Group web site (http://www.lpi.usra.edu/opag).

Theoretical and experimental studies will be considered, as well as quantitative terrestrial field experiments that improve scientific understanding of how *in situ* measurements at analog sites can or will improve our understanding of the potential for the environment to support life. Research areas include, but are not limited to, the presence of water and/or exotic solvents, sources of energy for life, presence of organics and their reactivity, and water body physics and chemistry as they pertain to habitability and habitability over time, as well as space weather signatures that may be indicative of impacts to planetary habitability. The target bodies for this program element include, but are not limited to:

- Mars - the astrobiological potential of past or present environments on or in the Martian surface or subsurface.
- Icy Worlds - the astrobiological potential of icy worlds in the outer Solar System, including Europa, Ganymede, Enceladus, and Titan.
- Habitable Exoplanets and/or their moons - A potentially habitable exoplanet implies a planet with conditions roughly comparable to those of Earth (i.e., an Earth analog) and thus potentially favorable to the presence of life.
- **Built or human activity induced environments (e.g. spacecraft assembly facilities or off-nominal impact of a spacecraft).**

Proposals are sought for new projects within the scope of the Habitable Worlds. Proposals submitted in response to this Program Element should be for new work that is not currently supported by the program or for investigations that would extend to their next logical phase those tasks that have been funded in the Astrobiology, Mars Fundamental Research, Living with a Star, Exoplanet Research, and Outer Planets (or other) programs.

2. Programmatic Information

The Habitable Worlds element will be administered primarily by the Planetary Science Division. As such, this program element is governed by information contained in program element C.1. However, highly-rated proposals of strong programmatic relevance to the Heliophysics Division will be considered for funding by the Heliophysics Division.

2.1 Relevance Statement Requirement

Step-2 Proposals to this program element must specifically address the relevance of the proposed work to this program element. This must be placed in a special section, not to exceed one page in length, immediately following Data Management Plan. This section is outside of the 15-page Scientific/Technical/Management Section. This requirement supersedes the *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation*, and the omission of this section is sufficient reason for a proposal to be returned without review.

The relevance discussion must explicitly refer to this program element and the section to which the proposal is responsive. If the proposed work is close in scope to research covered by any other program element, this discussion must also justify why it is more relevant to this program element than that other program element. This discussion may not be used to address the proposal's intrinsic merit, budget justification, or any other factor that remains in the 15-page main body, or any other section, of the proposal. This section must be anonymized.

2.2 Program Exclusions

Proposals focused on the formation of complex organic molecules in space and their delivery to planetary surfaces in the Solar System should be submitted to **C.5 Exobiology** ~~C.2 Emerging Worlds~~ **[Corrected March 2, 2020]**. Proposals focused on the formation and stability of habitable planets should be submitted to either C.2 Emerging Worlds or E.3 Exoplanet Research Program, depending on the nature of the study. **Proposals focused on the survivability of terrestrial microbes in non-Earth environments should be submitted to C.15, the Planetary Protection Research Program the next time it is solicited (it is not solicited in ROSES 2020 [Added October 19, 2020].** Refer to those program elements for more information.

Biosignature studies of samples from sites thought to be analogs of other planetary environments that might potentially harbor life should be directed to C.5 Exobiology. Models of environments in which organic chemical synthesis could occur and the forms in which prebiotic organic matter has been preserved in planetary materials should be directed to C.5 Exobiology. Work to understand the phylogeny, physiology, and adaptations of extant terrestrial organisms to extreme environments should be directed to C.5 Exobiology.

Field-based investigations focused on exploring the relevant environments on Earth in order to develop a sound technical and scientific basis to conduct planetary research on other Solar System bodies should be directed to C.14 PSTAR (Planetary Science and Technology from Analog Research) program.

Through its data analysis programs, C.7 New Frontiers Data Analysis Program (NFDAP), C.8 Lunar Data Analysis Program (LDAP), C.9 Mars Data Analysis Program (MDAP), C.10 Cassini Data Analysis Program (CDAP), and C.11 Discovery Data Analysis Program (DDAP), the Planetary Science Division solicits proposals for work that are primarily analysis of planetary mission data. This program element does not accept proposals that are eligible for submission to one of those data analysis

programs. If a proposal is not appropriate for one of the data-analysis programs, but does fit within the bounds of this program, then it should be submitted to this program.

2.3 Pilot Studies

Proposals for one to two-year pilot studies to demonstrate or develop a new technique or a new application of an established technique will be considered. Such proposals may also include the demonstration of a technique new to the proposer, but not new to the field in general.

2.4 Instrumentation: Purchase, Construction, or Upgrade

Proposers to Habitable Worlds are eligible to request funds for major equipment under the Planetary Major Equipment and Facilities (PMEF) program. See program element C.17 for information on how to append a PMEF request to a regular Habitable Worlds research proposal or submit a stand-alone PMEF proposal to supplement an existing Habitable Worlds award.

2.5 Development of Instruments

This program element does not request proposals for the development of advanced instrument concepts and technologies as precursors to astrobiology flight instruments. Such proposals may be submitted to C.12 Planetary Instrument Concepts for the Advancement of Solar System Observations (PICASSO) Program, for technology readiness levels (TRLs) 1-3 or C.13 Maturation of Instruments for Solar System Exploration (MatISSE) Program for TRLs 4-6. Proposals for science-driven field campaigns that are expected to produce new science results, as well as new operational or technological capabilities, should be submitted to the C.14 Planetary Science and Technology Analogs Research (PSTAR) program.

2.6 Astrobiology Program Research Coordination Networks

The NASA Astrobiology program uses Research Coordination Networks (RCN) as a virtual collaboration structure to help support groups of investigators to communicate and coordinate their research across disciplinary, organizational, divisional, and geographic boundaries. Habitable Worlds solicits proposals aimed at habitability of any planet, including those within the Solar System and beyond and PIs of proposals selected for funding from this program element that cover a research topic related to the habitability can opt to join a relevant RCN. For more information see https://astrobiology.nasa.gov/about/faq/what-is-rcn/.

2.6.1 *Nexus of Exoplanet System Science (NExSS)*

PIs of proposals selected for funding from this program element that cover a research topic related to the habitability of, or search for life on, exoplanets can join the Nexus of Exoplanet System Science (NExSS). Relevance to NExSS is not an evaluation criterion for proposals to this program element. Eligibility for participation in NExSS does not indicate that additional funding will be provided; NExSS is a research coordination network that brings together scientists from many disciplines that study planets beyond our Solar System. For more information see https://nexss.info/.

2.6.2 *Network for Ocean Worlds (NOW)*

PIs of proposals selected for funding from this program element that cover a research topic related to the habitability of ocean worlds can join the Network for Ocean Worlds (NOW). Relevance to NOW is not an evaluation criterion for proposals to this program element. Eligibility for participation in NOW does not indicate that additional funding will be provided; NOW is a research coordination network that brings together scientists from many disciplines that study ocean worlds across their interiors, oceans, and cryospheres. For more information see https://oceanworlds.space/.

2.7 Duration and Size of Awards

NASA anticipates that most proposals will seek three years of funding. Proposals for less than three years are encouraged for projects that can be completed on shorter timescales. In rare cases, funding for the proposed fourth year may be provided, if the need for the longer duration is sufficiently well justified. The appropriateness of the proposed funding period will be reviewed, and adjustments may be requested. Programmatic balance may limit the opportunities for funding in some areas.

The average size of awards resulting from Step-2 proposals submitted to Habitable Worlds has been ~$175-185K per year per award, but with a wide range, depending on the nature of the work proposed. Proposers are encouraged to request what they actually need to conduct the research proposed.

2.8 Planetary Science Early Career Award

Details of the new Planetary Science Early Career Award (ECA) program are given in program element C.19. The aim of this program is to support research and professional development of outstanding early-career scientists, and to help stimulate research careers in areas supported by the Planetary Sciences Division. This program is an ECA-participating ROSES program element. Proposals from eligible PIs, or Science PIs if applicable, selected from this program in 2020 may become the 'parent award' for future ECA proposals (i.e., in 2021 or later).

2.9 Antarctica

The Habitable Worlds Program is not accepting proposals for work in Antarctica.

2.10 Resources: Information, Data, and Facilities

For proposals that contain mission data analysis, planetary spacecraft mission data to be used in proposed investigations must be available in the Planetary Data System (PDS) or equivalent publicly accessible archive at least 30 days prior to the Step-2 proposal due date. Spacecraft data that have not been obtained yet (i.e., future mission data) or those that have not been accepted for distribution in approved archives are not eligible for use in investigations. Regardless of the archive(s) used, if the data to be analyzed have issues that might represent an obstacle to analysis, the proposers must demonstrate clearly and satisfactorily how such potential difficulties will be overcome. Investigators funded by spacecraft missions who wish to apply must demonstrate clearly how the proposed research does not overlap and is not redundant with data analysis, duties, or responsibilities already funded by their respective mission(s). Please see C.1, The Planetary Science Division Research Program Overview, for more

information.

2.10.1 Facilities and Data Sources Available to Proposers

Proposers are advised to read C.1 Planetary Science Division Research Program Overview for information on facilities and data sources that are available to supported investigators. If their use is anticipated, this must be discussed and justified in the submitted proposals in the separate "Expertise and Resources- Not Anonymized" document, as outlined in the "Guidelines for Anonymous Proposals" instructions (see Section 3.3). Also note that, per the directions in the *NASA Guidebook for Proposers*, a letter of support may be required from any facility required for the proposed effort. This letter should also be included in "Expertise and Resources- Not Anonymized" document, if applicable.

2.10.2 Geologic Maps

Proposers who plan investigations involving geologic mapping should consult program element C.1, Section 3.8, for guidance on submission and requirements for publication of U.S. Geological Survey (USGS) maps. The scientific goal of such a geologic map product should be clearly explained and justified.

2.11 NASA Postdoctoral Program Fellows

Grantees in the program are eligible to serve as mentors to Astrobiology NASA Postdoctoral Program (NPP) Fellows. The tenure of a Fellow must begin one year before the end of the award but may extend beyond it. Proposals from potential Fellows must be submitted through the standard NPP process. This Program expects to select no more than two Fellows this year. More information about the NASA Postdoctoral Program may be found at http://npp.usra.edu/.

2.12 Data Management Plans

Proposals submitted to this program element must include a Data Management Plan (DMP, see program element C.1, Section 3.6). This must be placed in a special section, not to exceed two pages in length, immediately following the References and Citations section for the Scientific/Technical/Management portion of the proposal. This section of the proposal must be anonymized. In cases where a letter of support from the Planetary Data System is required, that letter may be included in the separate "Expertise and Background" document as outlined in the "Guidelines for Anonymous Proposals" instructions (see Section 3.3).

3. The Two-Step Submission Process

To facilitate the early recruitment of a conflict-free review panel and to ensure proposals are submitted to the appropriate program, this program uses a two-step proposal submission process (see Section IV. (b) vii of the ROSES *Summary of Solicitation*).

A Step-1 proposal is required and must be submitted electronically by the Authorized Organizational Representative (AOR). No budget is required. Only proposers who submit a Step-1 proposal are eligible to submit a Step-2 proposal. Full (Step-2) proposals must broadly contain the same scientific goals proposed in the Step-1 proposal. The Principal Investigator (PI) cannot be adjusted and proposers that want to add funded investigators between the Step-1 and Step-2 proposals must inform the

point(s) of contact below and cc sara@nasa.gov at least two weeks in advance of the Step-2 due date. Submission of the Step-1 proposal does not obligate the proposer to submit a Step-2 (full) proposal later.

3.1 Step-1 Proposal

Proposers should refer to the "Instructions for Submitting a Step-1 Proposal" under "Other Documents" on the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) page for this program. The Scientific-Technical-Management section of the Step-1 proposal is restricted to the 4000-character Proposal Summary text box on the NSPIRES web interface cover pages and should include a description of the science goals and objectives to be addressed by the proposal, a brief description of the methodology to be used to address the science goals and objectives, and the relevance of the proposed research to this call. The Step-1 proposal may be used to determine whether the proposal has been submitted to the appropriate program element. No evaluation of intrinsic merit will be performed on Step-1 proposals.

NSPIRES will notify proposers whether their Step-1proposal has been designated as encouraged or not, at which point they will be able to create Step-2 proposals.

3.2 Step-2 Proposal

All proposals submitted to ROSES must strictly conform to the formatting rules in Section IV of this announcement and the *NASA Guidebook for Proposers*. Those that violate the rules may be rejected without review. In previous years, problems with the formatting of the Scientific/Technical/Management section proposals have been noted. Please pay particular attention to:

- Length: 15 pages
- Margins: 1 inch on all sides, with a standard page size of 8.5 × 11 inches.
- Font: The *NASA Guidebook for Proposers* requires that proposers use a 12-point or larger font. The selected font must meet the requirement of having, on average, no more than 15 characters per inch (e.g., Times New Roman and Arial). Proposers may not adjust the character spacing or otherwise condense a font from its default appearance.
- Line spacing: Font and line-spacing settings should produce text that contains no more than 5.5 lines per inch. Do not adjust line-spacing settings for your selected font below single-spaced.
- Figure captions: must follow the same font and spacing rules as the main text.
- Figures and tables: for text in figures and tables, font and spacing rules listed above do not apply, but all text must be judged to be legible to reviewers without magnification above 100%. Do not place expository text in tables or figures in order to gain space.

3.3 Instructions for Dual-Anonymous Peer Review

Step-2 proposals submitted to this program will be evaluated using a dual-anonymous peer review process in which, not only are proposers unaware of the identity of the members on the review panel, but the reviewers are not told the identity of the proposers until after the evaluation of merit, see below. The overarching objective of

dual-anonymous peer review is to reduce unconscious bias in the evaluation of the merit of a proposal.

To implement dual-anonymous peer review, reviewers may not see any information that would identify proposers, so proposers must follow the instructions in the "Guidelines for Anonymous Proposals" document under "Other Documents" on the NSPIRES page for this program element that explain how to properly prepare the proposal for dual-anonymous peer review.

The forms filled out on the NSPIRES web pages with Proposal Summary, Budget, Proposal Team and Program Specific and Business Data known as the NSPIRES "cover pages" will not be seen by peer reviewers. This has two implications: 1) The Proposal summary must also be included as the first page of the proposal PDF and the Relevance Statement that is normally input on the NSPIRES cover pages must be included in the proposal PDF instead and 2) proposers must upload a separate "Team Expertise and Resources - Not Anonymized" document, that contains all of the personally (and organizational) identifying information.

