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HEADQUARTERS
SCIENCE MISSION DIRECTORATE

RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES – 2018 (ROSES-2018)

NASA RESEARCH ANNOUNCEMENT (NRA)
SOLICITING BASIC AND APPLIED RESEARCH PROPOSALS

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FULL (STEP-2) PROPOSALS DUE
STARTING NO EARLIER THAN MAY 3, 2018
THROUGH NO LATER THAN APRIL 25 2019

RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES (ROSES)–2018
EXECUTIVE SUMMARY

This National Aeronautics and Space Administration (NASA) Research Announcement (NRA), Research Opportunities in Space and Earth Sciences (ROSES) – 2018, 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 supporting research and technology in space and Earth sciences supported by SMD. Awards will be made as grants, cooperative agreements, contracts, and inter- or intra-agency transfers, depending on the nature of the work proposed, the proposing organization, and/or program requirements. 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-2018 omnibus NRA will be available upon its release on February 14, 2018, at http://solicitation.nasaprs.com/ROSES2018. Tables 2 and 3 of this NRA, which will be posted at http://solicitation.nasaprs.com/ROSES2018table2 and http://solicitation.nasaprs.com/ROSES2018table3, 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 2019, at which time release of a subsequent ROSES NRA is planned, proposers should 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-2018 RSS feed for amendments, clarifications, and corrections at http://science.nasa.gov/researchers/sara/grant-solicitations/ROSES-2018/, and
(3) The ROSES-2018 due date Google calendar. Instructions are at https://science.nasa.gov/researchers/sara/library-and-useful-links.

Potential proposers should also be aware of the ROSES FAQ at http://science.nasa.gov/researchers/sara/faqs/ and the *Guidebook for Proposers Responding to a NASA Funding Announcement* (hereafter referred to as the *NASA Guidebook for Proposers* or simply the *Guidebook*).

ROSES–2018 SUMMARY OF SOLICITATION

TABLE OF CONTENTS

	Page
I. Funding Opportunity Description	1
(a) Strategic Objectives of NASA and the Science Mission Directorate	1
(b) Research Programs of NASA's Science Mission Directorate	1
(c) Significant Changes from Recent ROSES	2
(d) NASA-Provided High-End Computing (HEC) Resources	4
(e) Availability of Funds for Awards	6
(f) Successor, Resubmitted, Multiple and Duplicate Proposals	6
(g) Order of precedence: ROSES vs. Guidebook vs. Program Elements	6
(h) Access to NASA Facilities/Systems	7
(i) Citizen Science	7
II. Award Information	8
(a) Funding and Award Policies	8
(b) Award Period of Performance	9
(c) Increasing Access to the Results of Federally Funded Research	9
(d) Rephasing of Award Budgets	10
III. Eligibility Information	10
(a) Eligibility of Applicants	10
(b) Number of Proposals and Teaming Arrangements	11
(c) Restrictions involving China	11
(d) Cost Sharing or Matching	12
IV. Proposal and Submission Information	13
(a) Proposal Instructions and Requirements	13
(b) Content and Form of the Proposal Submission	13
(i) Electronic Proposal Submission	13
(ii) Proposal Format and Contents	15
(iii) Budget Rules with Redaction of Salaries and Indirect Costs	16
(iv) Submission of Proposals via NSPIRES	18
(v) Submission of Proposals via Grants.gov	21
(vi) Notice of Intent to Propose	23
(vii) The Two-Step Proposal Process	23
(viii) The Two-Phase Proposal Process	24
(c) Proposal Submission Due Dates and Deadlines	25
(d) Proposal Funding Restrictions	25
V. Suborbital-Class Investigations	28
(a) Overview of Suborbital-Class Platforms	28
(b) Points of Contact for Suborbital-Class Platforms	28
(i) NASA-provided Sounding Rocket Services	28
(ii) NASA-provided Balloon Services	28
(iii) Suborbital Reusable Launch Vehicles	29
(iv) Research Investigations utilizing the International Space Station	32
(v) Use of Short Duration Orbital Platforms, including CubeSats	34
(c) General Guidelines for Suborbital Investigation Proposals	37

VI. Proposal Review Information 37
(a) Evaluation Criteria 37
(b) Review and Selection Processes 39
(c) Selection Announcement and Award Dates 39
(d) Processes for Appeals 40
(i) Reconsideration by SMD 40
(ii) Ombudsman Program 40
(iii) Protests 40
(e) Service as a Peer Reviewer 41
VII. Award Administration Information 41
(a) Notice of Award 41
(b) Administrative and National Policy Requirements 41
(c) Award Reporting Requirements 41
VIII. Points of Contact for Further Information 42
IX. Ancillary Information 43
(a) Announcement of Updates/Amendments to Solicitation 43
(b) Electronic Submission of Proposal Information 43
(c) Electronic Notification of SMD Research Solicitations 43
(d) Further Information on SMD Research and Analysis Programs 44
(e) Archives of Past Selections 44
(f) Meeting Geospacial Standards 44
X. Concluding Statement 45
TABLE 1. Checklist for Proposers 46
TABLE 2. Program Elements (ordered by due date) follow link
TABLE 3: Program Elements (ordered by Division/Topic) follow link

Note: Table 2 and Table 3 of this NRA are posted and updated as separate html documents on the web and can be reached either by following the hypertext links above embedded in the electronic version of this document, or at http://solicitation.nasaprs.com/ROSES2018table2 and http://solicitation.nasaprs.com/ROSES2018table3, respectively, or by going to http://solicitation.nasaprs.com/ROSES2018 and following the links there.

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-2018 by signing up for the SMD NSPIRES mailing list and/or by signing up for the ROSES-2018 RSS feed at https://science.nasa.gov/researchers/sara/grant-solicitations/roses-2018/.

RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES (ROSES)–2018

LIST OF PROGRAM ELEMENT APPENDICES

APPENDIX A. EARTH SCIENCE RESEARCH PROGRAM

A.1	Earth Science Research Program Overview	A.1-1
A.2	Land Cover/Land Use Change	A.2-1
A.3	Ocean Biology and Biogeochemistry	A.3-1
A.4	Terrestrial Ecology	A.4-1
A.5	Carbon Cycle Science	A.5-1
A.6	Biodiversity	A.6-1
A.7	ECOSTRESS Science Team	A.7-1
A.8	Sustaining Living Systems in a Time of Climate Variability and Change	A.8-1
A.9	Physical Oceanography	A.9-1
A.10	Ocean Salinity Field Campaign SPURS II Processing and Synthesis	A.10-1
A.11	Ocean Salinity Science Team	A.11-1
A.12	Sea Level Change Science Team	A.12-1
A.13	Ocean Surface Topography Science Team	A.13-1
A.14	Ocean Vector Winds Science Team	A.14-1
A.15	Modeling, Analysis, and Prediction	A.15-1
A.16	Cryospheric Science	A.16-1
A.17	Atmospheric Composition: Upper Atmosphere Research Program	A.17-1
A.18	Atmospheric Composition: Radiation Sciences Program	A.18-1
A.19	Atmospheric Composition: Modeling and Analysis	A.19-1
A.20	Tropospheric Chemistry	A.20-1
A.21	Terrestrial Hydrology	A.21-1
A.22	NASA Energy and Water Cycle Study	A.22-1
A.23	Atmospheric Dynamics	A.23-1
A.24	Earth Surface and Interior	A.24-1
A.25	Rapid Response and Novel Research in Earth Science	A.25-1
A.26	Airborne Instrument Technology Transition	A.26-1
A.27	Earth Science U.S. Participating Investigator	A.27-1
A.28	Interdisciplinary Research in Earth Science	A.28-1
A.29	NISAR Science Team	A.29-1
A.30	CloudSat and CALIPSO Science Team	A.30-1
A.31	New (Early Career) Investigator Program in Earth Science	A.31-1
A.32	The Science of Terra, Aqua, and Suomi-NPP	A.32-1
A.33	Precipitation Science Team	A.33-1
A.34	ICESat-2 Research	A.34-1
A.35	SERVIR Applied Sciences Team	A.35-1

A.36	Earth Science Applications: Water Resources	A.36-1
A.37	Earth Science Applications: Disaster Risk and Response	A.37-1
A.38	Advancing Collaborative Connections for Earth Science	A.38-1
A.39	Making Earth System Data Records for Use in Research Environments	A.39-1
A.40	Citizen Science for Earth Systems Programs	A.40-1
A.41	Advanced Information Systems Technology	A.41-1
A.42	Instrument Incubator Program	A.42-1
A.43	Advanced Component Technologies	A.43-1
A.44	In-space Validation of Earth Science Technologies	A.44-1
A.45	Sustainable Land Imaging – Technology	A.45-1

APPENDIX B. HELIOPHYSICS RESEARCH PROGRAM

B.1	Heliophysics Research Program Overview	B.1-1
B.2	Heliophysics Supporting Research	B.2-1
B.3	Heliophysics Technology and Instrument Development for Science	B.3-1
B.4	Heliophysics Guest Investigators – Open	B.4-1
B.5	Heliophysics Grand Challenges Research - Theory, Modelling and Simulations	B.5-1
B.6	Heliophysics Living With a Star Science	B.6-1
B.7	Heliophysics Data Environment Enhancements	B.7-1
B.8	GOLD/ICON Guest Investigators	B.8-1
B.9	Heliophysics Grand Challenges Research – Science Centers	B.9-1
B.10	Heliophysics Early Career Investigator Program	B.10-1
B.11	Heliophysics U.S. Participating Investigators	B.11-1
B.12	Heliophysics Space Weather Operations to Research	B.12-1

APPENDIX C. PLANETARY SCIENCE RESEARCH PROGRAM

C.1	Planetary Science Research Program Overview	C.1-1
C.2	Emerging Worlds	C.2-1
C.3	Solar System Workings	C.3-1
C.4	Habitable Worlds (now in E.4)	C.4-1
C.5	Exobiology	C.5-1
C.6	Solar System Observations	C.6-1
C.7	Planetary Data Archiving, Restoration, and Tools	C.7-1
C.8	Lunar Data Analysis	C.8-1
C.9	Mars Data Analysis	C.9-1
C.10	Cassini Data Analysis	C.10-1
C.11	Discovery Data Analysis	C.11-1
C.12	Planetary Instrument Concepts for the Advancement of Solar System Observations	C.12-1
C.13	Maturation of Instruments for Solar System Exploration	C.13-1
C.14	Planetary Science and Technology Through Analog Research	C.14-1

C.15 Planetary Protection Research C.15-1
C.16 Early Career Fellowship Start-up Program for Named Fellows C.16-1
C.17 Planetary Major Equipment and Facilities C.17-1
C.18 Laboratory Analysis of Returned Samples C.18-1
C.19 New Frontiers Data Analysis C.19-1
C.20 Rosetta Data Analysis Program C.20-1
C.21 New Early Career Fellowship: Initial Applications C.21-1
C.22 Development and Advancement of Lunar Instrumentation C.22-1

APPENDIX D. ASTROPHYSICS RESEARCH PROGRAM

D.1 Astrophysics Research Program Overview D.1-1
D.2 Astrophysics Data Analysis D.2-1
D.3 Astrophysics Research and Analysis D.3-1
D.4 Astrophysics Theory D.4-1
D.5 Neil Gehrels Swift Observatory Guest Investigator – Cycle 15 D.5-1
D.6 Fermi Guest Investigator – Cycle 12 D.6-1
D.7 K2 Guest Investigator – Cycle 7 D.7-1
D.8 Strategic Astrophysics Technology D.8-1
D.9 Nancy Grace Roman Technology Fellowships for Early Career Researchers D.9-1
D.10 NuSTAR Guest Observer – Cycle 5 D.10-1
D.11 TESS Guest Investigator – Cycle 2 D.11-1
D.12 NICER Guest Observer – Cycle 1 D.12-1
D.13 LISA Preparatory Science D.13-1
D.14 SOFIA Next Generation Instrumentation D.14-1

APPENDIX E. CROSS-DIVISION RESEARCH

E.1 Cross Division Research Overview E.1-1
E.2 Topical Workshops, Symposia, and Conferences E.2-1
E.3 Exoplanets Research E.3-1
E.4 Habitable Worlds E.4-1

RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES (ROSES)–2018

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 Questions and Goals in the 2014 Science Plan, (and in the 2018 Science Plan when it is published), 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 its relevance of the 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. Questions about each specific program element should be directed 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 activities are organized into four Research 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 as a magnetic variable star and its effects on the Earth and other planets and the dynamics of structures in the Solar System.
- 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 and life in other planetary systems 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, while Appendix E describes cross-division program elements relevant to two or more of these science research programs. Each of these appendices is prefaced with an Overview section that provides an introduction to the research program content that all interested applicants to this NRA are encouraged to read. The program elements described in these appendices also provide any clarifications or modifications to the general guidelines contained in this *Summary of Solicitation*.