In order to meet the objectives of dual-anonymous peer review, review panels will be instructed to evaluate the anonymized proposals based on their scientific merit, without taking into account the proposing team qualifications. As a final check, and only after the scientific evaluation is finalized for all proposals, the panel will be provided with the "Expertise and Resources - Not Anonymized" documents. The panel will assess the qualifications of the team in order to allow the reviewers to assess the team capabilities required to execute a given proposed science investigation.

Any PMEF request shall be part of the "Expertise and Resources- Not Anonymized" document, and any contingency plans in the case that the PMEF request is not funded should be included as part of this document.

A summary of the key requirements for anonymized proposals, reproduced from the Guidelines for Anonymous Proposals documents, is listed below:

Item	Requirement
Anonymization	Step-1 proposals are not anonymized. Step-2 proposals must be anonymized.
References	References must be in the [1], [2] format.
Proposal summary	Enter as part of the NSPIRES cover page and as the first page of the uploaded proposal PDF file. This one-page anonymized summary does not count against the 15-page limit of the Science/Technical/ Management (S/T/M) section.
Page limits	15 pages for the central S/T/M section of proposal. In addition, one page each are allotted for the Proposal Summary and the Relevance Statement (see Section 2.1), and two additional pages are allotted for the Data Management Plan (see Section 2.12).
Bio sketches	Do not include in main proposal document. Include in separate "Expertise and Resources - Not Anonymized" document.
Current and pending support	Do not include in main proposal document. Include in separate "Expertise and Resources - Not Anonymized" document.

Redacted Budget **and** narrative	Include **both redacted budget and narrative** in main proposal document in an anonymized format. **[Clarified June 25, 2020]**
Summary Table of Work Effort	Include an anonymized version in main proposal document. Include a not-anonymized version in separate "Expertise and Resources - Not Anonymized" document.
Facilities and equipment	Do not include in main proposal document. Include in separate "Expertise and Resources - Not Anonymized" document.
PMEF Request, if applicable	Do not include in main proposal document. Include in separate "Expertise and Resources - Not Anonymized" document.
Data Management Plan	Include in main proposal document as a separate section in an anonymized format, not to exceed two pages in length, immediately following the References and Citations section for the Scientific/Technical/Management portion of the proposal
Relevance Statement	Include in main proposal document as a separate section in an anonymized format, not to exceed one page in length, immediately following Data Management Plan.
High end computing request	Submit PDF HEC form as document type "Appendix" in NSPIRES. Anonymized proposal should state that HEC request has been submitted.
Separate "Expertise and Resources - Not Anonymized" document	Submit as document type "Appendix" in NSPIRES. This document provides: 1) A list of all team members, together with their roles (e.g., PI, Co-I, collaborator). 2) Brief descriptions of the scientific and technical expertise each team member brings, emphasizing the experiences necessary to be successful in executing the proposed work. 3) A discussion of the contribution that each team member will make to the proposed investigation. 4) A discussion of specific resources ("Facilities and Equipment", e.g., access to a laboratory, observatory, specific instrumentation, or specific samples or sites) that are required to perform the proposed investigation. 5) A summary of work effort, to include the not-anonymized table of work effort. 6) Bio sketches (limit 2 pages for the PI, 1 page for each Co-I). 7) Statements of Current and Pending support. 8) Letters of resource support, as required by ROSES. 9) Any PMEF request in its entirety should also be included in this document.

4. <u>Summary of Key Information</u>

Expected program budget for first year of new awards	~$1.5M
Number of new awards pending adequate proposals of merit	8-10

Maximum duration of awards	4 years; shorter-term proposals (1-3 years) are typical; fourth year must be explicitly and scientifically justified.
Due date for Step-1 proposals	See Tables 2 and 3 of this ROSES NRA
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science/Technical/ Management section of proposal	15 pages. One additional page each are allotted for the Proposal Summary and the Relevance Statement (see Section 2.1), and two additional pages are allotted for the Data Management Plan (see Section 2.12).
Relevance	This program is relevant to Planetary Science, and Heliophysics Divisions questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See E.1 The Cross Division Research Overview and Section IV and Table 1 of *the ROSES Summary of Solicitation*.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/, Section IV(b) of *the ROSES Summary of Solicitation*, and Guidelines for Anonymous Proposals.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-HW
Main Point of Contact	**Lindsay Hays [Updated October 19, 2020]** Planetary Science Division NASA Headquarters Washington, DC 20546 Telephone: **(818) 356-3685** Email: **lindsay.hays@nasa.gov**

Other points of contact, both of whom share the following postal address: NASA Headquarters Washington, DC 20546	Delia Santiago-Materese (regarding dual-anonymous peer review) Planetary Science Division Telephone: (202) 358-4525 Email: delia.santiago-materese@nasa.gov Galen Fowler Heliophysics Division Telephone: (202) 358-0039 Email: galen.fowler@nasa.gov

E.5 FUTURE INVESTIGATORS IN NASA EARTH AND SPACE SCIENCE AND TECHNOLOGY

NOTICE: The text below is a draft based on text from last year as an example for potential proposers. Changes to the text are possible. Final text and due dates for proposals and information for the preproposal conference will be released as an amendment to ROSES no fewer than 90 days in advance of the proposal due date. Where "xx" appears in the text below it is a placeholder indicating a value that will be set later.

1. Introduction and Funding Opportunity Description

The Future Investigators in NASA Earth and Space Science and Technology (FINESST) is a program element in Research Opportunities in Space and Earth Sciences (ROSES)-2020. ROSES is an "omnibus" solicitation, having default guidelines and information in the *ROSES Summary of Solicitation* that apply to all of ROSES, including this program element. Through FINESST, the Science Mission Directorate (SMD) solicits proposals from accredited U.S. universities and other eligible organizations for graduate student-designed and performed research projects that contribute to SMD's science, technology and exploration goals.

The Future Investigator (FI, i.e., the student participant) shall have the primary initiative to define the proposed FINESST research project and must be the primary author, with input or supervision from the proposal's Principal Investigator (PI), as appropriate. In cases when the PI already has an ongoing research award from NASA, the research proposed under FINESST may address a similar topic, but the proposal should make clear how the proposed research goes beyond what NASA has already agreed to support.

FINESST awards are limited-cost category research grants. If necessary, however, as described in Section 3.4 of the *Grant and Cooperative Agreement Manual* (GCAM) "Determining Whether to Issue a Grant or Cooperative Agreement", NASA may issue cooperative agreements to the submitting universities or other eligible institutions.

The titles and abstracts of selected proposals by the participating divisions to the prior FINESST competition will be posted on the NSPIRES page for last year's FINESST (from ROSES-2019) in the summer of 2020 as PDF files under the heading "Selections".

A key criterion for proposal evaluation (See Section 5) and selection is the relevance of the proposed investigation to the Science Mission Directorate (SMD). Information on NASA's Strategic Goals and Objectives and SMD's high-level objectives is in 2018 NASA Strategic Plan. Detailed plans/objectives that correspond to the science divisions of SMD: Heliophysics, Earth Science, Planetary Science, and Astrophysics appear in Chapter 4 of the 2014 NASA Science Plan. All FINESST proposals must address one or more goal(s) and objective(s) relevant to at least one SMD division.

The proposal must present a well-defined research problem/activity and a justification of its scientific significance to NASA, as well as a detailed approach for its solution/conduct. Proposals should explain how the research is relevant to the particular SMD division that will review the proposal. The proposal should refer to a specific

research topic(s) solicited by a Division (e.g., but not limited to, the program or program elements listed in Table 3 of ROSES 2020).

Proposal submission requires choosing just one reviewing division. However, proposals that are relevant to more than one division are welcome. If, prior to a proposal's review, NASA determines that a submitted proposal belongs to a different division, then it may suggest that the proposal be sent to another division for review. Alternatively, NASA may choose to reassign the proposal without consulting the proposer and notify the proposer later.

1.1 Pre-Proposal Teleconference (Optional)

On a no-advance-reservation, first-to-dial-in basis callers can attend the pre-proposal teleconference. Email HQ-FINESST@mail.nasa.gov any teleconference agenda suggestions and questions using "FINESST 2020 Telecon" in the email's subject line on or before xxmonth xxday, 2020.

The optional pre-proposal teleconference on xxmonth xxday, 2020, begins xx:00 p.m. and ends xx:30 p.m. Eastern Time. SMD will post the teleconference charts no later than noon Eastern Time on the teleconference day under "Other Documents" on FINESST's NSPIRES page.

An operator will add callers in listen-only mode and on-hold music will play until the FINESST leaders start the conference. If there is time to take caller questions, the operator who moderates will provide instructions during the call. Caution: to preserve anonymity of callers, callers must not disclose their names or institutions. If a caller can't join the call for any reason, e.g., scheduling conflict, number of callers exceeds capacity, see Section 1.2 "Record/Replay of the Pre-Proposal Telecon".

No earlier than 30 minutes prior to the start time, call 1-888-xxx-xxxx (U.S.-only Toll Free) or 1-630-xxx-xxxx (U.S. Toll) and use Participant Passcode: xxxxxxx. Restrictions may prevent the use of a toll-free number from a mobile or free-phone or from telephones outside the U.S.

For TTY-equipped callers or other types of relay services no earlier than 30 minutes before the start of the teleconference, call 711 and provide the same conference call number 1-888-xxx-xxxx (U.S.-only Toll Free) or 1-630-xxx-xxxx (U.S. Toll) and Participant Passcode: xxxxxxx.

1.2 Record/Replay of the Pre-Proposal Telecon (Optional)

Unless the recording quality prevents it, e.g., poor sound, concerns about loss of caller anonymity, etc., audio-only, on-demand replays of the pre-proposal teleconference should be available by 6:00 p.m. Eastern Time starting on xxmonth xxday, 2020. No later than 9:00 p.m. Eastern on xxmonth xxday, 2021, on-demand replays will end. For the FINESST pre-proposal telecon replay call numbers 1-888-xxx-xxxx (Toll Free) or 402-xxx-xxxx (Toll) and enter Passcode: xxx-xxxx.

Reminders: Restrictions may prevent the use of toll-free replay number from a mobile or free-phone or from telephones outside the U.S. For relay services call 711 and provide the FINESST pre-proposal telecon replay call numbers.

NSPIRES will post a written summary of the recorded call under "Other Documents" no later than 45 days following the teleconference.

2. Scope of Program: Division Research Overviews

This section presents a partial overview of the research funded by SMD's science divisions that review FINESST proposals. Proposers may refer to the list of research program element(s) solicited by a particular division(s) in Table 3 of this year's ROSES solicitation to get an indication of topics that are covered by each division. This list is not exhaustive since it changes from year to year. If a particular program element is listed as "not solicited this year", TBD, or even absent this year, that topic is still in scope for FINESST. For example, despite the fact that ROSES-2019 did not solicit Terrestrial Ecology as program element A.4, a potential proposer to FINESST with an interest in that research was able to propose it to Earth Science.

2.1 Earth Science Research Program

Earth Science proposers must review ROSES-2020 A.1 Earth Science Research Overview for complete information.

The Earth Science Research Program, managed by the Earth Science Division (ESD) of the Science Mission Directorate (https://science.nasa.gov/earth-science), contributes to NASA's mission, in particular, Strategic Objective 1.1: "Understanding The Sun, Earth, Solar System, And Universe" (from the 2018 NASA Strategic Plan). This strategic objective involves the following key questions:

- How is the global Earth system changing?
- What causes these changes in the Earth system?
- How will the Earth system change in the future?
- How can Earth system science provide societal benefit?

The ESD welcomes proposals that relate to: Research and Analysis, Applied Sciences, Earth Science Technology Office, and Flight. ESD encourages proposals that place particular emphasis on the utilization of unique NASA capabilities in studies of the Earth.

Do not submit to the Earth Science Division proposals on these topics:

- molecular biology, biochemistry, development, physiology, or evolution of living organisms, without a direct utilization of remote sensing approaches or global/regional modeling which makes use of remote sensing data; or
- efforts in laboratory and/or theoretical chemistry that are not directly related to remote sensing and/or computational modeling of atmospheric gas phase and particulate composition; or
- social science research that is not directly linked to NASA observations and/or models.

Proposers should examine the relevance to other SMD programs in FINESST (e.g., astrobiology in the Planetary Science Research Program) or graduate research opportunities funded elsewhere at NASA, e.g., the Space Technology Mission Directorate, etc., or outside NASA.

2.2 Heliophysics Research Program

Heliophysics proposers must review ROSES-2020 B.1 Heliophysics Research Program Overview for complete information.

Chapter 4.1 of the *SMD Science Plan 2014* available at http://science.nasa.gov/about-us/science-strategy/ describes the Heliophysics research program. The NASA Strategic Objective for Heliophysics is to understand the Sun, Earth, Solar System, and Universe. In pursuit of this objective, and with guidance from the National Research Council's most recent decadal survey, *Solar and Space Physics, A Science for a Technological Society* (download free PDF), key questions are:

- What causes the Sun to vary?
- How do the geospace, planetary space environments, and the heliosphere respond?
- What are the impacts on humanity?

The research program supports theory, modeling, and data analysis utilizing remote sensing and *in situ* measurements. The program also supports investigations of the physics of magnetospheres, including their formation and fundamental interactions with plasmas, fields, and particles and the physics of the terrestrial mesosphere, thermosphere, ionosphere, and auroras, including the coupling of these phenomena to the lower atmosphere and magnetosphere. For further information, consult *Our Dynamic Space Environment: Heliophysics Science and Technology Roadmap for 2014-2033* (download PDF).

2.3 Planetary Science Research Program

Planetary Science proposers must review ROSES-2020 C.1 Planetary Science Research Program Overview for complete information.

The Planetary Science Research Program, managed by the Planetary Science Division, sponsors research that addresses the broad strategic objective to "Ascertain the content, origin, and evolution of the Solar System and the potential for life elsewhere." To pursue this objective, the Planetary Science Division has five science goals that guide the focus of the division's science research and technology development activities. As described in Chapter 4.3 of the SMD 2014 Science Plan (https://science.nasa.gov/about-us/science-strategy), these are:

- Explore and observe the objects in the Solar System to understand how they formed and evolve.
- Advance the understanding of how the chemical and physical processes in the Solar System operate, interact and evolve.
- Explore and find locations where life could have existed or could exist today.
- Improve our understanding of the origin and evolution of life on Earth to guide our search for life elsewhere.
- Identify and characterize objects in the Solar System that pose threats to Earth or offer resources for human exploration.

The Planetary Research Program invites a wide range of planetary science and astrobiology investigations in order to address the goals above, but this program also supports research into:

- Investigations into the potential for both forward and backward contamination during planetary exploration, methods to minimize such contamination, and standards in these areas for spacecraft preparation and operating procedures;
- Investigations which enhance the scientific return of NASA Planetary Science Division missions through the analysis of data collected by those missions;
- Advancement of laboratory- or spacecraft-based (including small satellites, e.g., CubeSats) instrument technology that shows promise for use in scientific investigations on future planetary missions; and
- Analog studies, laboratory experiments, or fieldwork to increase our understanding of Solar System bodies or processes and/or to prepare for future missions.

2.4 Astrophysics Research Program

Astrophysics proposers must review the ROSES-2020 D.1 Astrophysics Research Program Overview for complete information.

The Astrophysics Research Program, managed by the Astrophysics Division, explores the Universe beyond our Solar System: from the search for planets and life in other stellar systems to the origin, evolution, structure, and destiny of the universe itself.

Investigations submitted to the Astrophysics research program should explicitly support past, present, or future NASA astrophysics missions. These investigations may include theory, simulation, data analysis, and technology development. The Astrophysics research program and missions are described in Chapter 4.4 of the SMD 2014 Science Plan available at https://science.nasa.gov/about-us/science-strategy.

3. FINESST Program Principles and Proposal Constraints

3.1 Eligibility and Restrictions on Submissions

Participation in ROSES-funded research by non-U.S. organizations in this program is welcome, but on a "no exchange of funds" basis. It is NASA policy that each international partner, its sponsoring agency, or its funding/sponsoring institution, covers its own research contributions (further information on foreign participation is provided in ROSES FAQ #14 on this topic and the *NASA Guidebook for Proposers*).

Normally, a higher education institution will submit the proposal; however, other institutions that may receive a grant and that have a relationship with an educational institution may submit a proposal as long as the FI is enrolled at an accredited U.S. higher education institution. The budget justification must provide evidence from the U.S. institution of the student's enrollment/good standing in an eligible degree program.

This call solicits proposals for a research project conducted by an individual Future Investigator (FI) who is or will be pursuing a Masters or PhD degree in an Earth or space sciences-related discipline from an accredited U.S. university. By the proposal due date, the student, known as a future investigator (FI), must have applied to, been admitted to, or be enrolled as a graduate student at an eligible, accredited U.S. university. FINESST is not an application for a Fellowship, so the program does not specify limits or discourage submissions based on the number of years a student is enrolled in a graduate degree program.

An FI may be a participant on only one submitted FINESST proposal at a time. However, a student who is currently funded on a FINESST award for a period of performance less than the maximum performance period may submit a new, renewal or augmentation proposal as long as both proposals do no exceed the funding maximum.

There must be a principal investigator (PI) at the submitting institution who will serve as the research mentor and acts as a champion for the FI by serving as guide, role model, teacher, etc., who supports the FI's research and professional development. The PI is determined based on the norms, policies, and practices of the proposing institution and the requirements of the proposed research. NASA does not advise or assist on who should be the PI.

A PI may submit more than one proposal to this program element (if it is on behalf of more than one student). See Section 3.2.

A PI may have FINESST and other (e.g., ROSES) proposals with overlapping tasks submitted at the same time. However, upon selection of either, the PI must alert both the funding FINESST program scientist and the other program manager. Proposals that overlap with previously submitted proposals still under consideration should acknowledge, e.g., in the budget justification, that funds are requested elsewhere. If NASA selects both the FINESST and non-FINESST proposals, the AOR/PI must inform the NASA managers so that budget negotiations/adjustments may ensue.

Although a proposing organization may submit more than one proposal to this solicitation, duplicative proposals from the same organization in the same year are not solicited and may be returned without review. However, the resubmission of a not-funded proposal from a prior competition is permitted and will treated the same as an entirely new submission.

A student currently or in the past supported by a NESSF award is not normally eligible for FINESST. Only students supported by NESSF for fewer than three years are eligible for support via FINESST and only up to a maximum of three years total support from NESSF and FINESST combined.

An FI who proposed to, but was not funded by, a prior FINESST or another solicitation such as NESSF is eligible to be included on a proposal in response to this program element. Similarly, a FI (or PI) who previously declined to accept NASA funding is eligible.

Students in the first or second year of a multi-year, full-time fellowship, such as from National Science Foundation, or a student with a multi-year, full-time research assistant commitment from any source that provides stipend and tuition or full-time salary, etc., beyond September 2022 are discouraged from participating in this FINESST program call.

During the period that a FINESST proposal is under consideration or during the period of performance of a FINESST grant, the funded institution’s Authorized Organization Representative (AOR) must inform NASA if the student has accepted any Federal fellowship or traineeship that 1) provides stipend and other participant support costs, e.g., tuition *and* 2) is longer than three months in duration. In an instance when such a proposal is selected, NASA may require a revised budget and, if appropriate, a revised

proposal for any active award to ensure that the FI can devote sufficient time to the FINESST research.

Since FINESST is a research grant and not a fellowship, there are no deferments, reserves, or tenure years. Only after selection or award are requests for a period of performance change potentially allowable. The funding program's technical officer in conjunction with the NASA Shared Service's Center (NSSC) handles/decides such requests on a case-by-case basis.

In accordance with 2 CFR 200 and a recipient's institutional policies, students funded by a FINESST grant may be eligible to pursue other employment, e.g., teaching, consulting, etc., or receive stipend support from another source if it does not conflict with or preclude conducting the FINESST research.

NASA recognizes and supports the benefits of having diverse and inclusive scientific, engineering, and technology communities. FIs (and PIs) with disabilities and/or from underrepresented minority groups are urged to propose. No proposal shall be denied consideration on the grounds of race, color, age, ethnicity, national origin, religion, pregnancy, sexual orientation, gender identity, sex, marital status, disability, or status as of a team member as a U.S. Veteran.

3.1.1 Limitations on Participants and Research Conducted in Designated Countries

In accordance with language in Appropriation Acts that restrict NASA from funding certain projects involving the People's Republic of China (PRC), NASA is "prohibited from funding any work that involves the bilateral participation, collaboration, or coordination with China or any Chinese-owned company or entity, whether funded or performed under a no exchange of funds arrangement." Proposing organizations will be required to certify compliance with regarding this NASA PRC funding restriction. Prospective FINESST PIs or/and FIs affiliated with PRC institutions may not be eligible. See https://science.nasa.gov/researchers/sara/faqs/prc-faq-roses/ for the ROSES FAQ on this subject.

The purpose of FINESST is to provide support primarily for fundamental research and/or technology development projects that normally would not expect to be subject to export control. However, should the FI's proposed research project fall under International Traffic in Arms Regulations (ITAR) or Export Administration Regulations (EAR), then only U.S. persons may be participants, and proposers must identify the parts of the proposal that contain ITAR material as instructed in Appendix A of the *NASA Guidebook for Proposers*.

Proposals that would involve research or collaboration outside the United States in "Designated Countries" that also are "State Sponsors of Terrorism" will be subject to additional levels of review by the Office of International and Interagency Relations (OIIR) that may result in a proposal being denied. NASA's "Designated Country (DC) List" is hosted on the NASA Export Control website at https://www.nasa.gov/oiir/export-control. The relevant part of the list is Column II, i.e., Countries determined by the Department of State to support Terrorism. The DC list is updated regularly; therefore, please consult the website to ensure use of the most up-to-date list. Otherwise, beyond the standard restrictions that prevent subawards to non-U.S. institutions, there are no

restrictions on international collaboration. The FINESST program does not allow subawards/contracts.

NASA Centers and other Federal entities that do not grant degrees are not eligible institutions for FINESST awards. Federal civil servants who lack status or a qualifying affiliation at an eligible degree-awarding institution may not serve as Principal Investigators. Federal civil servants who are eligible to propose through an eligible institution may serve as PIs.

Regarding participation from a NASA Center, NASA civil servants must avoid any perception of or potentially real conflict of interest (COI). Civil servants who want to appear as a Collaborator or Co-Investigator in a FINESST proposal must follow the policies and procedures in place at their employing center or facility and, if applicable or necessary, refer questions to their Center's General Counsel. No Co-Investigators, including civil servants will be funded through this program.

3.2 Data Limitations and Requirements

3.2.1 *Data Eligibility*

Spacecraft mission data to be used in proposed work must be available in a publicly accessible archive (e.g., https://earthdata.nasa.gov/, http://spdf.gsfc.nasa.gov/, https://science.nasa.gov/astrophysics/astrophysics-data-centers, https://pds.nasa.gov/, and http://umbra.nascom.nasa.gov/) at least 30 days prior to the proposal due date.

Proposals that require spacecraft mission data that has not been public for at least 30 days prior to the full proposal due date are not compliant and may be returned without review or declined after review, no matter the peer review score. Proposals that can proceed with public data, i.e., are not reliant on future data, but would make use of future data if/when it comes along during the duration of the award are acceptable. Proposers should make it clear that the project would be improved by future data, but such data is not necessary.

The data eligibility requirement applies only to spacecraft mission data, not to other kinds of data, such as airborne campaigns, field campaigns, fieldwork, etc., that are collected as part of the proposed research. Proposing to use any kind of data that has not yet been collected is a risk but not prohibited. If a project is completely dependent on "risky" data, e.g., not acquired, not publicly available, etc., that could prevent selection and/or be noted as a proposal weakness.

3.2.2 *Data Management Plans*

A Data Management Plan (DMP), or an explanation of why one is not needed given the nature of the work proposed, is required to be contained by the NSPIRES coversheet. Unlike other ROSES-20 program elements, the DMP for FINESST proposals is not part of the proposal pdf, and it is limited to two, 4000-character plain text boxes on the NSPIRES web pages associated with the proposal. Please note: SMD divisions may have a particular template or requirements for DMPs (e.g., described in A.1, B.1, etc.), but FINESST uses only the NSPIRES coversheet for the DMP.

Proposers should plan that all data will be made available by the end of the award, with certain notable exceptions: work that is proprietary or may affect U.S. economic

competitiveness; work that results in personally identifiable human subjects research data; export-controlled data; controlled unclassified information data; national security classified data; and SBIR/STTR contracts. The point of the DMP is to ensure that the proposer plans in advance what data will be made public and that time is allocated to that important task. A DMP should answer these types of questions:

1. What data types, volumes, formats, and (e.g., where relevant) data standards?
2. Where does the project intend to make these data available?
3. When will these data be made available?
4. Who will do archiving and what experience do they have with this kind of data, archive, etc.?

Regardless of what the DMP submitted with the proposal says, grantees must still meet the mandatory minimum requirement that the data behind figures and tables in peer-reviewed publications be available electronically at the time of release, ideally in supplementary material with the article.

Third-party resource support letters to archive the data, permissions from data owners/authors, data licenses, or any other scenario are not required. Simply state in the DMP who has agreed to what. A data resource support letter(s) may be submitted with the FINESST budget. For additional guidance, see Section 4.1.6 "Budget Timeline and Narrative". Reminder: Do not add resource support letters from any collaborator or team member listed under Section VI of the NSPIRES cover page and who acknowledges commitment via NSPIRES. When a data collaborator directly confirms in NSPIRES, that is sufficient resource commitment to the FINESST project.

3.2.3 *Archiving Manuscript Versions of Publications*

In keeping with the NASA Plan for Increasing Access to Results of Federally Funded Research, awards deriving from ROSES, including this FINESST program, include terms and conditions requiring that as accepted manuscript versions of peer-reviewed publications (hereafter "manuscripts") that result from ROSES awards be uploaded into NASA's part of the PubMed Central (PMC) repository called NASA PubSpace. The Federal Register notice on this subject specifies that manuscripts be deposited within one year of completion of the peer review process. Please note that not doing so may delay or prevent awarding of funds. This applies only to peer reviewed manuscripts. Patents, publications that contain material governed by personal privacy, export control, proprietary restrictions, or national security law or regulations will not be covered by this requirement. For more details on public access to scientific publications and digital scientific data resulting from NASA-funded research, please see: https://www.nasa.gov/open/researchaccess.

4. Proposal Preparation and Submission

The FI (student) must be the primary author of the proposal's research project description and personal statement.

Proposals are due: 11:59 p.m. Eastern Time, xx, 2021.

All proposals must be submitted in electronic format only. For those unfamiliar with NSPIRES, instructions, tutorials, and FAQs for submitting electronic proposals are

located at https://nspires.nasaprs.com/tutorials/index.html. If you already know how to submit an NSPIRES proposal, just go to the NSPIRES page for this FINESST element of ROSES and click on the appropriate "Create" button. Proposers must complete the NSPIRES cover pages, including the FINESST Program Specific Data questions, such as filling out the text box for the Data Management Plan, described above.

When creating the proposal one must choose the division (see Section 2) to which the proposal will be submitted. If the proposed project would be relevant to more than one division (e.g., exoplanets) then please note this in the abstract and specify those other divisions.

4.1 FINESST Proposals

The contents of the proposal must include the elements listed below, clearly identified, starting on a new page, and appearing in the order below in a single PDF file. Page numbers are strongly encouraged and should be the only content in headers and footers. No format style, letters, numbers, or combination is specified. Main body text of proposals and captions must use an easily read font of no more than 15 characters per horizontal inch (typical of 12-point Times New Roman) and no more than 5.5 lines per vertical inch (*i.e.,* single-spaced). There must be at least one-inch margins on all sides, and the proposal must be sized for U.S. letter size (8.5x11) paper. ROSES table 1 says that no “content” is to be put in the margins, so page numbers or disclaimers are not counted as “content”. Non-compliant proposals may be returned without review. FINESST proposals do not require current and Pending Support, nor a Summary Table of Work Effort. In addition to (and after) the table of contents, the content of the proposal is as follows:

4.1.1 *Personal Statement*

This section must contain a personal statement of up to two pages authored by the FI that addresses the research readiness criterion from Section 5.1 and

a. Outlines the FI's goals, expertise, attributes, any relevant barriers to study and/or research encountered and steps taken to overcome any such barriers, etc.
b. Highlights any relevant academic or other experiences prior to proposal submission, e.g., undergraduate studies, or other degree(s), graduate study already completed, etc.
c. Provides a graduate study timeline that at minimum states the degree type (Ph.D/M.Sc. or both) and the start and completion dates estimates.

This section may total no more than two pages, conforming to formatting requirements (line spacing etc.) in Section 4.