(c) Significant Changes from Recent ROSES

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

- Section IV(b)(i) has new text on the Co-I/Science PI role.
- Section III(a) "Eligibility of Applicants" has been updated to more accurately reflect NASA policy on participation by non-U.S. organizations.
- NASA has increased the "Micro-purchase Threshold" for grantees from the prior $3K value (from 2 CFR §200.67) to $10K. What this means is that competitive quotes are not required for items or services costing up to $10K if management (at the organization receiving the grant) determines that the price is reasonable.
- Although, in general, Notices of Intent (NOIs) are optional, they are mandatory in a few cases (e.g., D.3 APRA, D.8 SAT and D.13 LISA). Grants.gov does not include

an option to submit a notice of intent. For more information on NOIs see Section IV(b)vi.

- As always, small changes have been made throughout this document and to program elements. For example, in Appendix B (Heliophysics) B.10 Heliophysics - Early Career Investigator Program will be a new opportunity this year, after having been released as draft last year. Program element B.12 Heliophysics Space Weather Operations to Research (H-SWO2R) was introduced late in ROSES-2017 as a pilot program and it is anticipated that it will also be solicited in ROSES-18. B.3 H-TIDeS has undergone major revision, and this year B.8 the Guest Investigator program is focused on Global Observations of Limb and Disk and Ionospheric Connection Explorer (GOLD/ICON). In Appendix C program element C.22, Development and Advancement of Lunar Instrumentation is a new opportunity this year and the Planetary Science Division early career program is undergoing major revision. In Appendix D, program elements D.12 NICER Cycle 1 and D.13 LISA Preparatory Science (LPS) are new opportunities this year. Other changes will occur throughout the year announced by Amendments, corrections, and clarifications. Subscribe to the NSPIRES mailing lists and the ROSES-2018 RSS feed for updates.
- All proposers are urged to carefully read the latest edition of the *NASA Guidebook for Proposers*, which has been updated since last year. The 2018 version of the *Guidebook* should be out well in advance of the first ROSES-2018 due dates. If so, the 2018 version of the *Guidebook* is the one that applies to all proposals submitted in response to ROSES-2018.

(ii) Individuals who did not propose last year should be aware of the following changes made in recent years:

- Salaries for all participants and overhead from all types of organizations must be included in the NSPIRES web cover page budget and a separately uploaded Total Budget PDF file. This applies to all funded participants, including NASA civil servants. See Section IV(b)iii.
- For all participants and all types of organizations, salaries and overhead may not be included anywhere in the body of the main proposal PDF, this information is relegated to the NSPIRES cover pages and the separately uploaded Total Budget PDF. See Section IV(b)iii.
- Awards deriving from ROSES now require that as accepted manuscript versions of peer-reviewed publications that result from ROSES awards be uploaded into NASA's part of the PubMed Central (PMC) repository called NASA PubSpace, see Section II(c).
- Section I(g) describes which instructions proposers should follow when there are discrepancies among the *ROSES Summary of Solicitation* vs. the *Guidebook* vs. program elements.
- Table 1 indicates that Current and Pending Support is required only for funded Co-Is at or above 10% of that person's time (0.1 FTE).
- Data Management Plans (DMPs) are required along with almost all proposals, see Section II(c) and the FAQ on this subject. For select instrument development programs DMPs are not required under the presumption that no significant research data will be generated. However, if those awards do 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 with the article. The default is for the data management plan to be put into a required text box on the NSPIRES cover pages, but some program elements (e.g., Appendix C) require the DMP to be part of the uploaded proposal PDF and have special instructions. Please read C.1 carefully if proposing to Planetary Science Division programs, including Habitable Worlds (E.4).

(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, 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 explicitly justified by completing a two-step request submission process: (1) generate a request form for inclusion with your ROSES proposal (see sections i and ii below); and (2) if selected for funding, submit detailed requirements for evaluation by the HEC Program (see section iii below).

(i) Generate Request for HEC Resources

The purpose of this step is to inform science review panels of your computational needs, and if your ROSES proposal is selected, establish eligibility to use HEC resources. First complete a request form in the HEC eBooks system (https://hec.reisys.com/hec/computing/index.do). 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.

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 eBooks system has a built-in calculation feature to assist with conversion from 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

The HEC eBooks system will generate a PDF version of your completed computing request for download, as well as send the PDF via email as an attachment. 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 in the email and on the PDF itself).

For proposals submitted via Grants.gov, it should be attached as an appendix to any appropriate location. This requirement for a separate document supersedes the general rule that proposals are 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 utilization of the highly constrained resources dedicated for each program element under this NRA.

It is important to note that selection of your proposal only means that your request is eligible to progress to the next step for evaluation by the HEC Program (see section iii below). Also, while you are guaranteed a HEC award, it may differ from your request given resource constraints.

(iii) Submit Detailed Requirements for Allocation of HEC Resources

If your proposal is selected for funding, you will be prompted to log back in to the HEC eBooks system to complete the request process. Principal Investigators (PIs) will be required to submit detailed requirements (e.g., preferred facility/system for where the computational project will be conducted and data security, data transfer, application information, etc.) to be evaluated along with the proposed multi-year phasing plan. The HEC Program will then issue award 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 will have the opportunity to submit requests to increase or decrease allocations of HEC resources as demands change on a semi-annual basis. The HEC website at https://www.hec.nasa.gov/request/science.html provides the mechanism for PIs to formally request changes. Requests for modifications 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 e-Books (accessed through the HEC website). PIs should identify this foreign national status in their request abstract.

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, Resubmitted, Multiple and Duplicate Proposals

PIs holding awards under any program element of any prior NRA are welcome to submit "successor" proposals that seek to continue a previously funded line of research. 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 program elements in ROSES may limit submissions in a couple of ways.

The first limitation on submission prevents "multiple" proposals to a given program element. Some program elements in Appendix B (Heliophysics) will not allow a particular individual to be the PI on more than one proposal to those program elements. 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 submission of "duplicate" proposals. Planetary Science will not accept duplicate (the same or essentially the same) proposals submitted to any of its program elements (Appendix C, or its parts of cross-division programs in Appendix E). See C.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. Please carefully read the program elements and propose to Heliophysics and Planetary Science with this in mind.

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

Any inconsistency among authorities or agency instructions stated in or referenced in this solicitation shall be resolved by giving precedence in the following order:

Statutes and regulations
Program elements
The *Summary of Solicitation* of the ROSES NRA (i.e., this document)
Guidebook for Proposers Responding to a NASA Funding Announcement

There may be cases when the instructions in more than one of these documents are contradictory. In cases of contradictions between texts, individual program elements

take precedence over this *Summary of Solicitation*, and this *Summary of Solicitation* takes precedence over the *Guidebook for Proposers*.

An example where individual program element may contradict and 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., A.36 Water Resources, 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 require explicit statements of relevance through mandatory text boxes on the NSPIRES cover pages.

Finally, answers to questions may appear in FAQs. 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 present clarification, 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 program staff to ensure proper credentialing. Special restrictions may apply to those who are neither U.S. citizens nor permanent residents, especially those from designated countries. Note, there is a presumption of denial for citizens of, or persons born in, State Sponsors of Terrorism (Column 2 of the NASA Designated Country List). For a current list of designated countries download the PDF at the NASA Export Control Website: https://oiir.hq.nasa.gov/nasaecp/.

(i) Citizen science

"Citizen science" activities, in which the public contributes to the scientific process, can advance science investigations through activities that include formulating research questions, conducting scientific experiments, collecting and analyzing data, interpreting results, making new discoveries, developing technologies and applications, and solving complex problems. See for example Section 3 of https://www.congress.gov/bill/114th-congress/house-bill/6414/text and https://science.nasa.gov/citizenscientists, which provides information about existing SMD-funded projects and where one may sign up for the NASA-SOLVE email listserve.

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.

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 tasks, or all tasks for a shorter duration (e.g., a one-year pilot study), or a combination. Awards may depend on acceptable revised versions of 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 may cancel an award for various reasons including but not limited to: direction from the Office of Management and Budget, congressional action (legislation, budget cuts) and if conditions have changed enough to make the completion of the award impossible, for example, if a mission with which the award is associated fails.

The amount of funds expected to be available for 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.

In all cases, NASA's goal is to initiate new awards as rapidly as possible after the selection of proposals is announced for each program element. 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- or interagency transfers. However, most program elements in ROSES exclude contracts because it would not be appropriate for the nature of the work solicited. For example, the research program overviews in A.1, C.1, and E.1 set no contracts as the default so, unless otherwise stated in a program element, contracts are not awarded from proposals to calls in Appendices A, C and E. Where contracts are permitted, the program element will indicate that explicitly. Similarly, most (but not all) of the program elements in Appendices B and D do not award contracts. When new program elements are added by Amendment to this NRA, they may or may not allow contracts. Please read the Research Program Overviews (i.e., A.1, B.1 C.1 etc.) and program elements carefully if planning to propose a contract. 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 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 (see https://prod.nais.nasa.gov/cgibin/nais/nasa_ref.cgi).

(b) Award Period of Performance

The maximum 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 maximum 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.

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

In keeping with the NASA Plan 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. Unless otherwise stated, the data management plan will be collected on the NSPIRES web cover pages and limited to 8000 characters. Any program element that doesn't require a DMP via the cover pages will say so explicitly. Even where DMPs are not required with the proposal, if those awards do result in peer reviewed publications, grantees must still meet the mandatory minimum requirement that the data behind figures and tables be available electronically at the time of publication, ideally in supplementary material with the article. The kind of proposal that requires a data management plan is described in the SARA FAQs on this subject. The appendices and individual program elements of ROSES may specify preferred archives and may require more than is outlined here for all proposers or just those that generate certain kinds of data. Please read the individual program elements carefully, especially Appendix C, which has its own instructions in Section 3.6 of C.1 and even templates. Proposers that include a plan to archive data should allocate suitable time and funding for this task. 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/.

Awards deriving from ROSES-2018 will 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. 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 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 may 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 facilitate carrying forward unobligated funds from one fiscal year to the next fiscal year (carryover). Program Officers may invite the PI 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 would not change, only the fiscal year (FY) in which they arrive.

SMD policy is that work on continuing awards should not be deferred because of a delay in receipt of funds. 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), 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.

Moreover, 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.

Participation by non-U.S. organizations in this program is welcome, but subject to NASA's policy of no exchange of funds, in which each government supports its own national participants and associated costs (further information on foreign participation is provided in the *NASA Guidebook for Proposers*).

NASA does not normally 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.

(b) Number of Proposals and Teaming Arrangements

There is no 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, each proposal must be a single separate, stand-alone, complete PDF document for evaluation purposes, other than the Total Budget and HEC request.

(c) Restrictions Involving China

Proposals must not include 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.

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, 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 can 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 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 that is not funded by NASA listed in this table 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 is implementing a process to collect demographic data from grant applicants 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 voluntary, only available to NASA in aggregate form, and is not a precondition of award.

Comments and suggestions of any nature about the *NASA Guidebook for Proposers* are encouraged and welcome and may be directed at any time to the point of contact identified in Section VIII below.

(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 for the proposal as the required original signature by an authorized official 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 the National Science Foundation (NSF) that use the NSF's FastLane system and the Astrophysics Guest Investigator and Guest Observer 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/portal/SAM/).
- 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.

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 any specified required electronic forms available through either of two proposal submission systems, NSPIRES or Grants.gov. Submission via NSPIRES requires responding to questions on the NSPIRES submission page.

The Science/Technical/Management 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*. Only appendices that are specifically requested in the *NASA Guidebook for Proposers* and allowed by this NRA or a program element will be permitted; proposals containing unsolicited appendices may be declared noncompliant. The *NASA Guidebook for Proposers* provides detailed discussions of the content and organization of proposals suitable for all program elements in this NRA, as well as the default page limits of a proposal's constituent parts.

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.

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. In addition, any proposer who creates files using TeX or LaTeX is required to first create a DVI file and then convert the DVI file to PDF (via an intermediate Postscript file if necessary). 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. Large file sizes can impact the time it takes for NASA and peer reviewers to download and access the proposal. In order to increase the ease in reviewing the proposal, the proposer should crop and compress any embedded photos and graphic files to an appropriate size and resolution.

(iii) Redaction of Salary, Fringe and Overhead Costs from the Proposal PDF

Peer reviewers do not need 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.10), TESS Guest Investigator (D.11), and NICER Guest Observer

(D.12). These are cost (only) proposals for NASA and 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. Thus, all proposals must include as much budget detail and justification as is required for the peer reviewers to evaluate whether costs of things (other than team members) are reasonable. For example, let's say your Co-I needs to purchase a Tektronix MDO4000C digital oscilloscope, which costs ~ $6.5K. In the detailed budget, you must give this price and in the budget justification you would explain why she needs such an expensive oscilloscope, when simple ones can be purchased for only ~$450.

Moreover, peer reviewers need to see the individual effort that will be spent on the project, whether at the proposing organization or not, whether or not NASA is paying for it. 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.

Example Table of Personnel and Work Effort

Person or Role	Time charged to this proposal	Time not charged to this proposal	Total Time per person/year
Bernstein, PI	3 months/year	N/A	3 months/year
Co-I Dr. West	1.5 months/year	N/A	1.5 months/year
Collaborator Bill Dyer	N/A	*de minimis*	*de minimis*
NESSF Grad Student fellow*	N/A	12 months/year	12 months/year

* The Graduate student has been awarded an NESSF fellowship, at no cost to this proposal.

Note, this table is outside of and is distinct from the budget and the page-limited main part of the proposal. Descriptions of the work that each team member would be performing must be included in the main part of the proposal. 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 typically more complicated, and your table should reflect the reality. Templates have been provided by the Planetary Science Division for those proposing to Appendix C, but all are welcome to use them.

In the budget justification in the main proposal PDF proposers should refer to the time but not costs for a subaward, e.g., "1.5 months/year are allocated for Co-I Dr. Herbert West, as can be seen in the Table of Personnel and Work Effort. Dr. West will be funded via a subaward to the Miskatonic foundation in Arkham, Mass. 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 then 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 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 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.

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, 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 a ! on a yellow field) 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.

In addition, it is unnecessary to download the Proposal Cover Page and incorporate it into the Proposal Document. NSPIRES will automatically route 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, 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 NNH18ZDA001N-XXXX where the "XXXX" will be an abbreviation for that program, e.g., NNH18ZDA001N-HSR for Heliophysics Supporting Research. Proposals submitted via Grants.gov must be submitted by the AOR.

Submitting a proposal via Grants.gov requires the following steps:

- 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 data site is secure and all information entered is strictly for NASA's use only.
- Follow Grants.gov instructions provided at the website to download any software tools or applications required to submit via Grants.gov.
- 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.
- Note that Grants.gov proposers must additionally download the "Instructions" document, as this includes the Program Specific Data form that contains the mandatory data management plan as well as important questions about, for example, China and ITAR.
- 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.
- 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.

- 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).
- 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.
- 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.
- 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.

  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>>."
- 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.

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 merely encouraged, 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, D.8 SAT and D.13 LISA, an NOI is a required prerequisite for submission of a full proposal. For those program elements where the NOI is mandatory that 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 (requested) by a program element, NOIs must (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 merely invited and 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 (e.g., A.2 LCLUC, A.35 SERVIR Applied Sciences Team, B.10 H-ECIP) requires a PDF document upload. 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., A.2 LCLUC and Appendix C), the team may be adjusted between the Step-1 and Step-2 proposal, but in other cases (e.g., Appendix B, Heliophysics), the team cannot be changed.

All of Appendix B and some other program elements limit the number of Step-2 proposals on which an individual may be PI. 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.

At the time of release of this ROSES-2018 NRA, the program elements that solicit proposals using a two-step process include: A few program elements in Earth Science (Appendix A) including A.2 LCLUC, A.35 SERVIR Applied Sciences Team, A.36 Water Resources (all of which employ the binding two-step process), all 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 Guest Investigator (D.5), Fermi Guest Investigator (D.6), K2 Guest Observer (D.7),

NuSTAR Guest Observer (D.10), the TESS Guest Investigator Program (D.11), and NICER Guest Observer (D.12).

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.

(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 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. It is not possible to submit a late proposal electronically via NSPIRES unless the electronic *Cover Page* was initially created prior to the proposal due date.

(d) Proposal Funding Restrictions

In addition to the funding restrictions and requirements given in the *NASA Guidebook for Proposers* and the *NASA 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 must subaward the funding of all proposed Co-Is who reside at other non-Government organizations, even though this may result in a higher proposal cost because of subawarding fees. Potential exceptions to this rule include, but are not limited to, the awards that stem from the Suborbital-Class Platforms (see Section V). Other 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) should 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*).
- 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.
- 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 that require access to space or near-space are solicited. Flight investigations solicited through ROSES generally have modest costs and reduced mission assurance requirements appropriate for the research program, and these investigations are referred to as suborbital-class investigations. Platforms for suborbital-class investigations include aircraft, balloons, sounding rockets, suborbital reusable launch vehicles, CubeSats, 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 Unmanned 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 Unmanned 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, contact David Tomko, Human Research Program and Fundamental Space Biology at (202) 358-2211 or via email at: dtomko@nasa.gov.

(b) 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 current 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) 824-1916 or (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 and included the NSPIRES cover page budget (in Section F, line 10 labeled appropriately) and also 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. Until NASA establishes a policy to sponsor spaceflight participants onboard sRLVs, the FOP will not sponsor participants to fly on commercial balloon or 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.

Proposals from non-governmental organizations, and government proposers who are not planning 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:

Robert Yang
Flight Opportunities Program
Space Technology Mission Directorate
NASA Headquarters
Washington, DC 20546
Telephone: (202) 358-0143
Email: robert.l.yang@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 annual external launch opportunities after 2018 on the Japanese HTV launch vehicle and the SpaceX vehicle. NASA also has regular opportunities on a suite of vehicles to launch pressurized 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 NASA Space Station Payload Office. This letter of feasibility must contain: (1) a preliminary assessment of the feasibility for proposed provisions for access to and accommodation at 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 provisions for access and accommodation. 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.

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 construction, ISS integration, launch and flight operations, data analysis, and publication of results.

The ISS Customer 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.

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 Customer 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 concept for conduct of the experiment during the flight 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) mounted to the ISS truss structure, 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 strongly urged to discuss International Space Station payload constraints, launch opportunities, and other technical matters with the ISS Research Integration Office.

For further information, please contact:

George Nelson
ISS Research Integration Office/OZ
Johnson Space Center
National Aeronautics and Space Administration
Houston, TX 77058
Telephone: (281) 244-8514
Email: George.Nelson-1@nasa.gov

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

Short duration orbital platforms, such as CubeSats (built in increments of 10 centimeter cubes), have historically been used as teaching tools and technology demonstrations, and now may 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.

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 provided under the NASA/HEOMD CubeSat Launch Initiative (CSLI) at no cost to the investigation. For this standard case proposers should merely 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.
- 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:

Larry Kepko
Phone: 202-358-0362,
Email: larry.kepko@nasa.gov

For further information on CSLI, please contact:

Anne E Sweet,
Launch Services Program Executive,
Phone: 202-358-3784,
Email: anne.sweet-1@nasa.gov

or

Jason C Crusan,
Director, Advanced Exploration Systems,
Phone: 202-358-0635,
Email: jason.c.crusan@nasa.gov

(c) 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 for three or four years' 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 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 either 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, suborbital-class investigations will sometimes be split into multiple awards, depending on circumstances. Please read the individual ROSES Appendix and consult with the POC.

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 that ROSES Appendix and/or specific program element, 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 both by peer review (for reasonableness) and by NASA program personnel (vs. 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, 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" and/or may employ numerical scores.
- 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 awards 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 (currently $150,000), 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/portal/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. In deciding which proposals submitted to this NRA are selected, the desire to achieve a balance of efforts across the solicited program objectives may play a role in the selections.

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.

(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 remain "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 was not handled correctly. This process may be found at 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

Assistant Administrator for Procurement
Office of Procurement
NASA Headquarters
Washington, DC 20546-0001
Telephone: 202-358-2090

(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 officially notified via NSPIRES from which they will be able to retrieve their official decision letter and evaluation. 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 offeror 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 less.

(b) Administrative and National Policy Requirements

This solicitation does not invoke any special administrative or national policy requirements: 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. All award requirements are posted at https://prod.nais.nasa.gov/pub/pub_library/srba/index.html.

(c) Award Reporting Requirements

The reporting requirements for awards made through this NRA will be consistent with 2 CFR 1800.902.

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 Federal share of any award issued under this NRA is more than $10M over the period of performance, additional reporting requirements will apply. See 2 CFR 200 Appendix XII—Award Term and Condition for Recipient Integrity and Performance Matters.

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 the subsection called "Other Project Information" in "View Proposal: Business Data" includes 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.

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.

IX. Ancillary Information

(a) Announcement of Updates/Amendments to Solicitation

Because this NRA is released far in advance of many of the deadlines given in Tables 2 and 3, additional programmatic information for any of its 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/ROSES2018 (or by going to http://solicitation.nasaprs.com/open and selecting "NNH18ZDA001N"). Also, an RSS feed for amendments, clarifications, and corrections to ROSES can be found in one place (and there is an RSS feed) at http://science.nasa.gov/researchers/sara/grant-solicitations/roses-2018/. 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), it is the responsibility of the prospective proposer to check this NRA's 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 web page, which can be found as described above.

(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 "NNH18ZDA001N" 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 will be 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, an RSS feed 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 solicitation by year at http://nspires.nasaprs.com: click "Solicitations" and then "Closed/Past Solicitations and Selections," choose the year from the pop-down menu, and click the find button to see the abstracts in a PDF file. One can 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-2018 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: Table 1 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.
	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.
	DMP	For most programs, the Data Management Plan (DMP) or explanation of why it is not needed must be provided in the 4000-character text boxes in the cover pages, unless otherwise stated in the program element. See Section II(c) and the ROSES FAQ for important information.
	Budget	List all costs. Include all salary and indirect costs in the NSPIRES cover page budgets.
	Submission	Both the author must "release" the proposal and the AOR must "submit" prior to the due date.
	Other	There are cover page questions that must be answered and there may be other required content, e.g., some program elements in Appendix C collect a relevance statement here, see VI (a).
Proposal document		
Table of contents		First component of proposal. One page only and optional.
Scientific/ Technical/ Management Section		Second component and the main part of the proposal. The sequence for science content here is recommended, but 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

Table 1 Continued: Checklist for ROSES-2018 Proposals

	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
	Format	No more than 15 characters per horizontal inch, including spaces
	Format	Font size 12 consistent with rules above, sans serif font recommended
	Figure Format	Text and content on/in figures must be easily legible without magnification.
	Captions Format	As above. Text necessary for the proposal may not be solely in figures, tables, or their captions.
	Table Format	Text and content on/in Tables must be easily legible without magnification. See also directly above
	Content	Discuss objectives and their significance.
	Content	Discuss perceived impact of the work.
	Content	Discuss relevance of the work to the solicitation. 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	Present 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 text only if it is required by program element.
	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 (e.g., unpublished manuscripts). No links to personal websites.
Biographical sketches/Curriculum Vitae (CVs): fourth component of proposal		
	Required	One for a PI and each Co-I
	Length restriction	CV for a 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 fifth component of the proposal. Note, location may differ from that given in *Guidebook*. See Section IV(b)iii		
	General	Note this table has been moved from the budget Section. Where names are not known, include the position, such as postdoctoral fellow or technician.