4.1.2 *Science/Technical/Management Section*

This section describes the proposed research project and may include figures and tables as appropriate. This section, excluding citations, may total no more than six (6) pages conforming to formatting requirements in Section 4. The project description should include the following elements:

a. A well-defined problem with a justification of its scientific significance and a detailed approach for its resolution.

b. A statement describing the relevance of the proposed work to the appropriate SMD Division and a program within that division. Note: If the research is relevant to more than one division/program, please identify the other division(s).
c. A description of the approach to be taken to address the chosen problem.
d. A period of performance or timeline for the proposed project listing anticipated accomplishments and major milestones, including planned publications.

4.1.3 *References/Citations and Acknowledgements*

Citations and/or endnotes must directly follow the project description and are not included in the research description's 6-page limit. Provide all references and citations for the 6-page project description using easily understandable, standard abbreviations for journals and complete names for books. Providing URLs is done at the proposer's own risk. Reviewers are not obligated to follow any links.

Though this FINESST element does not specify what is "allowed content" for either References/citations nor the Acknowledgements, it should not include technical information that belongs in the project description. The *Guidebook for Proposers Responding to A NASA Funding Announcement* explains restrictions and preferences for bibliographies and appendices.

In an acknowledgement statement of up to 150 words, describe the FI and PI or any other team member roles in preparing the proposal. This statement must affirm that the proposal is the work of the FI. It is acceptable for an FI to receive editorial and/graphic support from a writing center, copy editor, colleagues, and peers to improve the proposal (e.g., grammar, clarity, structure), but this help should be acknowledged, if applicable.

4.1.4 *Curriculum Vitae (CV) for the PI (mentor) and the FI*

The PI's and FI's CV or resume are mandatory and limited to two pages each. Any mentors beyond the PI may be given the role of (unfunded) Co-Is or collaborators, depending on their level of involvement. The CV is optional for any Co-I(s). Do not provide CVs for collaborators.

4.1.5 *Mentoring plan or agreement*

The Mentoring Plan/Agreement should not exceed 2-pages**.** Both the FI and PI prepare and sign this agreement that may include more than one mentor; however, having additional mentors does not extend the page limit. Non-PI mentors do not have to be at the submitting institution. It is optional to include mentors beyond the PI, but if they are named, they must be added to the NSPIRES cover page as team members.

At minimum, the Mentoring Plan must include a statement that the FI and PI have committed to the accomplishment of the research project. The content, format, and organization of mentoring plan are at the discretion of PI-FI team.

If the submitting institution has a standard Mentor-Mentee checklist, plan, agreement, template, etc., and it is longer than 2-pages, uses font size, margins, etc., that do conform to this solicitation, then the institution's standard is acceptable.

The plan's purpose is to provide the FI with a plan for developing skills and acquiring knowledge and experiences necessary to complete the research project and should

address the research readiness criterion from Section 5.1. This mentoring plan does not need to re-state information provided in response to sections 4.1.1-4.1.4. The mentor(s) may explain in the mentoring plan why the mentor has agreed to support this FI's research.

If the proposing institution has no mentorship standards, policies, forms, templates etc., then see Explanatory Note E: Mentoring Plan/Agreement: An Introduction for PI-FI Teams

4.1.6 *Budget Timeline and Narrative*

This section should not exceed 2-pages, excluding any special documentation that, for example, may be required from a non-profit that is not an education organization that the proposed FI is enrolled/in good standing in an eligible degree program at a university. Another example of special documentation allowed by ROSES and Section 3.17 in the *Proposer's Guidebook's* are "Letters of Resource Support." ROSES Table 1 explains: "A letter of support is required from the owner of any facility or resource that is not under the direct control of the PI or a Co-I acknowledging that the facility or resource is available for the proposed use during the proposed period." For FINESST, when a PI, Co-I or collaborator a) controls/owns any proposed asset, b) the proposal in its DMP or elsewhere explains the asset's commitment, *and* c) the owner is on the NSPIRES cover page as a PI, Co-I or collaborator, no separate letter is required. This program call does not list all varieties e.g. letter from the Planetary Data System Node, or any other scenario, of special documentation. If possible, use the FINESST format requirements for special documents such as, but not limited to, Resource Support Letters (RSL).

Propose a budget start date and end date. However, given NASA's review schedule and other limitations, the start date cannot be much earlier than September 1. In general, the latest proposed start date is one year (approximately) from this solicitation's February due date. NASA reserves the right to change the requested start date/end date for the award's period of performance.

Propose a timeline that makes sense for the research project year-by-year, month-by-month, quarterly, semester, etc. The budget timeline must include a brief budget justification narrative that explains the proposed allocation of funds across eligible participant support categories, e.g., what is the stipend? What is for the FI's activities as a mentee, e.g., travel, subscriptions, workshop registrations, society memberships, etc.? What, if any, amount is requested for tuition or similar funds for the university? When the university is committing to reduce or waive tuition and fees for the student, specify, if appropriate, that amount in the budget justification. See Section 10 Explanatory Note B - Limitations on FINESST Budget Categories. Reminder: Cost share is not evaluated and does not affect the likelihood of the proposal being selected.

Students funded by a FINESST grant may receive funding from other sources for expenses not covered by this award (e.g., to purchase equipment). FIs may take a hiatus to pursue other activities such as internships, family leave, military leave, etc. When a student is on hiatus for any period after the funding has been awarded, the student will not receive a FINESST stipend, and the institution shall not draw down/spend the FINESST stipend funds during the FI's hiatus.

FINESST funds may be requested to support an FI's tuition; fees (allowable under 2 CFR 200 and consistent with university policy); travel in support of the research investigation or to conferences, symposia, or collaborative meetings; text books or other instructional supports; expendable laboratory supplies; page charges for journal articles; printing of a thesis; or health insurance policy, see Section 10.2 Explanatory Note B-Limitations on FINESST Budget Categories.

4.1.7 *Optional High-End Computing Appendix*

The High-End Computing (HEC) program (https://www.hec.nasa.gov/) provides a specialized computational infrastructure to support NASA's research community. Proposers to FINESST may apply for HEC resources to support their research by uploading an Appendix as a separate PDF file, so do not include it in the main proposal PDF file. See Section 10.1, Explanatory Note A, below for details on how to pursue this option.

4.1.8 *Proposal compliance*

- Proposals containing unsolicited appendices/attachments may be declared noncompliant.
- Do not include undergraduate or graduate transcripts for the FI. This is a research grant not a fellowship.
- Proposals not submitted by the required deadlines, and/or that do not meet the eligibility, page length, formatting and/or other requirements as listed in the funding announcement may be returned without review.
- Team members beyond the FI and PI are permitted in cases where needed, e.g., to show a second mentor. NASA wants to know who will be participating on the project in order to manage organizational conflict of interest during peer review, but, in general, additional team members do not give any advantage nor may they be funded via FINESST.
- All team members must be listed on the NSPIRES cover page. Please note that a proposal cannot be submitted if any listed team member, including unfunded collaborators, do not log into NSPIRES and confirm their role on the proposal.
- FINESST does not invite recommendations or support letters. A recommendation letter is a type of "letter of affirmation," i.e., letters that endorse the Intrinsic Merit, including significance or impact, of a proposal. If letters of affirmation are submitted, they may not be submitted as an appendix; they are counted and included within the six (6) page Scientific/Technical/Management section. For full details see Section 3.17 "Statements of Commitment and Letters of Resource Support" of the *Guidebook for Proposers*.

4.2 Confirmation of Proposal Submission and Late Proposals

Proposals must be complete and submitted electronically by 11:59 p.m. Eastern Time on the due date given in Tables 2 and 3 of ROSES. NSPIRES generates an automatic acknowledgement when any proposal is submitted. When the FINESST solicitation completely shuts down on NSPIRES, the proposer is prevented from finishing a submission. If the institution did not receive an email confirming submission of a proposal, check spam filters and junk boxes. If unable to locate the email

acknowledgement, contact the NSPIRES Help Desk or log in directly to NSPIRES to check a submission status.

NSPIRES marks FINESST proposals submitted after the due date or deadline as "late". Late proposals will be handled in accordance with the SMD Policy on Late Proposals. SMD does not pre-approve the submission of a late proposal. The decision to submit a late proposal is solely that of the proposer, and it is then NASA's decision whether to accept it or not. Late proposals are rarely accepted, except in cases of problems with NSPIRES. The FINESST program scientists/administrators are not empowered to authorize the submission of a late proposal.

5. Proposal Evaluation and Selection

5.1 Review

NASA Headquarters Science Mission Directorate scientist(s) and program managers/executives, or their designees, conduct proposal evaluations through one or a combination of the following methods: individual reviews, virtual panels, or face-to-face panels. Reviewers can be from the external community including scientists at NASA Centers. While reviewers may not be experts in every subtopic or discipline within the FI's proposed research field, the reviewers will be experts in the broader research.

If SMD determines that a proposal has been submitted to the wrong division prior to review, then it may give permission for a proposal to be reassigned to another SMD division or shared for additional review.

For a detailed description of standard NASA review processes for proposals, including qualitative rating definitions, see APPENDIX D of the most recent *NASA Guidebook for Proposers* (also known as *Guidebook for Proposers Responding to a NASA Research Announcement* and *Guidebook for Proposers Responding to a NASA Funding Announcement*) available at: https://www.hq.nasa.gov/office/procurement/nraguidebook/.

The standard proposal review process includes for each review criterion a narrative assessment of a proposal's strengths and weakness. For detailed information, see the *ROSES-20 Summary of Solicitation* Section VI. "Proposal Review Information".

This program element has criteria that differ from the default presented in the *ROSES Summary of Solicitation*. The criteria for evaluation of FINESST proposals are:

(a) The scientific merit of proposed research project. Assessing the scientific merit of the proposed research includes:

1. The compelling nature of the research topic.
2. The exhibited depth of understanding of the research topic.
3. The expected impact of the research, should it succeed.
4. The feasibility of the proposed research plan, including the availability of resources for successful completion of the project.
5. The robustness of the research plan to anticipated setbacks.

(b) The relevance of the proposed research or technology development to SMD's objectives in Earth and/or space science as described in Section 2: Division Research

Overviews. Proposals must be specific about how the proposed research is relevant to the particular division/program that will review the proposal. Note: peer reviewers may comment on relevance, but the funding SMD Division makes the ultimate determination on relevance.

(c) Research readiness assessment.

This criterion focuses on how the FI's research design, approach, attitudes, or perceptions correlate to their actual research skills/capabilities as described in the:

1. FI's personal statement.
2. The PI-FI Mentoring Plan/Agreement.
3. The FI's curriculum vitae/resume.
4. The PI's curriculum vitae/resume.

Reviewers evaluating research readiness may be asked to consider the following questions: Does the FI’s record of performance demonstrate an ability to excel and to learn? Does the choice of research mentor(s) complement the proposed research project? Has the FI been involved in any activities within or outside of academia that make them particularly capable of conducting the proposed research? Will the proposed mentoring activities advance the FINESST research and enable access to resources, prepare the FI to apply for NASA opportunities, and/or in other ways facilitate the FI's growth as a new professional?

(d) Cost reasonableness.

FINESST grants are limited cost category awards. NASA personnel will look at the split between stipend and other participant support costs (see Section 6).

5.2 Selection

The Directors of the Science Divisions of SMD at NASA Headquarters or their designees make the respective award selections. The Selection Officials will select proposals as judged against the evaluation criteria in Section 5.1, divisional objectives, and those in this announcement, programmatic considerations, and the available financial resources.

Many proposals will receive scores that make them fundable but may not be selected for programmatic reasons, e.g., either because the proposed work is redundant with another FINESST project, or the topic is deemed by NASA to be of lower priority for funding/selection. Other programmatic considerations include and are not limited to balance across subdisciplines and institution types, technologies, methodologies, data accessibility, etc.

At the conclusion of the review/selection process, an NSPIRES email will be sent to the PI and the university asking them to log into the NSPIRES. PIs/organization representatives are responsible to download NASA letters and feedback and share with the FI. Abstracts of selected proposals will be publicly posted on the NSPIRES page for FINESST.

6. Award Information and Restrictions

Unless otherwise specified in the proposal, the default start date of all new awards is September 1, 2021. A NASA grant officer at the NASA Shared Services Center (NSSC) in Mississippi will conduct a pre-award review of risk associated with the proposer (*i.e.,* submitting university or non-profit) as required by 2 CFR 200.205.

FINESST supports an independent research project performed by a Future Investigator (FI). The PI and the FI are to work with the university Office of Sponsored Research or its equivalent to determine the appropriate allocation in each budget category.

The maximum amount of a FINESST award is $45,000 per 12-months and up to $135,000 total for a period of performance maximum of 36 months (not including a hiatus, if applicable).

SMD suggests a student stipend of $35,000 per 12 months; however, the stipend should be comparable with the institution's prevailing rate**.** When the FI's level of effort will be less than 12 months, and when a $35,000 stipend is the institution's normal prevailing rate, then the institution normally prorates the FINESST stipend in the budget.

The FINESST grant can fund up to a three-year research project, contingent upon availability of funds and satisfactory progress as demonstrated through the annual progress report from the university. If the NSSC implements the change of a period of performance as an administrative supplement or amendment, the duration or project's period of performance may exceed three calendar years or 36 months. For example, SMD will accommodate reasonable requests for a hiatus (to pause and later resume the research project and hence costing the FINESST grant), e.g., for family, medical, or military leave or for the student to gain other experiences (e.g., teaching, conducting fieldwork). Awardees may seek a No-Cost Extension Request at https://www.nssc.nasa.gov/nocostextension.

An FI supported for fewer than three years while obtaining a Masters may continue as a student participant on the FINESST grant while they pursue a PhD at the awarded institution. Even after completing a terminal degree, if acceptable to the awarded institution, the FI may remain at the grantee institution to continue the research. Not all projects require the maximum amount available in the period of performance. Proposers should lay out the proposal's budget justification as explained in 4.1.7 *Budget Timeline and Narrative*.

If, prior to the award's expiration date, a student departs the university, or ceases to perform the research project without a reasonable justification and expectation of return to the project, the university must communicate promptly to NASA. See Section 10 Explanatory Note D - Change of Original FINESST Student.

If the PI needs to be changed, then the standard NASA policies in the *Grants and Cooperative Agreement Manual* (GCAM) apply.

Students, faculty or staff in programs receiving NASA financial assistance, such as grant awards from this program, may raise allegations of discrimination, including harassment, by contacting the NASA Office of Diversity and Equal Opportunity. Find information on filing a complaint through ODEO at https://missionstem.nasa.gov/filing-a-complaint.html.

FINESST awards can follow a student to a new institution. FIs who have had less than the 3 years of FINESST funding are eligible to be on a proposal from the new institution with a new PI. The Science Mission Directorate may consider funding the FINESST student on a single source proposal, i.e., a non-competitive, invitation-only mechanism or, if timing permits, ask that a follow-on or transfer proposal be submitted to an open FINESST solicitation.

These decisions are made on a case-by-case basis with approval required from the funding SMD Division's Selecting Official and the NASA Shared Services Center. For example, when only the student is transferring and not the PI to a new institution, e.g., to start a PhD program or due to family reasons, etc., then the student, PI, and AOR must email HQ-FINESST@mail.nasa.gov, or if an Earth awardee claire.i.macaulay@nasa.gov, and the FINESST award's technical officer to determine whether funding is available. Send such requests as soon as they arise, and allow at least six (6) months for NASA processing.

7. Reporting Requirements and Intellectual Property

In accordance with any award terms and conditions provided by the NSSC at the time of award, a progress report must be emailed annually by March 15. If an adequate progress report is not received, then the NSSC will not send funds. See Section 10. Explanatory Note C - Elements of a FINESST Progress Report for the email addresses.

Expenditures under any NASA grants, including FINESST, are subject to inspection and audit during the period of the grant and for three (3) years thereafter. Records at the awarded institution must be maintained in sufficient detail to evidence prudent management and to facilitate the preparation of the required reports for determining whether expenditures are being/were made for the purposes for which the funds were granted.

Reporting requirements consistent with 2 CFR 200 will be specified by the official grant sent to the university upon issuance of the award, see Exhibit E – Required Publications and Reports of the *NASA Grant and Cooperative Agreement Manual* (accessible from https://prod.nais.nasa.gov/pub/pub_library/srba/index.html).

Award recipients may be subject to reporting requirements under the NASA Plan for Increasing Access to the Results of Scientific Research, including submitting peer-reviewed manuscripts and metadata to a designated repository (currently PubMed Central) and reporting publications with progress reports. For more details on public access to scientific publications and digital scientific data resulting from NASA-funded research, please see: https://www.nasa.gov/open/researchaccess. Any such requirements will be identified in the Notice of Award from the NSSC.

For information about data rights and other aspects of intellectual property such as invention rights resulting from awards, see the file entitled "Award and Intellectual

Property Information" under the section called "Grant and Cooperative Agreement Guidance" at https://prod.nais.nasa.gov/pub/pub_library/srba/.

8. Collection of Demographic Information

NASA requests and collects demographic data from principal investigators and other NSPIRES users for the purpose of analyzing demographic differences associated with its award processes. Information collected will include name, gender, race, ethnicity, and disability status. Submission of the information is voluntary, confidential, and is not a precondition of award.

9. Points of Contact and Frequently Asked Questions

The Astrophysics, Earth Science, Heliophysics, and Planetary Science Divisions provide representatives to the SMD-wide FINESST Team. Members of the Deputy Associate Administrator for Research (DAAR) team coordinate FINESST. Email questions to: HQ-FINESST@mail.nasa.gov.

ROSES-2020 E.5 FINESST questions and responses, with identifying information removed, will be posted on the NSPIRES page for this program under "Other documents".

10. Explanatory Notes

10.1 Explanatory Note A: NASA-Provided High-End Computing (HEC) Resources

SMD provides a specialized computational infrastructure to support its research community, managed on its behalf by NASA's High-End Computing (HEC) program (see the HEC website at https://www.hec.nasa.gov/). Two major computing facilities are offered, namely, the NASA Center for Climate Simulation (NCCS) at the Goddard Space Flight Center (GSFC), and the NASA Advanced Supercomputing (NAS) facility at the Ames Research Center (ARC).

The HEC program facilities maintain a range of computing systems with significant data storage resources. These offerings are summarized at https://www.hec.nasa.gov/about/overview.html. Augmentation and refreshment of these central systems occur on a periodic basis. The HEC program also provides assistance in code porting, performance tuning, scientific data visualization, and data transfer.

Any need for computing time and other HEC Program resources for the proposed research must be justified by completing a request for inclusion with a FINESST proposal (see sections i and ii below).

(i) Generate Request for HEC Resources

The purpose of this step is to inform FINESST reviewers at NASA of your computational needs, and if the FINESST proposal is selected, establish eligibility to use HEC resources. The PI (not the FI) completes and submits a request in the HEC Request Management System (RMS) at https://request.hec.nasa.gov or https://request.hec.nasa.gov/login?url=%2F. The form includes a written justification of how the computational resources would support the investigation as well as a multi-year resource-phasing plan, in annual increments, identifying the computing time and data storage requirements covering the duration of the proposed award period.

About the RMS User Interface: The RMS asks for information in six different sections. Some RMS items will capture responses in a text box and some items provided restricted or limited choices. When RMS asks:

1. NASA Sponsoring Directorate, select NASA Science Mission Directorate (SMD).
2. NASA Sponsoring Program, select the proposal's reviewing/funding division, e.g., Astrophysics Division (APD), etc.
3. Requested Start Date, type in 09/01/2021. Reminder: Normally FINESST start on this date, but if you have a different start date on your NSPIRES cover page, then use that date.
4. Project Duration (in years), select either 1 or 2 or 3.
5. Funding Type, select Research Opportunities in Space and Earth Science (ROSES).
6. Funding Year, select 2020
7. Funding Name, select Future Investigators in NASA Earth and Space Science and Technology (FINESST).
8. Funding Manager, select the name of funding division's FINESST Program Scientist, i.e., Astrophysics (APD) = Evan Scannapieco, Earth (ESD) = Allison Leidner, Heliophysics (HPD) = Roshanak Hakimzadeh, and Planetary (PSD) = Lindsay Hays.

Computing time must be described in the request using Standard Billing Units (SBUs), a common unit of measurement employed by the HEC program for allocating and tracking computing usage across its various architectures. The RMS has a built-in calculator to help convert processor (CPU) hours to SBUs. SBU Conversion Factors are also available at https://www.hec.nasa.gov/user/policies/sbus.html, or proposers may contact HEC support staff for further assistance calculating SBUs. Contact information can be found at https://www.nas.nasa.gov/hecc/support/user_support.html for NAS User Support and https://www.nccs.nasa.gov for NCCS User Services Group.

If you are having difficulties using RMS and need technical support, then please email support@hec.nasa.gov and specify in the subject line "NNH20ZDA001N-FINESST HEC Request". Please allow 72 hours for a response before sending a second email.

(ii) Upload Request for HEC Resources

Save a PDF copy of your request after submitting it using the button provided in RMS. During the proposal submission in the NSPIRES system:

- Upload the PDF version of your computing time request as a separate file from your proposal and select "Appendix" as the document type when uploading.
- On the NSPIRES Cover Page
  - Check the box indicating that a request for HEC resources is included in the proposal, and
  - Enter the HEC Request Number (specified on the PDF). Reminder: Be sure to answer the HEC Program Specific Data questions with the NSPIRES Cover Page.

During the review of the proposed investigation, NASA will consider whether the computing time requested is an appropriate use of the highly constrained resources dedicated to FINESST.

Selection of your FINESST proposal does not guarantee that your HEC request is will be fully allocated; it means that your HEC request is eligible to progress to the next step for evaluation by the HEC Program (see section iii). While you are guaranteed some HEC time, it may differ from your request given resource constraints.

(iii) Allocation of HEC Resources

If your proposal is selected for funding, your HEC request will be evaluated by the HEC Allocation Authority. The HEC program will then issue letters identifying yearly allocations of HEC resources for the duration of the project, which again, may differ from your request due to limited availability of resources. However, PIs may submit requests to increase or decrease allocations of HEC resources if there are unexpected changes to computational needs. Requests for modifications must be submitted via RMS. Allocation in full cannot be guaranteed, but SMD will make every attempt to satisfy the needs in the context of the overall set of requirements, resource constraints, and science priorities.

To expedite initiation of new projects where PIs and/or users are foreign nationals (whose accounts will require additional documentation and longer processing), the HEC program will consider providing a minimal allocation to such projects that have been notified of pending funding soon after the PI submits an allocation request in RMS. PIs must provide the name of the FI participant (note that an FI is not a Co-I) who may use the account and identify foreign national status in the HEC request abstract.

For further information (no-how-to-use RMS questions) about NASA-provided High-End Computing resources, please contact Dr. Tsengdar Lee at Tsengdar.J.Lee@nasa.gov or 202-358-0860.

10.2 Explanatory Note B: Limitations on FINESST Budget Categories

FINESST research grants are limited to the cost categories identified in 2 CFR 200.75 Participant Support

- stipends
- subsistence allowances
- travel allowances
- registration fees paid to or on behalf of the student in connection with conferences

In general, NASA does not permit indirect costs (overhead) to be requested or recovered on participant support costs.

Because FINESST is not a fellowship, there is flexibility in what can be included as a reasonable, allowable, and allocable participant support cost, i.e., supplies, etc. However, because this particular program is limited solely to participant support costs, do not request indirect costs in the budget. Indirect costs are not an allowable, allocable, or reasonable cost under FINESST. NASA may return a non-compliant proposal that includes indirect costs without review.

Since a PI's, Co-I's, or Collaborator's current employment includes compensation and continues whether or not the proposal is selected by NASA, no salary, travel, or other costs shall be requested from SMD for the PI's, Co-I's, or Collaborator's use.

While the purchase of equipment in excess of $5,000 is not permitted through FINESST awards, if an institution's policy permits the purchase of computers, digital devices, or materials, such as to support mentoring activities for the FI or to construct a CubeSat as a participant support cost without charging indirect, then these "other" charges are allowable.

FINESST budgets require a narrative justification in the proposal (about 1-2 pages) by three or four broad cost categories 1) FI stipend; 2) FI allowance(s), *e.g.,* travel, *etc.*; 3) University Fees/Tuition; and 4) Other.

Input these FI costs on the NSPIRES coversheet under letter E. Direct Costs-Participant/Trainee Support Cost. NSPIRES listed subcategories are 1) Tuition/Fees/Health Insurance, 2) Stipends, 3) Travel, 4) Subsistence, and 5) Other.

FINESST awards are limited to a single students, so the Number of Participants/Trainees on the NSPIRES cover sheet is never greater than one.

SMD suggests an FI's maximum stipend normally is $35,000 in any 12-month period. If an FI's stipend will be less (or more) than $35,000, then the amounts in the stipend and other participant support budget categories may be adjusted/exchanged. Normally, however, the FI's travel, registration fees, and other participant support costs do not exceed $10,000 in a 12-month period. A request for partial year, i.e., a period of less than 12 months, should propose to prorate the stipend and other costs when practical and appropriate.

In cases where the FINESST $45,000 is not enough to cover the standard cost of the student at the university for a 12-month period then, in order to cover the remaining FI costs, the university may choose to cover these additional expenses from other sources and may show in the proposed budget the amount and source of the cost share. Alternatively, the proposal can plan that the FI take a hiatus to work on something funded by a non-FINESST source. Other creative FI support strategies may be proposed.

If NASA determines the proposal provides sufficient justification, then the amounts in the stipend and other budget categories are adjustable as long as the total amount requested does not exceed $45,000 in a 12-month period.

Changes to the period performance, including no cost extensions, will follow normal NASA grant procedures. The PI and FI are to work with the university's Office of Sponsored Research, or its equivalent, to determine the appropriate allocation in each budget category at the time of proposal and any subsequent changes to the budget post award in the annual progress report.

A proposed project's proposed start date, for example, may or may not be the same as its award date. A revised budget and revised detailed narrative justification may be requested before a selection or an award can be made. No commitment on the part of NASA should be inferred from technical or budgetary communications with a SMD civil servant, contractor, or JPL employee requesting budget revisions. Proposers are cautioned that only a NASA Grant/Contracting Officer from the NSSC may make commitments, obligations, or awards on behalf of NASA or authorize the expenditure of funds.

While the NSPIRES coversheet asks for cursory budget data, it is not a budget; therefore, it is necessary to address Section 4.1.6 Budget Timeline and Narrative. Proposed budgets, with narrative and any necessary supporting documentation, are a required section of the FINESST proposals and are subject to NASA procurement policies and negotiations.

10.3 Explanatory Note C: Elements of a FINESST Progress Report

As normal NASA grants under 2 CFR 200, this program requires only the standard mandatory minimum Research Performance Progress Report (RPPR). Progress reports are due annually by March 15. If March 15 falls on a non-work day, however, the next business day is a suitable email delivery/send date. The first progress report will be for a period of performance shorter than 12 months and due by March 15, 2022.

Progress Reports for Space Science: Email an annual progress report as a PDF attachment to NSSC-Grant-Report@mail.nasa.gov and the Space Science, (i.e., Astrophysics, Heliophysics, Planetary Science) technical officer identified on the NASA Form 1687, which is the first page of the grant award documents from the NSSC.

Progress Reports for Earth Science: Email the progress report as a PDF attachment to NSSC-Grant-Report@mail.nasa.gov and claire.i.macaulay@nasa.gov.

All FINESST progress report emails must have subject line that states 1) the NSSC-issued award number, 2) PI Name and 3) Institution Name. Failure to use and include the three items in the email subject line may significantly delay processing.

If for any reason, the organization will not be requesting continuation of a FINESST grant, a progress report should not be submitted. Instead, send an email to the award's 1) technical officer, 2) HQ-FINESST@mail.nasa.gov, 3) only applicable for Earth Science, the Earth Science FINESST administrative point of contact, and 4) the Grant's Officer at the NASA Shared Services Center (NSSC) to the effect that the project is ending early and a final report forthcoming to close out the award. Various final and closeout reports will be described in the NSSC award documentation.

Progress reports are short documents of approximately 2-4 pages, particularly for the first report. Progress reports are not new proposals. Progress report elements, excluding the optional high-end computing appendix, must be combined into a single PDF document and include the following, although each given section may be brief:

I. Administrative

- Name and address of the recipient's institution & Award Number
- Name of the Principal Investigator
- Name of the Future Investigator
- Award Title
- Type of Report: Choose one: Annual/Final
- Period covered by the report: <Month/Year to Month/Year>

II. Accomplishments

Start by reminding NASA what are the major goals and objectives of the project, and what did the FI do to progress toward those goals?

Did the FI do coursework or receive any professional development funded by the project? Provide an update toward completing a degree program with month/year completion date estimated. If no course work was planned or taken, state no coursework for this period.

III. Status/Changes/Issues/Updated Budget Narrative Justification (if applicable)

FI should discuss any stated goals not met or started.

If the PI/Institution got a warning/notification from the NSSC (e.g., "zero drawdown") because funds are not being spent, then the progress report should explain the lack of funds drawn down (e.g., because the student is on hiatus).