Table 1 Continued: Checklist for ROSES-2018 Proposals

	Required	Names and/or titles of all personnel to perform the proposed effort
	Required	Planned work commitment (e.g., in fractions of a work year) to be funded by NASA
	Required	Planned work commitment (e.g., in fractions of a work year) that will not be funded by NASA, if any. Note: time commitment included here that is not funded by NASA is not considered cost sharing, as defined in 2 CFR § 200.29.
Current and Pending Support: Sixth 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 one 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 Seventh 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 A.36 Water Resources, C.17 PMEF, and E.2 TWSC.

Table 1 Continued: Checklist for ROSES-2018 Proposals

Budget Justification: The eighth 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 ninth 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 tenth 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 document type "Total Budget").	
	Required	Separately uploaded "Total" Budget PDF file see Section IV(b)(iii).
	HEC Appendix Document (separate PDF file attached as document type "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.

TABLE 2: PROGRAM ELEMENTS (ORDERED BY PROPOSAL DUE DATE) and TABLE 3: PROGRAM ELEMENTS (ORDERED BY DIVISION/TOPIC) are posted as separate documents on the web at http://solicitation.nasaprs.com/ROSES2018table2 and http://solicitation.nasaprs.com/ROSES2018table3, respectively.

ROSES 2018
TABLE 2: SOLICITED RESEARCH PROGRAMS
(In Order of Proposal Due Date) [1]

Appendix	Program Element	NOI/(Step-1) Due Date [2]	Proposal Due Date
A.10	Ocean Salinity Field Campaign SPURS-2 Processing and Synthesis	03/29/2018	05/03/2018
A.24	Earth Surface and Interior	04/13/2018	05/15/2018
A.8	Sustaining Living Systems in a Time of Climate Variability and Change	03/28/2018	05/16/2018
D.2	Astrophysics Data Analysis	03/28/2018	05/17/2018
C.5	Exobiology	04/16/2018	05/24/2018
E.3	Exoplanets Research Program	03/29/2018 (Step-1)	05/30/2018 (Step-2)
C.2	Emerging Worlds	**04/12/2018** (Step-1)	06/01/2018 (Step-2)
C.22	Development and Advancement of Lunar Instrumentation Program	04/03/2018 (Step-1)	06/05/2018 (Step-2)
C.6	Solar System Observations	04/05/2018 (Step-1)	06/07/2018 (Step-2)
D.13	LISA Preparatory Science	03/**19**/2018 (mandatory)	06/14/2018
B.4	Heliophysics Guest Investigators - Open	04/13/2018 (Step-1)	06/15/2018 (Step-2)
C.13	Maturation of Instruments for Solar System Exploration	04/18/2018 (Step-1)	06/20/2018 (Step-2)
A.33	Precipitation Measurement Missions Science Team	04/30/2018	06/28/2018
A.9	Physical Oceanography	05/31/2018	06/29/2018
A.37	**Earth Science Applications: Disaster Risk Reduction and Response**	04/17/2018	**06/29/2018**
A.27	Earth Science U.S. Participating Investigator	N/A	07/12/2018
C.7	Planetary Data Archiving, Restoration, and Tools	05/10/2018 (Step-1)	07/12/2018 (Step-2)
D.15	**Astrophysics Science SmallSat Studies**	**N/A**	**07/13/2018**
B.3	Heliophysics Technology and Instrument Development for Science	05/18/2018 (Step-1)	07/20/2018 (Step-2)

B.7	Heliophysics Data Environment Enhancements	05/18/2018 (Step-1)	07/20/2018 (Step-2)
C.18	**Laboratory Analysis of Returned Samples**	**05/24/2018 (Step-1)**	**07/26/2018 (Step-2)**
A.30	CloudSat and CALIPSO Science Team	05/04/2018	07/27/2018
D.14	**SOFIA Next Generation Instrumentation**	**06/01/2018**	**08/01/2018**
B.12	**Heliophysics Space Weather Operations to Research**	**06/22/2018**	**08/03/2018**
C.10	**Cassini Data Analysis**	06/01/2018 (Step-1)	08/**14**/2018 (Step-2)
A.36	Earth Science Applications: Water Resources	04/17/2018 (Step-1)	08/17/2018 (Step-2)
C.24	**Apollo Next Generation Sample Analysis Program**	**06/22/2018**	**08/21/2018**
C.19	New Frontiers Data Analysis	06/12/2018 (Step-1)	08/23/2018 (Step-2)
A.19	Atmospheric Composition: Modeling and Analysis	N/A	08/24/2018
A.46	**DSCOVR Science Team**	**07/09/2018**	**09/04/2018**
A.4	**Terrestrial Ecology**	**06/18/2018**	**09/07/2018**
B.2	Heliophysics Supporting Research	07/06/2018 (Step-1)	09/07/2018 (Step-2)
C.23	**Instrument Concepts for Europa Exploration 2**	**06/22/2018 (Step-1)**	**09/07/2018 (Step-2)**
C.17	**Planetary Major Equipment and Facilities: Stand-alone proposals**	**07/17/2018 (Step-1)**	**09/17/2018 (Step-2)**
B.10	**Heliophysics - Early Career Investigator Program**	**03/20/2018 (Step-1)**	**09/21/2018 (Step-2)**
D.5	Neil Gehrels Swift Observatory Guest Investigator - Cycle 15	N/A	09/27/2018 (Phase-1 via ARK RPS)
C.25	**Scientific Exploration Subsurface Access Mechanism for Europa**	**07/27/2018 (Step-1)**	**09/28/2018 (Step-2)**
A.29	Science Team for the NASA ISRO Synthetic Aperture Radar (NISAR) Mission	08/01/2018	10/02/2018
A.22	**NASA Energy and Water Cycle Study**	**07/26/2018**	**10/11/2018**

C.27	**Mars 2020 Returned Sample Science Participating Scientist Program**	**08/24/2018 (mandatory)**	**10/24/2018**
C.9	Mars Data Analysis	08/23/2018 (Step-1)	10/25/2018 (Step-2)
C.11	Discovery Data Analysis	08/30/2018 (Step-1)	11/01/2018 (Step-2)
C.20	Rosetta Data Analysis Program	08/30/2018 (Step-1)	11/01/2018 (Step-2)
C.12	Planetary Instrument Concepts for the Advancement of Solar System Observations	09/20/2018 (Step-1)	11/20/2018 (Step-2)
C.26	**Cassini Data Analysis Program: PDS Cassini Data Release 54**	**09/18/2018 (Step-1)**	**12/07/2018 (Step-2)**
D.12	**NICER Guest Observer Cycle 1**	**N/A**	**12/20/2018 (Phase-1 via ARK RPS)**
C.21	**DRAFT Planetary Science Early Career Program**	**Comments due on draft 02/14/19**	
C.28	**Lunar Surface Instrument and Technology Payloads**	**11/19/2018 (Step-1)**	**02/27/2019 (Step-2)**
D.11	**TESS Cycle 2**	N/A	**03/14/2019** (Phase-1 via ARK RPS)
D.6	Fermi Cycle 12	N/A	**03/20/2019** (Phase-1 via ARK RPS)
A.25	Rapid Response and Novel Research in Earth Science	N/A	Rolling submissions through 03/29/2019
C.8	Lunar Data Analysis	11/29/2018 (Step-1)	**03/29/2019** (Step-2)
C.16	Early Career Fellowship Start-up Program for Named Fellows	N/A	Rolling submissions through 03/29/2019
D.3	**Astrophysics Research and Analysis**	**02/27/2019 (mandatory NOI)**	**03/29/2019**
D.8	**Strategic Astrophysics Technology**	**02/27/2019 (mandatory NOI)**	**03/29/2019**
D.9	Nancy Grace Roman Technology Fellowships for Early Career Researchers	**See D.3**	

D.10	**NuSTAR Cycle 5**	N/A	**03/29/2019** (Phase-1 via ARK RPS)
E.2	Topical Workshops, Symposia, and Conferences	N/A	Rolling submissions through 03/29/2019
E.4	Habitable Worlds	11/15/2018 (Step-1)	**03/29/2019 (Step-2)**
A.2	Land Cover Land Use Change	08/01/2018 (Step-1)	**04/02/2019** (Step-2)
A.47	**Remote Sensing Theory for Earth Science**	**02/28/2019**	**04/02/2019**
C.3	Solar System Workings	11/15/2018	**04/02/2019**
A.41	**Advanced Information Systems Technology**	**N/A**	**04/16/19**
C.29	**Astrodynamics in Support of Icy Worlds Missions**	**03/11/2019 (Step-1)**	**04/18/2019 (Step-2)**
A.7	**ECOSTRESS Science and Applications Team**	**02/27/2019**	**04/24/2019**
B.6	**Heliophysics Living With a Star Science**	**03/12/2019 (Step-1)**	**05/09/2019 (Step-2)**
C.15	**Planetary Protection Research**	**04/12/2019**	**05/10/2019**
B.14	**Second Heliophysics Space Weather Operations to Research**	**03/12/2019 (Step-1)**	**05/16/2019 (Step-2)**
D.16	**Second Astrophysics Data Analysis**	**04/05/2019**	**05/17/2019**
A.48	**Plankton, Aerosol, Cloud, Ocean Ecosystem (PACE) Mission System Vicarious Calibration**	**03/26/2019**	**05/23/2019**
A.49	**Carbon Monitoring System**	**03/25/2019**	**05/23/2019**
E.5	**Second Exoplanets Research Program**	**03/29/2019 (Step-1)**	**05/30/2019 (Step-2)**

C.30	**Planetary Mission Concept Studies**	**04/01/2019 (mandatory NOI)**	**05/31/2019**
C.31	**Korea Pathfinder Lunar Orbiter Participating Scientist Program**	**04/11/2019 (Step-1)**	**06/11/2019 (Step-2)**
B.13	**Heliophysics Phase I DRIVE Science Centers**	**03/01/2019 (Step-1)**	**06/20/2019 (Step-2)**
A.35	SERVIR Applied Sciences Team	10/25/2018 (Step-1)	**07/19/2019** (Step-2)
A.34	**Studies with ICESat-2**	**See A.36 of ROSES-2019**	
C.17	**Planetary Major Equipment and Facilities: Appended proposals**	**See Program of Interest**	
A.3	Ocean Biology and Biogeochemistry	Not Solicited This Year	
A.5	Carbon Cycle	Not Solicited This Year	
A.6	Biodiversity	Not Solicited This Year	
A.11	Ocean Salinity Science Team	Not Solicited This Year	
A.12	Sea Level Change Science Team	Not Solicited This Year	
A.13	Ocean Surface Topography Science Team	Not Solicited This Year	
A.14	Ocean Vector Winds Science Team	Not Solicited This Year	
A.15	Modeling Analysis and Prediction	Not Solicited This Year	
A.16	Cryospheric Science	Not Solicited This Year	
A.17	Atmospheric Composition: Upper Atmosphere Research Program	Not Solicited This Year	
A.18	Atmospheric Composition: Radiation Sciences Program	Not Solicited This Year	
A.20	Tropospheric Chemistry	Not Solicited This Year	
A.21	Terrestrial Hydrology	Not Solicited This Year	
A.23	Weather and Atmospheric Dynamics	Not Solicited This Year	
A.26	Airborne Instrument Technology Transition	Not Solicited This Year	
A.28	Interdisciplinary Science in Earth Science	Not Solicited This Year	
A.31	New (early Career) Investigator Program in Earth Science	Not Solicited This Year	
A.32	The Science of TERRA, AQUA, and SUOMI-NPP	Not Solicited This Year	

A.38	Advancing Collaborative Connections for Earth System Science	Not Solicited This Year	
A.39	Making Earth System Data Records for Use in Research Environments	Not Solicited This Year	
A.40	Citizen Science for Earth Systems Program	Not Solicited This Year	
A.42	Instrument Incubator Program	Not Solicited This Year	
A.43	Advanced Component Technology	Not Solicited This Year	
A.44	In-space Validation of Earth Sciences Technologies	Not Solicited This Year	
A.45	Sustainable Land Imaging - Technology	Not Solicited This Year	
B.5	Heliophysics Grand Challenges Research - Theory, Modelling and Simulations	Not Solicited This Year	
B.8	Global Observations of Limb and Disk and Ionospheric Connection Explorer Guest Investigator	**Not Solicited This Year**	
B.9	Heliophysics Grand Challenges Research - Science Centers	**Not Solicited This Year**	
B.11	Heliophysics U.S. Participating Investigator	**Not Solicited This Year**	
C.14	Planetary Science and Technology Through Analog Research	**Not Solicited This Year**	
D.4	Astrophysics Theory Program	Not Solicited This Year	
D.7	**K2 Guest Observer Cycle 7**	**Not Solicited**	
A.1	Earth Science Research Overview	N/A	N/A
B.1	Heliophysics Division 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-2018 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

required by a program in order to be able to submit a proposal, it will be indicated on this table with "(mandatory)".

ROSES 2018
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	08/01/2018 (Step-1)	**04/02/2019** (Step-2)
A.3	Ocean Biology and Biogeochemistry	Not Solicited This Year	
A.4	**Terrestrial Ecology**	**06/18/2018**	**09/07/2018**
A.5	Carbon Cycle	Not Solicited This Year	
A.6	Biodiversity	Not Solicited This Year	
A.7	**ECOSTRESS Science and Applications Team**	**02/27/2019**	**04/24/2019**
A.8	Sustaining Living Systems in a Time of Climate Variability and Change	03/28/2018	05/16/2018
A.9	Physical Oceanography	05/31/2018	06/29/2018
A.10	Ocean Salinity Field Campaign SPURS-2 Processing and Synthesis	03/29/2018	05/03/2018
A.11	Ocean Salinity Science Team	Not Solicited This Year	
A.12	Sea Level Change Science Team	Not Solicited This Year	
A.13	Ocean Surface Topography Science Team	Not Solicited This Year	
A.14	Ocean Vector Winds Science Team	Not Solicited This Year	
A.15	Modeling Analysis and Prediction	Not Solicited This Year	
A.16	Cryospheric Science	Not Solicited This Year	
A.17	Atmospheric Composition: Upper Atmosphere Research Program	Not Solicited This Year	
A.18	Atmospheric Composition: Radiation Sciences Program	Not Solicited This Year	
A.19	Atmospheric Composition: Modeling and Analysis	N/A	08/24/2018
A.20	Tropospheric Chemistry	Not Solicited This Year	

A.21	Terrestrial Hydrology	Not Solicited This Year	
A.22	**NASA Energy and Water Cycle Study**	**07/26/2018**	**10/11/2018**
A.23	Weather and Atmospheric Dynamics	Not Solicited This Year	
A.24	Earth Surface and Interior	04/13/2018	05/15/2018
A.25	Rapid Response and Novel Research in Earth Science	N/A	Rolling submissions through 03/29/2019
A.26	Airborne Instrument Technology Transition	Not Solicited This Year	
A.27	Earth Science U.S. Participating Investigator	N/A	07/12/2018
A.28	Interdisciplinary Science in Earth Science	Not Solicited This Year	
A.29	Science Team for the NASA ISRO Synthetic Aperture Radar (NISAR) Mission	08/01/2018	10/02/2018
A.30	CloudSat and CALIPSO Science Team	05/04/2018	07/27/2018
A.31	New (early Career) Investigator Program in Earth Science	Not Solicited This Year	
A.32	The Science of TERRA, AQUA, and SUOMI-NPP	Not Solicited This Year	
A.33	Precipitation Measurement Missions Science Team	04/30/2018	06/28/2018
A.34	**Studies with ICESat-2**	**See A.36 of ROSES-2019**	
A.35	SERVIR Applied Sciences Team	10/25/2018 (Step-1)	**07/19/2019** (Step-2)
A.36	Earth Science Applications: Water Resources	04/17/2018 (Step-1)	08/17/2018 (Step-2)
A.37	**Earth Science Applications: Disaster Risk Reduction and Response**	04/17/2018	**06/29/2018**
A.38	Advancing Collaborative Connections for Earth System Science	Not Solicited This Year	
A.39	Making Earth System Data Records for Use in Research Environments	Not Solicited This Year	
A.40	Citizen Science for Earth Systems Program	Not Solicited This Year	
A.41	**Advanced Information Systems Technology**	**N/A**	**04/16/2019**
A.42	Instrument Incubator Program	Not Solicited This Year	
A.43	Advanced Component Technology	Not Solicited This Year	
A.44	In-space Validation of Earth Sciences Technologies	Not Solicited This Year	

A.45	Sustainable Land Imaging - Technology	Not Solicited This Year	
A.46	**DSCOVR Science Team**	**07/09/2018**	**09/04/2018**
A.47	**Remote Sensing Theory for Earth Science**	**02/28/2019**	**04/02/2019**
A.48	**Plankton, Aerosol, Cloud, Ocean Ecosystem (PACE) Mission System Vicarious Calibration**	**03/26/2019**	**05/23/2019**
A.49	**Carbon Monitoring System**	**03/25/2019**	**05/23/2019**
B.1	Heliophysics Division Overview	N/A	N/A
B.2	Heliophysics Supporting Research	07/06/2018 (Step-1)	09/07/2018 (Step-2)
B.3	Heliophysics Technology and Instrument Development for Science	05/18/2018 (Step-1)	07/20/2018 (Step-2)
B.4	Heliophysics Guest Investigators - Open	04/13/2018 (Step-1)	06/15/2018 (Step-2)
B.5	Heliophysics Grand Challenges Research - Theory, Modelling and Simulations	Not Solicited This Year	
B.6	**Heliophysics Living With a Star Science**	**03/12/2019 (Step-1)**	**05/09/2019 (Step-2)**
B.7	Heliophysics Data Environment Enhancements	05/18/2018 (Step-1)	07/20/2018 (Step-2)
B.8	Global Observations of Limb and Disk and Ionospheric Connection Explorer Guest Investigator	**Not Solicited This Year**	
B.9	Heliophysics Grand Challenges Research - Science Centers	**Not Solicited This Year**	
B.10	**Heliophysics - Early Career Investigator Program**	**03/20/2018 (Step-1)**	**09/21/2018 (Step-2)**
B.11	Heliophysics U.S. Participating Investigator	**Not Solicited This Year**	
B.12	**Heliophysics Space Weather Operations to Research**	**06/22/2018**	**08/03/2018**
B.13	**Heliophysics Phase I DRIVE Science Centers**	**03/01/2019 (Step-1)**	**06/20/2019 (Step-2)**
B.14	**Second Heliophysics Space Weather Operations to Research**	**03/12/2019 (Step-1)**	**05/16/2019 (Step-2)**
C.1	Planetary Science Research Program Overview	N/A	N/A

C.2	Emerging Worlds	**04/12/2018** (Step-1)	06/01/2018 (Step-2)
C.3	Solar System Workings	11/15/2018	**04/02/2019**
C.4	Habitable Worlds - see E.4	See E.4	
C.5	Exobiology	04/16/2018	05/24/2018
C.6	Solar System Observations	04/05/2018 (Step-1)	06/07/2018 (Step-2)
C.7	Planetary Data Archiving, Restoration, and Tools	05/10/2018 (Step-1)	07/12/2018 (Step-2)
C.8	Lunar Data Analysis	11/29/2018 (Step-1)	**03/29/2019** (Step-2)
C.9	Mars Data Analysis	08/23/2018 (Step-1)	10/25/2018 (Step-2)
C.10	**Cassini Data Analysis**	06/01/2018 (Step-1)	08/**14**/2018 (Step-2)
C.11	Discovery Data Analysis	08/30/2018 (Step-1)	11/01/2018 (Step-2)
C.12	Planetary Instrument Concepts for the Advancement of Solar System Observations	09/20/2018 (Step-1)	11/20/2018 (Step-2)
C.13	Maturation of Instruments for Solar System Exploration	04/18/2018 (Step-1)	06/20/2018 (Step-2)
C.14	Planetary Science and Technology Through Analog Research	**Not Solicited This Year**	
C.15	**Planetary Protection Research**	**04/12/2019**	**05/10/2019**
C.16	Early Career Fellowship Start-up Program for Named Fellows	N/A	Rolling submissions through 03/29/2019
C.17	**Planetary Major Equipment and Facilities: Appended proposals**	**See Program of Interest**	
C.17	**Planetary Major Equipment and Facilities: Stand-alone proposals**	**07/17/2018 (Step-1)**	**09/17/2018 (Step-2)**
C.18	**Laboratory Analysis of Returned Samples**	**05/24/2018 (Step-1)**	**07/26/2018 (Step-2)**
C.19	New Frontiers Data Analysis	06/12/2018 (Step-1)	08/23/2018 (Step-2)
C.20	Rosetta Data Analysis Program	08/30/2018 (Step-1)	11/01/2018 (Step-2)

C.21	**DRAFT Planetary Science Early Career Program**	**Comments due on draft 02/14/2019**	
C.22	Development and Advancement of Lunar Instrumentation Program	04/03/2018 (Step-1)	06/05/2018 (Step-2)
C.23	**Instrument Concepts for Europa Exploration 2**	**06/22/2018 (Step-1)**	**09/07/2018 (Step-2)**
C.24	**Apollo Next Generation Sample Analysis Program**	**06/22/2018**	**08/21/2018**
C.25	**Scientific Exploration Subsurface Access Mechanism for Europa**	**07/27/2018 (Step-1)**	**09/28/2018 (Step-2)**
C.26	**Cassini Data Analysis Program: PDS Cassini Data Release 54**	**09/18/2018 (Step-1)**	**12/07/2018 (Step-2)**
C.27	**Mars 2020 Returned Sample Science Participating Scientist Program**	**08/24/2018 (mandatory)**	**10/24/2018**
C.28	**Lunar Surface Instrument and Technology Payloads**	**11/19/2018 (Step-1)**	**02/27/2019 (Step-2)**
C.29	**Astrodynamics in Support of Icy Worlds Missions**	**03/11/2019 (Step-1)**	**04/18/2019 (Step-2)**
C.30	**Planetary Mission Concept Studies**	**04/01/2019 (mandatory NOI)**	**05/31/2019**
C.31	**Korea Pathfinder Lunar Orbiter Participating Scientist Program**	**04/11/2019 (Step-1)**	**06/11/2019 (Step-2)**
D.1	Astrophysics Research Program Overview	N/A	N/A
D.2	Astrophysics Data Analysis	03/28/2018	05/17/2018
D.3	**Astrophysics Research and Analysis**	**02/27/2019 (mandatory NOI)**	**03/29/2019**
D.4	Astrophysics Theory Program	Not Solicited This Year	
D.5	Neil Gehrels Swift Observatory Guest Investigator - Cycle 15	N/A	09/27/2018 (Phase-1 via ARK RPS)
D.6	Fermi Cycle 12	N/A	**03/20/2019** (Phase-1 via ARK RPS)
D.7	**K2 Guest Observer Cycle 7**	**Not Solicited**	
D.8	**Strategic Astrophysics Technology**	**02/27/2019 (mandatory NOI)**	**03/29/2019**

D.9	Nancy Grace Roman Technology Fellowships for Early Career Researchers	See D.3	
D.10	**NuSTAR Cycle 5**	N/A	**03/29/2019** (Phase-1 via ARK RPS)
D.11	**TESS Cycle 2**	N/A	**03/14/2019** (Phase-1 via ARK RPS)
D.12	**NICER Guest Observer Cycle 1**	**N/A**	**12/20/2018 (Phase-1 via ARK RPS)**
D.13	LISA Preparatory Science	03/**19**/2018 (mandatory)	06/14/2018
D.14	**SOFIA Next Generation Instrumentation**	**06/01/2018**	**08/01/2018**
D.15	**Astrophysics Science SmallSat Studies**	**N/A**	**07/13/2018**
D.16	**Second Astrophysics Data Analysis**	**04/05/2019**	**05/17/2019**
E.1	Cross Division Research Overview	N/A	N/A
E.2	Topical Workshops, Symposia, and Conferences	N/A	Rolling submissions through 03/29/2019
E.3	Exoplanets Research Program	03/29/2018 (Step-1)	05/30/2018 (Step-2)
E.4	Habitable Worlds	11/15/2018 (Step-1)	**03/29/2019 (Step-2)**
E.5	**Second Exoplanets Research Program**	**03/29/2019 (Step-1)**	**05/30/2019 (Step-2)**

Notes:

[1] Amended due dates and new program elements will be indicated with bold red text as ROSES-2018 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 required by a program in order to be able to submit a proposal, it will be indicated on this table with “(mandatory)”.