If not previously reported in writing to the NASA Shared Services Center and the awards technical officer at NASA Headquarters through other mechanisms, i.e., calls, emails, provide the following additional information:

Changes in approach and reason for change.
Actual or Anticipated problems or delays and actions or plans to resolve them.
Changes that have a significant impact on expenditures.

An updated budget justification narrative, if needed, especially if it is anticipated that the student may graduate, take a hiatus, or leave the program or university for any reason.

IV. Dissemination Activities (if applicable)

Have the results/activities been disseminated? For example, include a list of presentations, publications, videos with URLs, etc. Publications including web postings should acknowledge NASA support, including the FINESST program name and the NASA award number.

V. An Updated PI/FI mentoring plan/agreement (optional)

For example, if there will be a proposed PI change on the current FINESST award, explain that change to the mentoring plan and include a 2-page bio for the new PI requesting the change.

VI. Known Future Plans

Do the PI/FI anticipate a hiatus and/or no-cost extension?
If this is a final report, will the work continue post funding?
Is the FI remaining at the institution or moving on to new studies or a job offer, etc.?

VII. High-End Computing (if applicable)

If applicable, a progress report may include a new (or updated) request or modify high-end computing resources. If you are submitting a new HEC request, see Explanatory Note A of this solicitation for details. Be sure to allow enough time to compete the steps outlined in Explanatory Note A in order to create a new HEC appendix request for the progress report. A copy of a new HEC request should be provided as separate PDF file from FINESST award’s progress report to the

technical officer. The NSSC does not need a copy of the HEC request. If the project has an existing HEC-issued award and a modification is needed, please follow the guidance provided with the HEC award.

10.4 Explanatory Note D: Change of Original FINESST Student

In the event that an FI leaves the institution prior the completion of the research project or ceases to participate in the FINESST research for any other reason, NASA will determine how best to proceed.

The PI and FI should email the NASA program manager to let them know of the anticipated request so that the program manager can weigh in on the best course of action. On a case-by-case basis, NASA will formally consider a request for an FI change from the PI when the university's AOR emails a change request to the award's FINESST manager at HQ; the grants officer at the NSSC; and to HQ-FINESST@mail.nasa.gov.

An FI change request may propose that a masters or Ph.D. candidate, who is pursuing similar research, be named to expend the balance of the FINESST funds already with the institution. The request from the PI and the Office of Sponsored Research must include: 1) A statement (preferably from the original FI) indicating the date and reason for departure. 2) The successor FI's 2-page CV and mentoring plan. 3) Confirmation of the substitute student's status as a M.Sc. or Ph.D. candidate. 4) Specify what, if any, change is necessary to the period of performance and/or research scope. NASA will consider FI changes for administrative and/or merit-based reasons.

NASA review of such change requests includes, but is not limited to, scientific merit and continued relevance to NASA factors before deciding whether to approve. If approved, NASA may only allow a substitute student to use the current grant year funds and will not provide additional funds in future years. Caveat: Students who had three years of NESSF funding are not eligible to be named as an FI.

If the institution chooses not to propose a substitute FI, then the AOR still must email the award's program officer at HQ; grants officer at the NSSC; and HQ-FINESST@mail.nasa.gov with the news of the FI's departure and request an earlier end date to the period of performance. NASA will then proceed to grant close out.

10.5 Explanatory Note E: Mentoring Plan/Agreement: An Introduction for PI/FI Teams

Please verify whether your organization has mentorship resources or templates available. Go to your institution's website and search on key words, e.g., "mentor", "mentee", "mentor resources", etc., and communicate with your PI and organization about mentorship resources. If your proposing organization has mentorship information, please use it and refer to it. If your organization really has no mentorship plan, then adapting a mentoring plan designed originally for another purpose (such as a postdoctoral fellowship, NSF award) for use with FINESST is acceptable.

A mentoring plan or an agreement is not a confidential recommendation; rather, it sets respectful, reasonable expectations or goals and thus may help to foster a good working relationship that will further the FINESST research. It is to be hoped that the FINESST mentoring plan/agreement will set appropriate expectations for the working relationship

early, be reviewed regularly, and be easily revisable, providing an opportunity for FIs to request adjustments that they may otherwise find uncomfortable bringing up with the PIs.

Through the mentoring plan, the PI and FI identify and work toward research career development goals designed to deepen the FI's understanding of the FINESST research, career pathways, broaden resource networks, and facilitate growth as new professionals. A non-exhaustive list of mentoring activities that a plan may include, but is not limited to: 1) training in the preparation of data, publications, presentations, etc.; 2) opportunities to collaborate with researchers from diverse backgrounds and/or disciplinary areas; and/or 3) responsible professional practices coaching.

A FINESST selection by NASA has the potential to be life changing for the FI as a graduate student and in the early career years that follow degree attainment. A FI's potential for success improves when the PI and the mentoring plan support the FI's research development and independence; recognizes when to refer an FI to other experts and resources; and provides the FI with regular, kind, clear, and honest input. For resources related to STEM mentoring, selected URLs include:

American Association for the Advancement of Science STEM Mentor Resources
Pathways to Science: Mentoring Manual
Committee on the Status of Women in Astronomy's Mentoring Page

10.6 Explanatory Note F FINESST Proposal Preparation: Item Check List, Page Limits and Number of PDF Files

All FINESST proposals must include the following materials in the following order. First, the system-generated Proposal Cover Page created by filling out the required fields such as name of the FI, electronic Commitments from Co-Is or any Collaborators, if any, answering the questions on the NSPIRES web page, e.g., providing the Data Management Plan, a research abstract suitable for public posting upon selection, etc. There is no page limit, NSPIRES will generate the required number of pages and automatically place this at the front of the proposal if the fields are filled out. There is no need to download the cover page and attach it to the uploaded PDF file.

Checklist of Items to be included in the single proposal PDF File (all page limits maximum, unless specified):

- Table of Contents - 1 page.
- Personal Statement (authored by the FI) - 2 pages.
- Science/Technical/Management Section (authored by the FI) 6 pages
  Including illustrations, tables, figures, and foldouts.
- References/Citations and Acknowledgements 1 page or more as needed.
  At minimum must include a statement that the proposal is the work of the FI.
- Resume/Curriculum Vitae (CV) For the PI and FI – 2 pages each.
- CV for Co-I(s): Optional – 1 page each.
- A PI-FI mentoring plan or agreement – 2 pages.
  Exception: If the submitting institution has a standard Mentor-Mentee checklist, plan, agreement, template, etc., and it is longer than 2-pages, uses font size, margins, etc., that do conform to this solicitation, then the institution's standard is acceptable.

- Budget Timeline and Narrative – 2 pages.
  Excluding any special documentation, e.g., when submitting institution is not an education organization, proof that the proposed FI is enrolled/in good standing in an eligible degree program at a university, etc.

Second PDF File - only when applicable

- Optional High-End Computing (HEC) Appendix, See Explanatory Note- A for details.

Unlike other ROSES elements, there is no need for a separately uploaded "Total Budget" file.

11. Summary of Key Information

Expected annual program budget for new awards	No dedicated budget; selected proposals will be funded by the relevant SMD Division or program.
Number of new awards pending adequate proposals of merit	The number of proposals selected will be dependent on the number and quality of proposals submitted and on the availability of funds from the relevant SMD Division or program.
Maximum duration of awards	3 years and see Section 6.
Due date for Notice of Intent to propose (NOI)	Not Applicable. Notices of Intent are not requested/accepted for this program element.
Due date for proposals	Proposals may be submitted at any time until 11:59 pm Eastern time on xx, 2021.
Planning date for start of investigation	xx, 2021
Page limit for the central Science/Technical/Management section of proposal	6 pp; see also Sections 4.1 and 10.6 of this program element.
Relevance	See Section 2. Proposals that are relevant to this program element are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*. Grants and cooperative agreements will be subject to the policies and provisions identified in the regulations at 2 CFR (Code of Federal Regulations) 200, *NASA Grants and Cooperative Agreements Manual* (GCAM), and the *NASA Guidebook for Proposers*. In the case of any conflict, the order of precedence is as follows: regulations, NASA GCAM, this program element, the umbrella NRA, and then the *NASA Guidebook for Proposers*.
General requirements for content of proposals	See Section 3 of the *NASA Guidebook for Proposers* and Section IV and Table 1 of *the ROSES Summary of Solicitation*.

Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading a proposal package from Grants.gov	NNH20ZDA001N-FINESST
Funding Points of Contact	Emails FINESST Program Scientists by Division: Earth Science: allison.k.leidner@nasa.gov Planetary Science: lindsay.hays@nasa.gov Astrophysics: evan.scannapieco@nasa.gov Heliophysics: hakimzadeh@nasa.gov
Coordinating point of contact concerning this program	The HQ-FINESST Team Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Email: HQ-FINESST@mail.nasa.gov

E.6 SCIENCE ACTIVATION PROGRAM INTEGRATION

NOTICE: Amended on February 24, 2020. This Amendment presents final text for this program element. Notices of intent are requested by March 25, 2020, and proposals are due May 27, 2020. No data management plans are requested for this program element.

1. Scope of Program

1.1 Description of Solicited Focus Areas

The SMD Science Activation Program (SciAct) seeks to further enable NASA science experts and content into the learning environment more effectively and efficiently with learners of all ages. Competitively selected teams from across the Nation work in partnership with each other and with NASA to connect NASA science experts, real content, and experiences with community leaders to do science in ways that activate participation and promote understanding. Baselined in 2016, SciAct is building long-term relationships to bring NASA science to learners of all ages.

At a top level, SMD SciAct Objectives are:

- Enable STEM Education
- Improve U.S. Scientific Literacy
- Advance National Education Goals
- Leverage Efforts through Partnerships

Taking into account evolving national education priorities and following a program review by the National Academies of Science, Engineering and Medicine in 2019, additional teams are now invited to propose to complement those awards continuing into SciAct 2.0 (2021-2025). Proposals should not duplicate work already being done within Science Activation. Specific focus areas for this opportunity are:

- A process by which Subject Matter Experts (SME), especially NASA and NASA-funded SMEs, can engage with learners, content producers and audience-focused disseminators within the Science Activation Program portfolio.
- A process by which to broaden participation of under-represented and under-served learners in order to maximize participation in advancement of knowledge.

Proposers must propose and explain processes to integrate SMEs into the SciAct portfolio towards the overall outcome of more effectively and efficiently connecting with learners of all ages, and/or processes to broaden participation in SciAct offerings. Supporting community-based efforts and/or scaling to the national level is encouraged. Proposals may be SMD science Division-specific or include multiple science areas. All proposals must focus on the needs of the learners and must be evidence-based. Each proposal must also include an independent professional evaluator. Innovative partnerships with well-established (i.e., not wholly sustained by grant funding) systems or networks are particularly encouraged.

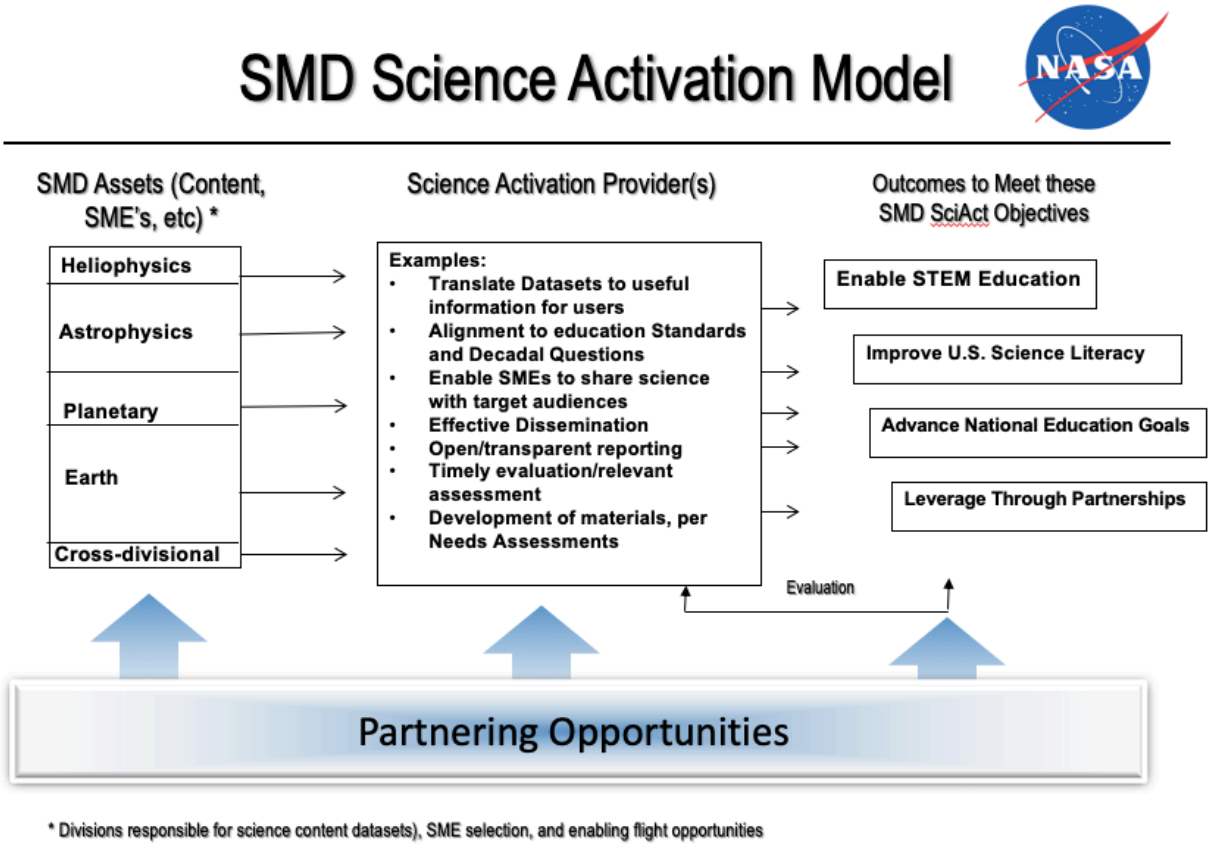
In addition, proposals may leverage NASA SciAct infrastructure activities as well as ongoing SciAct teams and other NASA communications Infrastructure to include web and social media sites.

Note: this program element does not solicit efforts associated with science communications, but there is a recognition that in some activities, synergy does occur since science communications are integral to the scientific process and STEM. Neither does this element solicit efforts associated with the NASA Internships and Fellowships program, which is the responsibility of the NASA Office of STEM Engagement.