APPENDIX A. EARTH SCIENCE RESEARCH PROGRAM

A.1 EARTH SCIENCE RESEARCH OVERVIEW

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 2.1 to "Advance Earth System Science to meet the challenges of climate and environmental change." (See the most recent *NASA Strategic Plan*: https://smd-prod.s3.amazonaws.com/science-red/s3fs-public/atoms/files/FY2014_NASA_StrategicPlan_508c.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 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). Similarly, there are interagency programs related to Oceans and the Arctic. In addition, there are several other subgroups of the Committee on the Environment, Natural Resources and Sustainability (CENRS) 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).

Most proposals to ROSES-2018 will require a data management plan (DMP) or an explanation of why one is not necessary given the nature of the work proposed. Proposers will satisfy this requirement by responding to the compulsory NSPIRES cover page question about the DMP, unless otherwise specified in a specific program element. 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 (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, such as Making Earth System data records for Use in Research Environments (MEaSUREs) and Advancing Collaborative Connections for Earth System Science (ACCESS), include data requirements in the text that make redundant the cover page DMP.

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.

Toward that end, NASA encourages software developed in response to Appendix A program elements be designated, developed, and distributed to the public 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.

Program elements will give preference to proposals that include a plan for committing software as 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 will be in the form of grants (or, where indicated in the solicitation, cooperative agreements), which are most appropriate given the nature of the work solicited

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 make up a significant fraction of the Earth system's volume; 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
- 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-2018 elements this year or in the recent past (Rapid Response and Novel Research in Earth Science – program element A.25).

Several elements solicited in prior years are not being solicited this year, but have program-specific ROSES-2018 elements for completeness, as well as to provide potential proposers with plans about the anticipated dates of the next solicitation.

- Ocean Biology and Biogeochemistry (program element A.3);
- Carbon Cycle Science (program element A.5);
- Biodiversity (program element A.6);
- Ocean Salinity Science Team (program element A.11);
- Sea Level Change Science Team (program element A.12);
- Ocean Surface Topography Science Team (program element A.13);
- Ocean Vector Winds Science Team (program element A.14);
- Modeling, Analysis, and Prediction (program element A.15);
- Cryospheric Science (program element A.16);
- Upper Atmosphere Research Program (program element A.17);
- Radiation Sciences Program (program element A.18);
- Tropospheric Chemistry Program (program element A.20);
- Terrestrial Hydrology Program (program element A.21);
- Atmospheric Dynamics (program element A.23);
- Airborne Instrument Technology Transition (program element A.26);
- Interdisciplinary Science (program element A.28);
- New (Early Career) Investigator Program in Earth Science (program element A.31);
- The Science of Terra, Aqua, and Suomi-NPP (program element A.32);
- ICESat-2 Research (program element A.34);
- Advancing Collaborative Connections for Earth System Science (program element A.38);
- Making Earth System Date Records for Use in Research Environments (program element A.39);
- Citizen Science for Earth Systems Program (program element A.40);
- Instrument Incubator Program (program element A.42);
- Advanced Component Technology (program element A.43);
- In-Space Validation of Earth Science Technologies (program element A.44); and
- Sustainable Land Imaging Technology (program element A.45).

Elements for which it has not yet been decided whether or not to solicit during the period of applicability of ROSES-2018 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;
- 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 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-2018 are:

- Land-Cover and Land-Use Change (program element A.2);
- Terrestrial Ecology (program element A.4);
- ECOSTRESS Science Team (program element A.7); and
- Sustaining Living Systems in a Time of Climate Variability and Change (program element A.8).

Topics relevant to the Carbon Cycle and Ecosystems Focus Area that are actively or potentially soliciting in ROSES-2018 include the following program elements:

- US Participating Investigator (program element A.27);
- NISAR Science Team (program element A.29);
- Rapid Response and Novel Research in Earth Science (program element A.25);
- SERVIR Applied Sciences Team (program element A.35);
- Earth Science Applications: Water Resources (program element A.36); and
- Advanced Information Systems Technology (program element A.41).

2.2 Climate Variability and Change

Climate change is one of the major themes guiding Earth System Science today. NASA is at the forefront of quantifying forcings and feedbacks of recent and future climate change. Our comprehensive end-to-end program goes 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 is global ocean circulation varying on interannual, decadal, and longer time scales?
- What changes are occurring in the mass of the Earth's ice cover?
- How can climate variations induce changes in the global ocean circulation?
- How is global sea level affected by natural variability and human-induced change in the Earth system?
- How can predictions of climate variability and change be improved?

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 oceans are a major part of the climate system and a unique NASA contribution to climate science is the near-global coverage of observations from space of selected ocean properties every two to ten days. Additionally, NASA provides observations of the vast expanses of polar ice, including both ice sheets and sea ice, on the temporal and spatial scales necessary to detect change and sampling of the other critical elements of the climate system that link climate to other Focus Areas, such as cloud distribution, snow cover, surface temperatures, humidity characteristics, etc.

NASA makes substantial investments to characterize and understand the nature and variability of the climate system. As part of those investments, 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. 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.

Understanding interactions within the climate system also requires strong modeling and analysis efforts. 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-2018 are:

- Physical Oceanography (program element A.9); and
- Ocean Salinity Field Campaign – SPURS Processing and Synthesis (program element A.10).

Topics relevant to the Climate Variability and Change Focus Area that are actively or potentially soliciting in ROSES-2018 include the following program elements:

- Rapid Response and Novel Research in Earth Science (program element A.25);
- US Participating Investigator (program element A.27);
- NISAR Science Team (program element A.29);
- CloudSat and CALIPSO Science Team (program element A.30);
- Precipitation Science Team (program element A.33);
- SERVIR Applied Sciences Team (program element A.35); and
- Advanced Information Systems Technology (program element A.41).

2.3 Atmospheric Composition

Changes in atmospheric composition affect air quality, weather, climate, and critical constituents, such as ozone and aerosols. 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 in coming 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 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.

The ROSES element most closely directed towards the Atmospheric Composition Focus Area that are or may be soliciting for proposals in ROSES-2018 is:

- Atmospheric Chemistry Modeling and Analysis Program (program element A.19).

Topics relevant to the Atmospheric Composition Focus Area are also included in the following program elements that are actively or potentially soliciting in ROSES-2018 include the following program elements:

- Rapid Response and Novel Research in Earth Science (program element A.25);
- US Participating Investigator (program element A.27);
- CloudSat and CALIPSO Science Team (program element A.30);
- Precipitation Science Team (program element A.33);
- SERVIR Applied Sciences Team (program element A.35); and
- Advanced Information Systems Technology (program element A.41).

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.

Within this Focus Area are the following R&A programs: Precipitation and Atmospheric Dynamics and Terrestrial Hydrology. Also, the Radiation Sciences and Land-Cover Land-Use Change programs are shared with, respectively, the Atmospheric Composition and Carbon Cycle and Ecosystems Focus Areas. 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 the 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 http://nasa-news.org/. 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 element most closely directed towards the Water and Energy Cycle Focus Area that are or may be soliciting for proposals in ROSES-2018 is:

- NASA Energy and Water System (program element A.22).

Topics relevant to the Water and Energy Cycle Focus Area are included in the following program elements that are actively or potentially soliciting in ROSES-2018 include the following program elements:

- ECOSTRESS Science Team (program element A.7);
- Rapid Response and Novel Research in Earth Science (program element A.25);
- US Participating Investigator (program element A.27);
- NISAR Science Team (program element A.29);
- CloudSat and CALIPSO Science Team (program element A.30);
- Precipitation Science Team (program element A.33);
- SERVIR Applied Sciences Team (program element A.35);
- Earth Science Applications: Water Resources (program element A.36); and
- Advanced Information Systems Technology (program element A.41).

2.5 Weather

The Weather 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 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. 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) satellite launched in October 2011.

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) makes a significant impact on a global integrated forecast metric. Preparatory work and channel selection for the assimilation of the CrIS data and tests of the impact of that sensor have been completed. The preparations involved modifications to the Community Radiative Transfer model, passive monitoring of systematic and random errors in the CrIS data products, observation minus forecast residuals, and finally preoperational data assimilation/forecast experiments.

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 short-term 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.

NASA periodically provides opportunities for participation in the JCSDA and SPoRT programs. The most recent such activity was ROSES-16 element A.29 (NASA Data for Operation and Assessment (https://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={7BA4BC85-71ED-7C0B-074D-42EF39DB8E6F}&path=closedPast).

NASA also has a long history of conducting airborne field campaigns in support of hurricane research (https://ghrc.nsstc.nasa.gov/home/field-campaigns). Most recently,

the Hurricane and Severe Storm Sentinel (HS3) Mission, a five-year Earth Venture Class Suborbital mission that was awarded in 2010, has obtained data from its base at the Wallops Flight Facility (WFF) on the coastline of Virginia during the hurricane seasons of 2012-2014 (https://espo.nasa.gov/missions/hs3/). This campaign used two Global Hawk (GH) unmanned aircraft systems (UAS) with distinct payloads to address both over-storm and near-storm environmental issues. The HS3 Mission was designed to investigate some basic questions regarding changes in hurricane intensity:

1. What impact does the large-scale environment, particularly the Saharan Air Layer (SAL), have on intensity change?
2. What is the role of storm internal processes such as deep convective towers?
3. To what extent are these intensification processes predictable?

In June 2012, NASA selected the Cyclone Global Navigation Satellite System (CYGNSS) satellite mission under its Earth Venture program. CYGNSS data will enable scientists, for the first time, to probe key air-sea interaction processes that take place near the inner core of the storms, which are rapidly changing and play large roles in the genesis and intensification of hurricanes. The CYGNSS Mission satellites launched in 2016. While this is a Principal-Investigator led mission, NASA provided an opportunity for community members not part of the original proposal to be involved with the mission in ROSES-2013 (Program element A.22 – Weather; see http://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={6E74C972-BD4C-2286-AF21-D6B43CF3BA4C}&path=closedPast).

Topics relevant to the Weather Focus Area are included in the following program elements that are actively or potentially soliciting in ROSES-2018 include the following program elements:

- Rapid Response and Novel Research in Earth Science (program element A.25);
- US Participating Investigator (program element A.27);
- CloudSat and CALIPSO Science Team (program element A.30);
- Precipitation Science Team (program element A.33);
- SERVIR Applied Sciences Team (program element A.35);
- Earth Science Applications: Water Resources (program element A.36);
- Earth Science Applications: Disaster Risk Reduction and Response (program element A.37); and
- Advanced Information Systems Technology (program element A.41).

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) and U.S. Geologic Survey (USGS) in support of the EarthScope initiative to apply modern observational, analytical, and telecommunications technologies to investigate the structure and evolution of the North American continent and the physical processes controlling Earthquakes and volcanic eruptions.

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-2018 is:

- Earth Surface and Interior (program element A.24).