1.2 SMD Science Activation Model

As background, NASA SMD has developed a model to govern its SciAct efforts (See Figure 1). At its foundation is the recognition that NASA SMD brings unique assets to the national education environment. These assets are approved, developed and implemented through the respective organizational structure of the SMD science Divisions.

Figure 1



2. Programmatic Information

2.1 Eligibility

Participation is open to all categories of U.S. institutions (except as provided below), including educational, industrial, and not-for-profit organizations, Federally Funded Research and Development Centers (FFRDCs), University Affiliated Research Centers (UARCs), NASA Centers including JPL, and other Government agencies.

Proposals from non-U.S. institutions are not solicited. Foreign participation in Teaming Arrangements or Leveraging Relationships may only be proposed at no cost to NASA.

2.2 Principal Investigators and Proposal Team Members

Every organization submitting a proposal must designate a single individual, the Principal Investigator (PI), who will be responsible for the quality and direction of the entire proposed effort and for the use of all awarded funds. Individuals who are critical for the successful completion of activities through the contribution of unique expertise and/or capabilities, and who serve under the direction of the PI, shall be identified as Co-Investigators (Co-Is). A Co-I must have a well-defined role that is explicitly defined in the Management section of the proposal. Team members shall not be duplicative on selected proposals. See Appendix B of *NASA Guidebook for Proposers* for additional guidance on team members.

2.3 Funding

NASA will negotiate Cooperative Agreements with selected proposing Organizations and will administer all funding. All funds for a given team will be sent to the proposing Institution, which can in turn provide research and salary funding to non-NASA and non-Governmental Co-Is. That is, only one Cooperative Agreement will be negotiated per selected proposal.

Projects that require additional substantial effort from one or more of the SciAct infrastructure activities linked to in Section. 1.1 shall include funding in their budget to support that effort.

NASA will fund such SciAct infrastructure support, as well as other NASA (including JPL) and other Government Organizations directly.

2.4 Description of NASA Contribution

It is anticipated that awards to non-governmental organizations will be in the form of cooperative agreements. The cooperative agreement(s) resulting from this element represent a partnership between NASA/SMD and the competitively selected team(s) to promote and advance public understanding of science and technology, as well as to collaborate with NASA to advance SciAct activities to meet SMD objectives.

In addition to funding (subject to availability of appropriated funds), oversight, and monitoring, NASA will be substantially involved by facilitating access for awardees to SMD-sponsored scientists, programs, and projects, and to related activities being conducted throughout the Agency. In particular, NASA shall:

- Provide policy guidance to the awardees as needed
- Provide information on SMD research programs, flight projects and other opportunities
- Work with awardees to develop a variety of approaches for informing both the SMD science and education communities of the services available from Science Activation, and the programs, products, and services resulting from the awardees' activities in open and transparent reporting
- Work with the awardees to develop appropriate mechanisms for the coordination and integration of activities with each other and other members of the Science

Activation Program. SMD will be responsible for planning and scheduling meetings for the Program.

3. Proposal Preparation

SciAct proposals must be prepared in accordance with the instructions given in the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*. The Science/Technical/Management section of the proposal must contain a detailed statement of the proposed work within 15 single-spaced pages including figures and tables. Please see section IV(b)ii of the *ROSES Summary of Solicitation* for complete guidelines.

No data management plan or software development plan is requested for proposals submitted to this program element. However, SMD expectations regarding software (as described in Section 2 of E.1 The Cross Division Research Overview) still apply to awards that derive from this program element.

3.1 Budget Requirements and Restrictions

The duration for SciAct awards may be up to five years, but cooperative agreements are funded annually, and progress must be demonstrated in order to warrant continuation into subsequent years. Proposals must provide clear, measurable milestones for each year of performance against which progress will be measured. The award amount will be judged according to the scope of the proposed work and the overall competition. Budgets – year by year for a proposed five-year period of performance - should include travel funds for the PI, a Co-I, and the project evaluator to attend a weeklong SciAct annual meeting in Northern Virginia every November and one additional meeting in an East Coast location.

4. Reporting and SciAct Participation

In addition to the normal annual progress and evaluation reports required from grantees, recipients of cooperative agreements from proposals to this program element will be expected to participate in monthly SciAct virtual meetings as well as the annual face-to face meeting noted in Section 3.1.

5. Proposal Review and Evaluation

Proposals will be evaluated against the three evaluation criteria: Intrinsic Merit, Relevance, and Cost, as defined in Appendix D of the NASA Guidebook for Proposers and as described in Section VI(a) of the ROSES *Summary of Solicitation*.

In addition to the definition given in Appendix D of the guidebook, for proposals to this element the evaluation of Merit will include these two additional factors:

A. Approach for Evaluation
Degree to which the proposed effort identifies measures for success consistent with the Science Activation Model; external and internal processes for evaluation; decision gates and criteria to continue and discontinue activities over the five-year agreement(s); and checks and balances of the evaluation system.

B. Partnerships/Sustainability, including collaboration with Other NASA SMD Science Activation Activities

Degree to which the proposed effort integrates and synergizes with the Science Activation portfolio and other Science Mission Directorate activities, and the degree to which the proposer has established external partners who share mutual values to enable successful achievement of outcomes. Evaluation of sustainability considers the likelihood that the activity will continue past the funding period.

Assessment of Relevance will be according to alignment with one or both of the two specific focus areas identified in Section 1.1.

6. Summary of Key Information

Expected annual program budget for new awards	~ $5.0M
Number of awards pending adequate proposals of merit	~4-6
Maximum duration of awards	5 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 of this ROSES NRA
Due date for proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	January 1, 2021
Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of ROSES and the *NASA Guidebook for Proposers*.
Relevance	This program is relevant to the questions and goals of the Science Mission Directorate as described in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	Please see *ROSES Summary of Solicitation* Section I(g) Order of Precedence and the *NASA Guidebook for Proposers*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-SciAct

Point of contact concerning this program	Lin Chambers Science Engagement and Partnerships Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: 757-864-4371 Email: lin.h.chambers@nasa.gov

E.7 SUPPORT FOR OPEN SOURCE TOOLS, FRAMEWORKS, AND LIBRARIES

NOTICE: Amended October 19, 2020. This amendment releases the final text for this program element. Optional notices of intent to propose are requested by November 19, 2020 and the due date for proposals is January 19, 2021.

1. Scope of Program

1.1 Motivation

Open source software tools, libraries, and frameworks play an increasingly prominent role in SMD-related science research and applications. As the adoption of open software accelerates the rate of scientific discovery, the National Academies' has recognized the growing need among the NASA science community to provide sustained support and maintenance of these types of software in their 2018 report *Open Source Software Policy Options for NASA Earth and Space Sciences*. This program is designed to provide support to the sustainable development of open source software, tools, libraries, and framework that are critical for SMD scientific objectives.

1.2 Objectives

SMD seeks proposals for the improvement and sustainment of high-value, open source tools, frameworks, and libraries that have made significant impacts to the SMD science community. We are seeking proposals that satisfy the following objectives:

- Open source software tools, libraries, and frameworks that have significant usage in the NASA science community, developed following open and collaborative practices, and are aligned with the scientific vision and data strategic plan of SMD.
- Proposals should look to improve the sustainability and utility of these packages through improvements to adding extensions, documentation, infrastructure, and maintenance of the software.

This program seeks to support projects under active development and usage, and it does not support updating of legacy software that is no longer supported, which can be supported under other calls. We are not soliciting the development of new open source tools, frameworks, or libraries with this call.

2. Programmatic Information

2.1 Eligibility

Participation is open to all categories of U.S. institutions (except as provided below), including educational, industrial, and not-for-profit organizations, Federally Funded Research and Development Centers (FFRDCs), University Affiliated Research Centers (UARCs), NASA Centers including JPL, and other Government agencies.

Proposals from non-U.S. institutions are welcome, but they must be for funding of a co-investigator at a U.S. institution. Foreign participation in Teaming Arrangements or Leveraging Relationships may only be proposed at no cost to NASA.

To be eligibile to be the subject of work in a proposal to this progam element, the open source software tools, libraries, and frameworks proposed must have already been

released under a generally accepted, open source license (e.g., Apache-2, BSD-2-clause, GPL) at the time this call has been released.

2.2 Funding

It is anticipated that the funding available for awards made in response to proposals to this program element will be $1.5 million per year. This is expected to support 5-10 projects for the call. The awards will be for a maximum duration of three years.

Funding to non-governmental organizations will be administered through either grants or cooperative agreements. NASA will negotiate with the selected proposing organizations and will administer all funding. All funds for a given team will be sent to the proposing institution, which must in turn provide any research and salary funding to funded team members at non-governmental organizations. That is, only one Cooperative Agreement or Grant will be negotiated per selected proposal.

3. Proposal Preparation

Proposals must be prepared in accordance with the instructions given in the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*. The proposal must be submitted via NSPIRES or Grants.gov by the organization's Authorized Organizational Representative (AOR). A budget and other specified information is required.

The Science/Technical/Management section of the proposal must contain a detailed statement of the proposed work within 15 single-spaced pages including figures and tables. Proposals must adhere to formatting requirements (e.g., margins, font sizes, line spacing). Please see section IV(b)ii of the *ROSES Summary of Solicitation* for complete guidelines.

The following elements must be included in the proposal to allow for the evaluation of the proposal:

- A clear description of the software and relevance to the SMD science community and the relationship to NASA SMD scientific vision and data strategic plan. This should include:
    - the impact of the software in the SMD science community.
    - the current usage in the SMD science community.
    - the current status of development of the software package.
- The sustainable activities to be undertaken for the software must be described.
    - This may include, but not be limited to, adding extensions, documentation, infrastructure, and maintenance of the software.
    - A discussion that demonstrates that the requested resources are necessary and sufficient for success in achieving the proposed effort. The resource discussion should include how many hours at what specific level of support persons are required.
    - This should include aspects of how information about the software is disseminated to the community, which may include documentation, training, workshops, and/or publications.
- The project management for the software must be described. This must include:
    - governance and development model for the project.
    - information including how the license the project is using.

- metrics for assessing the successful implementation of sustainability.
- collaboration with related projects.
- the inclusive practices of the project to foster community development (e.g. code of conduct, contributors' guides, open development model).

The proposals must clearly state the process of adding extensions, documentation, and maintenance of the software to support the user community and should include an assessment of the potential impact to the SMD science community of the proposed work.

A data management plan must be included. If there are any underlying data that are part of the software, then a clear management plan for those data should be included. The management plan should include sustainable plans for both the data and the software. In addition to the aspects outline in Section 2 of E.1 the Cross Division Research Overview, as part of the data management plan, the sustainability of the software should be described.

4 Proposal Review and Evaluation

Proposals will be evaluated against the three evaluation criteria: Intrinsic Merit, Relevance, and Cost, as defined in Appendix D of the *NASA Guidebook for Proposers* and as described in Section VI(a) of the *ROSES Summary of Solicitation*.

In addition to the definitions given in Appendix D of the Guidebook for Proposers, the evaluation of proposals submitted to this element will include the following additions/clarifications:

A. The evaluation of relevance will include the alignment of the software with the SMD scientific vision and data strategic plan.
B. The evaluation of impact as part of Merit will include an assessment of usage in the community; open source software, tools, libraries, and frameworks that are currently widely used in the community will be prioritized for support.
C. The evaluation of impact may include the level of collaboration and coordination as a strength. However, the absence of this is not in and of itself a cause of weakness.

5. Summary of Key Information

Expected program budget for first year of new awards	~$1.5M
Number of new awards pending adequate proposals of merit	~5-10
Maximum duration of awards	3 years
Due date for Notices of Intent	See Tables 2 and 3 of this ROSES NRA
Due date for proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	6 months after proposal due date
Page limit for the central Science/Technical/Management section of proposal	15 pp; see also Table 1 of ROSES.

Relevance	This program is relevant to the questions and goals of the Science Mission Directorate as described in the Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	Please see ROSES *Summary of Solicitation* Section I(g) Order of Precedence, Table 1, and the *NASA Guidebook for Proposers*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Submission medium	Electronic proposal submission is required; no hard copy is required.
Web site for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-OSTFL
Point of contact concerning this program.	Steven Crawford Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Email: steven.m.crawford@nasa.gov Telephone: (410) 338-6386

E.8 SUPPLEMENTAL OPEN SOURCE SOFTWARE AWARDS

NOTICE: Amended October 27, 2020. This amendment releases the final text for this program element. Notices of intent are not requested. Proposals will be accepted on a rolling basis with a final due date of April 14, 2021.

1. Scope of Program

Supplemental open source software awards are used to encourage the conversion of legacy software into modern code to be released under a generally accepted, open source license (e.g., Apache-2, BSD-2-clause, GPL). The supplement would add a software component to an existing "parent" research and analysis award.

2. Programmatic Information

2.1 Eligibility

In order to propose an activity as a supplement to a research and analysis proposal submitted in response to this program element, the proposer must have a research proposal that has been selected for funding (hereinafter called the "parent award"), through any previous SMD solicitation that has at least 15 months remaining in its period of performance at the time of the submission of the open source software proposal. Previous SMD solicitations include any from the Biological and Physical Science Division. Proposals that have not yet been selected for funding are not eligible.

2.2 Funding

It is anticipated that the current funding for the program will be up to $250K per year. The funds will be distributed across the different Science Mission Directorate divisions.

The cost cap for a proposal by an individual investigator is $20K/year.

A "Collaborative Proposal" option is available that allows several SMD-funded researchers to collectively carry out a more ambitious, expansive open source software program, with a recommended cap of $50K per year, not to exceed $125K over the nominal three-year lifetimes of the parent awards.

To diminish administrative burden on of such small supplemental awards, funds will be awarded as augmentations to existing awards. As a result, the total period of performance for any open source software award is limited to that of its parent award (for a collaborative award, this limit applies to the last expiring award involved in the consortium of proposing investigators).

If a proposal is submitted within 90 days after the date of the letter of selection for the parent award, the funding will be applied to the first year of the parent award. In all other cases, the funding will be applied to the next yearly funding supplement. If the proposal is submitted within 90 days of the yearly anniversary, it may only be applied to the funding for the following year.

3. Proposal Preparation

Proposal formatting must be in accordance with the instructions given in the *ROSES Summary of Solicitation*. The proposal must be submitted via NSPIRES or Grants.gov

by the organization's Authorized Organizational Representative (AOR). A budget and other specified information is required.

The proposal must be contained within 3 single-spaced pages including any tables or figures. The proposal must contain the following elements:

- A brief summary of the scientific goals of the original proposal
- A description of the software to be open sourced and the benefit to the community of that software. This can either be for an entire package or an incremental release of specific algorithms.
- A development plan that describes the required resources and how the development will be managed. This should include any documentation, any supporting infrastructure, and dissemination of the software to the community.
- A timeline for the development and release of the software

4. Proposal Review and Evaluation

Proposals will be evaluated against the three evaluation criteria: Intrinsic Merit, Relevance, and Cost, as defined in Appendix D of the *NASA Guidebook for Proposers* and as described in Section VI(a) of the *ROSES Summary of Solicitation*.

As part of the evaluation of impact, which is a factor in Merit, reviewers will assess the potential benefit of the software to the community and the reasonableness of the development plan in the proposal.

Proposals that are rated highly will be considered for funding prior to the close of the call.

5. Summary Table of Key Information

Expected program budget for first year of new awards	~$250K; $20K/year see Section 2.2
Number of new awards pending adequate proposals of merit	~10
Maximum duration of awards	Up to 3 years
Due date for Notices of Intent	No Notices of Intent are requested for this program element.
Due date for proposals	Proposals may be submitted at any time until 11:59 pm Eastern time on April 14, 2021
Planning date for start of investigation	At the start of the yearly funding supplement for the award.
Page limit for the central Science/Technical/Management section of proposal	3 pp; see Section 3, above.
Relevance	This program is relevant to the questions and goals of the Science Mission Directorate as described in the *Science Plan*. Proposals that are relevant to this program are, by definition, relevant to NASA.

General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Section IV and Table 1 of *the ROSES Summary of Solicitation* and Section 3 of the *NASA Guidebook for Proposers*, but see Section 3, above.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-SOSS
Point of contact concerning this program.	Steven Crawford Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Email: steven.m.crawford@nasa.gov Telephone: (410) 338-6386

E.9 Citizen Science Seed Funding Program

NOTICE: Amended September 11, 2020. This amendment releases final text for this program element which was previously released for community comment. Notices of Intent to propose are requested by October 13, 2020 and 6-page Proposals are due December 11, 2020. A Frequently Asked Questions (FAQ) document will be posted on the NSPIRES page for this program element under "Other Documents".

1. Scope of Program

Citizen science is a form of open collaboration in which individuals or organizations participate voluntarily in the scientific process. The SMD Citizen Science Seed Funding Program (CSSFP) aims to support scientists and other experts to develop citizen science projects relevant to NASA's Astrophysics, Heliophysics and Planetary Science Research Programs. In addition, proposals relevant to Biological and Physical Sciences will also be considered on a case by case basis. See below for information on citizen science projects related to Earth Sciences. Note that the term "citizen science" does not pertain to citizenship in any particular country, and that "citizen scientists" may include "amateur" scientists.

The CSSFP aims to advance the use of citizen science by incubating citizen science projects as they are being conceived or during critical transitions, like the year when they are first launched or beta tested (i.e., when the first group of volunteers is invited to try the project) or when the project changes scientific direction. CSSFP awards require relatively short proposals to encourage new proposers to experiment with citizen science techniques; the Science/Technical/Management section has a limit of 6 pages.

CSSFP awards have a duration of up to one year only. Citizen science projects enabled by this program may be eligible to apply for longer-term support via other ROSES elements. As described in section I(i) of the *ROSES Summary of Solicitation*, proposers to any ROSES program element are invited to incorporate citizen science and crowdsourcing methodologies into their submissions, where such methodologies will advance the objectives of the proposed investigation. More information on proposing citizen science projects to other ROSES elements can be found at http://science.nasa.gov/citizenscience underneath the heading that says "For Researchers" on the top of the right navigation menu.

This program element solicits efforts to perform research that will be published in the scientific literature. Such publications are not required after only one year of effort, but work on them should be underway. SMD citizen science projects shall be held to the same rigorous standards as any SMD science program. Documented project goals must include advances in science, the merit of which shall be determined by peer review.

The CSSFP does not solicit efforts whose sole aim is to create tools for citizen science or efforts whose primary purpose is outreach or education. It does not support crowdsourcing efforts whose primary goal is engineering or software development. Projects that involve students are acceptable, but proposers should keep in mind that proposals will be evaluated based on their potential to produce scientific results.

The CSSFP does not support projects that are only relevant to the Earth Science Research Program. However, the Earth Science Research Program supports citizen science through other ROSES elements, including, this year, A.41, Citizen Science for Earth Systems Program.

2. Citizen Science in SMD

NASA's science objectives are discussed in section 1.a of the *ROSES Summary of Solicitation*. In addition, SMD's citizen science efforts have the following top-level goals. SMD's portfolio of citizen science projects shall contribute to building a scientifically literate nation by:

i. Providing opportunities for U.S. citizen scientists;
ii. Encouraging highly educated volunteers who can benefit NASA via their expertise;
iii. Leveraging existing communities of citizen scientists or other enthusiasts for a variety of projects; and
iv. Connecting citizen scientists with NASA Subject Matter Experts who provide role models and mentorship.

SMD currently funds approximately 22 citizen science projects, reaching about 1.5 million participants. More than 100 citizen scientists have become named coauthors on scientific papers as a result of these projects. NASA embraces developing and growing a diverse and inclusive community of citizen scientists in a positive and safe environment where individuals can be authentic. For a list of active SMD citizen science projects, and more resources for developing new projects, see the SMD citizen science website, http://science.nasa.gov/citizenscience.

The SMD citizen science website also includes:

- A citizen science news page, https://science.nasa.gov/citizenscience/news
- Citizen scientist profiles, https://science.nasa.gov/people/view?title=&tid=7
- Links to the DoNASAScience Social media accounts on Twitter and Facebook

You are encouraged to work with the science writers/press officers at your home institution to publicize your citizen science project and disseminate the results, but these communications tools listed above provide additional avenues for NASA-funded citizen science projects to communicate with the public. For more information about NASA citizen science communications, contact SMD citizen science communications lead Maria Santos (Maria.Santos@nasa.gov).

SMD holds an annual workshop, the "Building the NASA Citizen Science Community" workshop, bringing together scientists, NASA leaders, and citizen scientists to exchange ideas and best practices. (The first workshop was held June 20-22, 2019. A second workshop is being held virtually from May 27, 2020 to September 30, 2020.) At least one representative member of each proposal team that receives a grant via the CSSFP is expected to participate in this annual workshop, where they will receive training in citizen science best practices.

3. Funding and Division Representatives

The CSSFP, a new program in ROSES-2020, is jointly funded by three SMD science Divisions: the Astrophysics Division, the Heliophysics Division and the Planetary

Science Division. Each of these Divisions will select proposals to fund based on its own programmatic priorities and relevance to that Division's research program. In addition, proposals relevant to Biological and Physical Sciences will also be considered on a case by case basis. Cross-divisional projects will also be considered, provided they can demonstrate relevance to at least one ROSES element (other than CSSFP) in any of the above three Divisions as a possible source of long term support. A Point of Contact (POC) for each Division for the CSSFP is listed below. The Citizen Science Officer (Marc Kuchner) serves as the point of contact for cross-divisional projects.

4. Proposal Preparation and Budget Requirements

Baseline instructions for proposals to all NASA solicitations may be found in the *NASA Guidebook for Proposers*, and the standard instructions for all proposals to ROSES are given in the *ROSES Summary of Solicitation*. The order of precedence for those preparing proposals for this program element is the following: First, the instructions this CSSFP program element, this document takes precedence, followed by the Cross Division Research Overview, the *ROSES Summary of Solicitation* and, last, the *NASA Guidebook for Proposers*. Thus, this CSSFP program element may provide instructions that supersede the defaults. For example, the Science/Technical/ Management (S/T/M) section of a proposal to this program may be no more than 6 single-spaced pages including figures and tables. This differs from the default 15 pages for the S/T/M section given in the *NASA Guidebook for Proposers*, and the *ROSES Summary of Solicitation*. See section IV(b)ii of the *ROSES Summary of Solicitation* for default formatting guidelines.

The S/T/M section of the proposal must contain a detailed statement of the proposed work. It must include a discussion of how existing platforms and/or existing enthusiast communities can be utilized to maximize the project's impact. Development of new platforms and/or building of new communities will be considered on a case by case basis, and require justification.

Proposals must include a thorough plan for beta testing: testing the project with a group of citizen scientist volunteers (or another group of non-experts, like summer interns) to ensure data quality and positive participant experience.

A proposal team should include appropriate expertise in order to foster broad participation, communication and dissemination of results, e.g., two-way communication between volunteers and scientists, with scientists giving feedback to and receiving feedback from the volunteers.

As stated in Section II(c) of the *ROSES Summary of Solicitation* and Section 2 of E.1 the Cross Division Research Overview, proposals must include a data management plan in a special section, not to exceed two pages in length, immediately following the References and Citations section for the Scientific/Technical/Management portion of the proposal and the sufficiency of the data management plan will be evaluated as part of the proposal's intrinsic merit.

Investigators proposing citizen science projects in which participants are actively involved in conducting observations are encouraged to read the NASA ESDS Citizen Science Data Working Group White Paper to learn more about standards and best

practices for citizen science data collection, management and long-term archiving. Also, note that SMD Policy SPD-33 also lists "Inclusion of a sunset plan" as an evaluation element for SMD citizen science projects. However a sunset plan is not required for CSSFP proposals, since CSSFP funding only lasts one year.

Proposals must be specific about how the proposed research is relevant to one or more of the following SMD science Divisions: Astrophysics, Heliophysics, Planetary Science or Biological and Physical Sciences. Proposals that focus on Heliophysics should address one of the high level science goals from the relevant Decadal Survey: *Solar and Space Physics: A Science for a Technological Society* (www.nap.edu/catalog.php?record_id=13060). For information on SMD's science priorities, see *SCIENCE 2020-2024: A Vision for Scientific Excellence*.

The duration for CSSFP awards may be up to one year. The proposal should describe both the work to be completed during this one year of funding and also provide a long term plan for the project. This long term plan must include a discussion of potential sources of future funding to continue the project after one year. For example, the plan could specify which other ROSES elements the project would likely be relevant to in future years. Biological and Physical Sciences has not yet become part of ROSES, but note that a new program funded by this division, “Research Opportunities in Space Biology” is expected to be included in ROSES starting in 2021.

Budgets should include funds for the PI to participate in an annual "Building the NASA Citizen Science Community" meeting, which we anticipate will be take place virtually (online only). Budgets shall not include salary funding for citizen scientists/volunteers. However, since training and communicating with citizen scientists is a necessary component of a citizen science project, proposal budgets should include resources for accomplishing these tasks. For example, funds may be used for graphic design, or development of trainings, website content, newsletters, or tutorials.

Proposals that rely on an existing citizen science platform such as Anecdata, iNaturalist, Zooniverse, etc., are encouraged to include a letter of endorsement from that platform unless the project clearly does not require any modification or maintenance of the tools that are already publicly available. If such a letter is not included, the proposal must explain how the investigation is feasible with the publicly available tools. If selected, a letter of endorsement from the platform must be provided before the award is made.

5. Reporting and Annual Meeting Participation

In addition to the normal annual progress and evaluation reports required from grantees, recipients of grants from proposals to this program element will be expected to participate in the annual meeting noted in Section 2.

6. Proposal Review and Evaluation

Proposals will be evaluated against the three evaluation criteria: Intrinsic Merit, Relevance, and Cost, as defined in Appendix D of the *NASA Guidebook for Proposers* and as described in Section VI(a) of the ROSES *Summary of Solicitation*.

Assessment of Intrinsic Merit: for proposals to this program element the evaluation of Intrinsic Merit is clarified as follows:

A) As described in the *NASA Guidebook for Proposers*, the evaluation of Intrinsic Merit will include an assessment of the qualifications and capabilities of the team. In this case, that will include the extent to whch the team includes the necessary expertise in order to foster broad participation, communication and dissemination of results.

B) As described in the *NASA Guidebook for Proposers*, the evaluation of Intrinsic Merit includes "the significance and/or impact of the proposed work". In this case, that includes how effectively the proposed project utilizes existing platforms and/or existing enthusiast communities, or argues that the creation of new communities or platforms is necessary given the many existing platforms and communitites that are available.

C) As described in the *NASA Guidebook for Proposers*, the evaluation of Intrinsic Merit will include "the scientific quality of the proposed project". In this case, that includes an assessment of the plan for beta testing to ensure data quality and positive participant experience.

Assessment of Relevance: Relevance will be assessed vs. the goals, objectives and priorities of the Division(s) to which the proposal stated it was relevant. For Astrophysics, Heliophysics, and Planetary Science, these goals, objectives and priorities are described in the 2020 Science Plan "*SCIENCE 2020-2024: A Vision for Scientific Excellence*". The relevance of proposals that focus on Heliophysics will also be compared to the high level science goals in the relevant Decadal Survey: Solar and Space Physics: A Science for a Technological Society (www.nap.edu/catalog.php?record_id=13060). The relevance of proposals that focus on Biology and Physical Sciences will be assessed vs. the goals, objectives and priorities described in the Decadal Survey on Biological and Physical Sciences in Space. Note: peer reviewers may comment on relevance, but the funding SMD Division(s) will make the ultimate determination on relevance.

7. Summary of Key Information

Expected annual program budget for new awards	Up to $720K ($80K average per award)
Number of awards pending adequate proposals of merit	Up to three in each Division: Astrophysics, Heliophysics, and Planetary Science, for a total of up to 9 awards. In addition, proposals relevant to Biological and Physical Sciences will also be considered on a case by case basis.
Maximum duration of awards	1 year; shorter term proposals are also welcome.
Due date for optional Notice of Intent to propose (NOI)	See Tables 2 and 3 of this ROSES NRA
Due date for proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	May 1, 2021
Page limit for the central Science/Technical/Management section of proposal	6 pages.
Relevance	See Section 6, above.

General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
General requirements for content of proposals	See Table 1 and Section IV of *the ROSES Summary of Solicitation* and E.1 The Cross Division Research Overview.
Detailed instructions for the submission of proposals	See https://nspires.nasaprs.com/tutorials/ and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH20ZDA001N-CSSFP
Points of contact concerning this program all of whom share the following postal address: Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001	Main Point of Contact Marc Kuchner Citizen Science Officer Science Engagement and Partnerships Division Telephone: (301) 286-5165 Email: marc.kuchner@nasa.gov Hashima Hasan Astrophysics Division Telephone: (202) 358 0692 Email: hhasan@nasa.gov Katya Verner Heliophysics Division Telephone: (202) 358-1213 Email: ekaterina.m.verner@nasa.gov Becky McCauley Rench Planetary Science Division Telephone: (202) 358-0530 Email: rebecca.l.mccauleyrench@nasa.gov Continued…

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