Topics relevant to the Earth Surface and Interior Focus Area are included in the following program elements:

- Rapid Response and Novel Research in Earth Science (program element A.25);
- US Participating Investigator (program element A.27);
- NISAR Science Team (program element A.29);
- SERVIR Applied Sciences Team (program element A.35);
- Earth Science Applications: Water Resources (program element A.36);
- Earth Science Applications: Disaster Risk Reduction and Response (program element A.37); and
- Advanced Information Systems Technology (program element A.41).

2.7 Cross-Cutting and Interdisciplinary

There are several cross-cutting and interdisciplinary elements in ROSES-2018, 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-2018 or are being evaluated for possible solicitation, are:

- *Rapid Response and Novel Research in Earth Science* (program element A.25) – 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;
- *NISAR Science Team* (program element A.29) - This solicitation seeks proposals for membership in a NASA NISAR Science Team to support further prelaunch planning and preparation for the NISAR mission. NISAR will be the first NASA radar mission to systematically and globally study the dynamics of solid Earth, the ice masses, and ecosystems, all of which are sparsely sampled at present. The NISAR mission has three science foci (surface deformation, ecosystem dynamics, and cryosphere dynamics) and one application focus (hazard/disaster management). The competed science team will help develop algorithms and provide scientific input to the project that can be used in the course of mission development;
- *CloudSat and CALIPSO Science Team* (program element A.30) - This program element requests proposals for the CloudSat/CALIPSO science team that draw on the results of the nearly 12 years of operation of the two satellites, and take

advantage of both their particular results and the synergies of their flying in the A-Train constellation which allowed for nearly-simultaneous measurements with other NASA satellites (e.g., Aqua, Aura, OCO-2) and those of NASA's international partners (PARASOL, GCOM-W1); and

- *Precipitation Science Team* (program element A.33*)* - The Precipitation Measurement Missions (PMM) science team seeks investigations related to satellite observations of precipitation using measurements from, but not limited to, the Global Precipitation Measurement (GPM) Core Observatory (2014-present), GPM mission constellation partner spacecraft, and the Tropical Rainfall Measuring Mission (TRMM, 1997-2015).

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 elements most closely directed towards Applied Sciences that are or may be soliciting for proposals in ROSES-2018 are:

- SERVIR Applied Sciences Team (program element A.35);
- Earth Science Applications: Water Resources (program element A.36); and
- Earth Science Applications: Disaster Risk Reduction and Response (program element A.37).

In addition, topics relevant to the Applied Sciences Program that are actively or potentially soliciting in ROSES-2018 include the following program elements:

- Rapid Response and Novel Research in Earth Science (program element A.25);
- US Participating Investigator (program element A.27);
- NISAR Science Team (program element A.29);
- CloudSat and CALIPSO Science Team (program element A.30);

- Precipitation Science Team (program element A.33); and
- Advanced Information Systems Technology (program element A.41).

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, the Advanced Information Systems Technology Program will be solicited in ROSES-2018:

- AIST (program element A.41): The Advanced Information Systems Technology program advances information systems that are used to process, archive, access, visualize, and communicate science data.

Other ESTO programs that are periodically solicited are NOT being solicited in ROSES-2018:

- IIP (program element): The Instrument Incubator Program 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;

- ACT (program element A.43): The Advanced Component Technology program develops a broad array of components and subsystems for instruments and observing systems.
- InVEST (program element A.44): 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; and
- SLI-T (program element A.45): The Sustainable Land Imaging Technology program develops technologies 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.

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 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.

5.2 Graduate and Early-Career Research

With a focus on continued workforce enrichment, the Earth Science component of the NASA Earth and Space Science Fellowship (NESSF) program, which supports the training of graduate students in Earth system science and/or remote sensing, is solicited outside of ROSES with new applications due February 1 of each year (NESSF is posted at http://nspires.nasaprs.com/ in November). The New (Early Career) Investigator Program in Earth Science (program element A.31), 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 not being solicited in ROSES 2018.

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.

Two program elements have been solicited periodically by the Data and Information Management programs of the Earth Science Division – The Advancing Collaborative Connections for Earth System Science (ACCESS, program element A.38) and the Making Earth System Data Records for Use in Research Environments (MEaSUREs, program element A.39). Neither are being solicited as part of ROSES-2018. In addition, the Citizen Science for Earth Science Program (program element A.40) was solicited in 2016 and is not being solicited in ROSES 2018.

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

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. Starting in ROSES-2016, SMD began implementing a more rigorous resource allocation process. Proposals should include up to a one-page justification (not counted against the technical proposal page limit) for the computational resource requirement 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-2018, 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. 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, PIs who require the use of such a system are encouraged to register on the NEX Website at https://nex.nasa.gov/nex/auth/register/. Proposals should include a section that justifies the need for using NEX, specifies the data storage and processing needs, and includes a data management plan. 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-2018, 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.

A.2 LAND-COVER/LAND-USE CHANGE

NOTICE: Amended January 31, 2019. The proposal due dates for this program element were previously temporarily changed to "TBD" as a result of the partial government shutdown. This amendment releases new due dates for the effected program elements in Appendix A. For this program element the new Step-2 proposal due date is April 2, 2019.

Proposals to this program are taken by a "binding" two-step process in which the Notice of Intent is replaced by a required five-page Step-1 proposal submitted by an organization Authorized Organizational Representative. Only proposers who submit a Step-1 proposal and are invited to proceed may submit a Step-2 (full) proposal. See Section 4.3.

1. The LCLUC Program

The Land-Cover/Land-Use Change (LCLUC) program is developing interdisciplinary approaches combining aspects of physical, social and economic sciences, with a high level of societal relevance, using remote sensing tools, methods, and data. One of its stated goals is to develop the capability for periodic satellite-based inventories of land cover and monitoring and characterizing land-cover and land-use change. The program focuses on analysis at global to regional scales, taking advantage of the synoptic capability afforded by satellite remote sensing and with the understanding that land-use change occurs locally. Additional information on the NASA LCLUC program can be found at http://lcluc.hq.nasa.gov or contact Dr. Garik Gutman, the Land-Cover/Land-Use Change Program Manager, see Section 5, below.

2. Scope of the current solicitation: Land-Use Transitions in Asia

Increasing demand for land is leading to significant land-cover and land-use changes around the world. Changes in market forces and demand for agricultural products are leading to changes in traditional agricultural practices. Forest and woodlands continue to be converted to agriculture. Urban expansion has been rapid and significant over the last few decades, as rural populations in developing countries become increasingly urban. Suburban areas of the developed world continue to expand. Changing land rights and ownership are changing land management. Land use in some regions is adapting to the increased frequency of extreme weather events and a warming climate.

Documenting land-use transitions using satellite observations and understanding the causative factors and various impacts is gaining importance. High performance computing and increased frequency and availability of moderate resolution data and fine resolution systems are enabling enhanced monitoring of land cover and land use change. The accurate reporting and analysis of the observed land-use changes provides an opportunity to advance land-change science and inform land-use policy.

The LCLUC program takes a regional approach to studying changes that have regional to global scale impacts. The region of interest for this solicitation is Asia. The following significant types of land-cover and land-use transitions in this region can be quantified

and characterized using different types of satellite-based remote sensing and are of interest to the current solicitation:

- Transitions in smallholder agricultural systems
- Growth in urban areas and urban teleconnections
- Land use transitions in dryland systems

Smallholder farming is a major component of agricultural production in Asian countries and central to the challenges of sustainable development and poverty alleviation. Smallholder agriculture is changing in many regions due to national and global market forces, raising questions of land rights, governance and resilience. Data on smallholder farming is limited due to inaccessibility of disaggregated data. With the increased availability of moderate and fine resolution satellite data, the detection and characterization of smallholder systems and how they are changing is more feasible.

Urban areas are growing throughout Asia, often replacing agricultural land. This expansion is resulting in large peri-urban areas where there is a gradient between strictly urban and strictly rural environments, with many locations falling in between. The expansion of urban areas and changes in peri-urban areas can be monitored and documented using satellite remote sensing systems. Developing an understanding of the gradient and the teleconnections between urban areas and the land use and livelihoods in surrounding rural areas is a challenge for LCLUC researchers.

Degradation is a characteristic of many dryland systems in Asia. In Central Asia, the move from centralized land management to the promotion of economic growth, resulted in conversion of many natural landscapes to agriculture and industrial land, with an associated increase in water use. The push for increasing livestock production and the decrease in traditional nomadic pastoralism is putting grazing land under pressure. In the dryland systems of South Asia, human population is growing rapidly and there are efforts underway to expand agro-pastoral productivity. Monsoon rainfall distribution is uneven and groundwater resources in some areas are subject to over exploitation and poor management. In other areas, traditional ruminant grazing is being intensified and in some cases replaced by intensive dairy production. In addition to documenting such land-use transitions using the satellite record, there is a need to understand the biophysical, economic and livelihood impacts of these various changes.

To understand the drivers of land-use change and the processes of the above land transformations, the socio-economic processes need to be considered and, as such, social science needs to be an integral part of each proposal (see 3.1). Studies can vary from the landscape to regional scale, integrating multiple data sources as needed and providing an understanding of LCLUC dynamics at multiple spatial and temporal resolutions. Local case studies that document LCLUC trajectories and their causative factors are welcome, however, the analysis and outputs should be scalable to larger regions. Proposals should highlight the theoretical and analytical frameworks appropriate for investigating the patterns of physical and socio-economic interactions influencing land-use and land-cover changes in the region. Further, proposals including data acquisition, preprocessing, image interpretation, and accuracy assessment for land-use and land-cover characterization, mapping and change analysis, should apply state-of-the-art methods and techniques.

Proposers should familiarize themselves with the existing literature and make the case for how their proposal offers improved methods, advances land-use science, or could inform land-use policy. Proposers should explore the LCLUC program web site to learn from the projects on a particular subject that have already produced results.

The successful proposals from this round will contribute to regional and global programs that the LCLUC program is investing in the Northern Eurasia Future Initiative (NEFI; http://neespi.org/NEFI-ExecutiveSummary.pdf), the South/Southeast Asia Research Initiative (SARI; http://sari.umd.edu) and the Global Observation of Forest Cover and Land Use Dynamics (GOFC-GOLD; http://www.fao.org/gtos/gofc-gold/). The GOFC-GOLD Regional Information Networks rely on the science developed by participating scientists, therefore Science Teams selected from this round will feed in to the regional networks' new algorithms and data products developed under the LCLUC Program, as appropriate. Specifically, the established Southeast Asia Regional Research Information Network (SEARRIN), the emerging South Asia Regional Information Network (SARIN), and the re-established Central Asia Regional Information Network (CARIN) will be the relevant GOFC-GOLD networks for this solicitation. For regional proposals, the LCLUC program strongly encourages collaborations with regional scientists with experience and insights on the topic of the proposal. It is intended that such collaborations will strengthen the research with local knowledge. Collaborations may be developed following the guidelines and with the appropriate letters of support at Step-2.

3. Principles of the LCLUC program to be reflected in proposals

3.1 Social and Economic Sciences in the NASA LCLUC program

The NASA LCLUC program is aimed at using satellite observations to improve our understanding of land-cover and land-use change as an important component of global and climate change. The LCLUC program includes studies that quantify land-cover and land-use changes; examine their impact on the environment, climate, and society; or model future scenarios of land-cover and land-use change and its various impacts and feedbacks. Humans play an important role in modifying land cover and are instrumental in land-use change. To understand the process of land-use change it is, therefore, important to address its human dimensions.

Social and economic science research plays an important role in the NASA LCLUC program and includes analyses of the impacts of changes in human behavior at various levels on land use, studies of the resultant impacts of land-use change on society, or how the social and economic aspects of land-use systems adapt to climate change.

The LCLUC program evaluates a proposal's responsiveness to the above aspects in terms of a meaningful integration of social and economic science theories, perspectives, methods, and data (quantitative and/or qualitative) with innovative analyses of land system dynamics in the proposed research. In this context, simple treatments of human dimensions, such as mere correlations of socioeconomic variables in lieu of rich empirical analyses linked to theorized social dynamics, or summary descriptions of potential societal or policy benefits of the proposed study without demonstrable linkages to the same, are not considered adequately responsive to the socio-economic aspect of the program. Successful proposals will fully integrate social and economic sciences into the research questions, data used, and analytical approaches in order to couple remote

sensing observations of land-cover with research on the human dimensions of land-use change.

3.2 Remote Sensing Component

The NASA LCLUC program will only support proposals with a strong remote sensing component. The use of observations and data products from U.S. and/or non-U.S. Earth-observing satellites is a requirement for each proposal. The use of commercial satellites with fine spatial resolution is also encouraged (see, e.g., http://cad4nasa.gsfc.nasa.gov/).

To get the most out of current remotely sensing capabilities, we encourage data fusion from various sources with different spatial and/or temporal resolution and different parts of the solar and microwave spectra. For example, a variety of multispectral, hyper-spectral, optical, thermal, and radar data may be integrated in the analysis, as needed. Proposals that undertake fusion of data from various sources of Landsat-type data, as well as radar observations, are welcome. Special attention should be given to the dissemination of data and products associated with the proposed research. If appropriate, we also encourage use of NASA's new collaboration facility for the NASA Earth science community: NASA Earth Exchange (NEX; https://c3.nasa.gov/nex/) web portal. This portal includes a state-of-the-art supercomputing Earth system modeling system for the use of remote sensing data from NASA and other agencies. Much of the global Landsat data have been transferred to that facility. The NEX web portal represents a scientific social networking 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.

3.3 International Collaboration

NASA’s policy welcomes the opportunity to conduct research with non-U.S. organizations on a cooperative, no exchange-of-funds basis. Although Co-Is or Collaborators employed by non-U.S. organizations may be identified as part of a proposal submitted by a U.S. organization, as noted in the *NASA Guidebook for Proposers* "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". Note that travel by a non-U.S. 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 funding may not be used for research efforts by foreign organizations at any level, including payment of travel expenses. See also Section III (c) of the *Summary of Solicitation* for restrictions involving China.

4. Programmatic Information

4.1 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. Principal

Investigators are expected to provide input to the program web site and participate in the program webinars and outreach activities.

4.2 Funding Available for Support of Selected Proposals

Approximately $2.5M per year is expected to be available for new awards from proposals submitted to this program element. NASA anticipates supporting approximately 10 investigations, each with annual budgets in the $200-250K range. NASA will make selections for this announcement in the Fall of 2019 with anticipated starting date in early 2020.

A budget for domestic travel to at least one LCLUC Science Team Meeting in the DC area per year and international travel to SARI or NEFI workshops or project meetings in Asia is required in the proposal. Involvement of local scientists from the selected region is strongly encouraged and letters of endorsement from foreign partners, with financial commitments, although not needed at Step-1, will be required at Step-2. Note that direct support of research by foreign investigators is not allowed, including services and supplies that constitute research (see Appendix A of the *NASA Guidebook for Proposers*. See more details above in 3.3 on what is and what is not allowed in the budget concerning non-U.S. participation.

4.3 The Two-Step Proposal Procedure

To streamline the proposal process and relieve the work load on the community of interested applicants and those that help NASA in reviewing proposals, the LCLUC program is using a two-step procedure (see also Section IV(b)(vii) of the *ROSES Summary of Solicitation*). Step-1 proposals replace the Notice of Intent (NOI). Step-1 proposals must be submitted electronically by the NOI/Step-1 Due Date (see Tables 2 and 3 in the *ROSES Summary of Solicitation*). Unlike an NOI, a Step-1 proposal is required and must be submitted electronically by the Authorized Organizational Representative (AOR). 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.

NSPIRES will be open for the submission of Step-1 proposals starting ~30 days in advance of the Step-1 Due Date. NASA will then review each Step-1 proposal to determine whether or not the anticipated research project is considered of sufficient merit, responsiveness, and relevance to warrant submission of a full Step-2 proposal. A separate Step-1 proposal must be submitted for each intended (and thus corresponding) Step-2 proposal.

Only proposers who submit a Step-1 proposal and are invited to submit a Step-2 proposal are eligible to submit a Step-2 proposal. Submission of a Step-1 Proposal is, therefore, required in order to submit a Step-2 proposal. Step-2 proposals must contain the same scientific goals proposed in Step-1, but the proposal team identified at Step-1 (other than the PI) may be adjusted in an invited Step-2 proposal. However, the submission of a Step-1 proposal is not a commitment to submit a Step-2 proposal.

The NSPIRES system will guide proposers through submission of all required proposal information. Please note that the Proposal Summary, Business Data, Program Specific Data, and Proposal Team are required Cover Page Elements for a Step-1 proposal. A

budget should not be included with the Step-1 proposal, but will be needed with a budget explanation at Step-2.

To facilitate the work by reviewers on Step-1 proposals, the following abbreviated template is suggested for use. Step-1 proposals should be provided as a PDF proposal document-upload not to exceed five pages, including any references or citations. The five-page, Step-1 proposal must:

a) Emphasize responsiveness, clearly indicating how the proposed project addresses the call, and which remote sensing assets are to be used. Identify social science aspects in the proposed study.
b) Describe the proposed research, showing knowledge of previous research carried out by the international scientific community in the subject area. Identify new research aspects being proposed.
c) Outline the expected outcomes of the research. Identify proposed deliverables. Provide a tentative schedule.

Step-2 proposals should provide more detail on the previous studies related to the research topic and the proposed research methodology, the anticipated results and deliverables, and schedule. Step-2 proposals should include a budget and the associated explanation. For consistency and to ease the burden of reviewing, it is preferable that Step-2 proposals follow approximately the same structure as outlined for the Step-1 proposals expanded to 15 pages.

Step-2 proposals must be submitted electronically by the Proposal Due Date in full compliance with the requirements specified in this NRA's *Summary of Solicitation* and the *NASA Guidebook for Proposers*.

4.4 Evaluation of Proposals

All proposals will be submitted to the NASA peer review process in accordance with the guidelines provided in this NRA and the *NASA Guidebook for Proposers*. This program is unique in that the evaluation of Relevance will include an assessment of the extent to which the proposal successfully includes social and economic sciences, as described in Section 3.1. The inclusion of remote sensing is not an evaluation criterion but is a compliance requirement: proposals that don't address remote sensing, as described in Section 3.2 may be rejected without review. Finally, International Collaboration is encouraged but not required, i.e., all else being equal when deciding between proposals of otherwise equal merit NASA will give preference to those with International Collaboration.

The 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 the Selecting Official for confirmation. NASA then will announce the official selection of proposals for award via NSPIRES.

5. Summary of Key Information

Expected annual program budget for new awards	~ $2.5M, see Section 4.2
Number of new awards pending adequate proposals of merit	10
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	Early Calendar 2020
Page limit for the central Science-Technical-Management section of proposal	Step-1 proposals: 5 pp; Step-2 proposals: 15 pp; see also Chapter 2 of 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*.
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 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	NNH18ZDA001N-LCLUC
NASA 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: NASA will not solicit research proposals under the Ocean Biology and Biogeochemistry program element in ROSES-2018. The next estimated release of an Ocean Biology and Biogeochemistry program element is potentially ROSES-2019.

1. Scope of Program

NASA's Ocean Biology and Biogeochemistry program focuses on describing, understanding, and predicting the biological, ecological, and biogeochemical regimes of the upper ocean, as determined by observation of aquatic optical properties using remote sensing data, including those from space, aircraft, and other suborbital platforms.
Overarching programmatic goals include:

1. Understanding and quantifying the impacts and feedbacks of Earth System processes, particularly oceanographic mechanisms, on the global and regional spatial and temporal variability of ocean biology, including phytoplankton and organisms from other trophic levels;
2. Understanding and quantifying the impacts and feedbacks of Earth System processes, particularly oceanographic mechanisms, on the global and regional spatial and temporal variability of ocean biogeochemistry, including carbon sources and sinks and the fate of other chemical species or components in the ocean;
3. Exploring the development of new biological and biogeochemical observations (e.g., plankton functional types) beyond traditional ocean color (e.g., phytoplankton chlorophyll *a*) from space-based assets, as well as furthering the climate research enabled by existing time series of climate observations (Earth System Data Records); and
4. Improving future climate predictions (impacts and feedbacks) by incorporating a dynamic understanding of ocean biology and biogeochemistry into global biogeochemical and ecological models to understand the ocean's role in the Earth System.

Ocean Biology and Biogeochemistry research mainly supports the Carbon Cycle and Ecosystem Focus Area (https://science.nasa.gov/earth-science/focus-areas/carbon-cycle-and-ecosystems). Each of the Earth Science Focus Areas portrays a strategy for a decade of progress through 2015, based on a suite of systematic observations, novel new Earth Science observations, and specific programmatic elements. NASA's Ocean Biology and Biogeochemistry program utilizes remotely sensed observations from land, ocean, and atmosphere, as well as field studies and campaigns, and interdisciplinary data assimilation and modeling efforts to better understand the ocean's role in the Earth System and to predict future causes of change and feedbacks on ocean biology and biogeochemistry within the Earth System. In support of the Carbon Cycle and Ecosystems Roadmap, scientific questions of interest to the Ocean Biology and Biogeochemistry Program include (but are not limited to):

1. How are ocean ecosystems and the biodiversity they support influenced by climate and environmental variability and change, and how will these changes occur over time?
2. How do carbon and other elements transition between ocean pools and pass through the Earth System, and how do biogeochemical fluxes impact the ocean and Earth's climate over time?
3. How (and why) are the diversity and geographical distribution of coastal marine habitats changing, and what are the implications for the well-being of human society?
4. How do hazards and pollutants impact the hydrography and biology of the coastal zone? How do they affect us, and can we mitigate their effects?

Appendix A.1 of ROSES ("Earth Science Research Program") provides an overview of how the Ocean Biology and Biogeochemistry 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 (https://oceancolor.gsfc.nasa.gov/docs/technical/obb_report_5.12.2008.pdf), and update of which is underway and will be posted in late 2017 or early 2018.

2. Programmatic Information

Questions or comments may be directed to the Ocean Biology and Biogeochemistry Program Manager at the address given below:

Paula Bontempi
Earth Science Division
Science Mission Directorate
NASA Headquarters
Washington, DC 20546-0001
Telephone: (202) 358-1508
Email: Paula.Bontempi@nasa.gov

Laura Lorenzoni
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A.4 TERRESTRIAL ECOLOGY: ARCTIC-BOREAL VULNERABILITY EXPERIMENT – PHASE 2

NOTICE: Corrected June 26, 2018. The list of components of the proposal in Section 5 was not complete. Biographical Sketches, Table of Personnel and Work Effort, and Current and Pending Support have been added. New text is in bold. The due date for proposals remains unchanged.

Amended May 4, 2018. This amendment presents final text for this program element. Data management plans are part of the uploaded proposal PDF and evaluated as part of merit, see Section 5. The due date for Notices of Intent is June 18, 2018 and the due date for proposals is September 7, 2018.

1. About NASA's Terrestrial Ecology Program

This announcement offers opportunities for terrestrial ecology research within NASA's Earth Science Division. The NASA Terrestrial Ecology (TE) Program uses airborne and space-based observations to understand how Earth's carbon cycle and terrestrial ecosystems respond to environmental changes and human intervention. The goals of the NASA TE Program are to improve understanding of the structure, function, and productivity of terrestrial ecosystems across the globe, their interaction with the atmosphere and hydrosphere, and their role in cycling the major biogeochemical elements and water. The program addresses the spatial and temporal variability of terrestrial ecosystem states and processes, how terrestrial ecosystems and biogeochemical cycles respond to and affect global environmental change, and what future changes might be expected in carbon cycle dynamics and ecosystems. The research approach combines (i) use of remote sensing to observe and analyze changes in terrestrial ecosystems; (ii) field campaigns and related process studies to elucidate ecosystem functions at multiple scales; and (iii) data assimilation and modeling to analyze and predict ecosystem and biogeochemical cycle responses to environmental change. The program seeks to strengthen the theoretical and scientific basis for measuring Earth surface properties using reflected, emitted, and scattered electromagnetic radiation and develop the methodologies and technical approaches required to analyze and interpret such measurements. These activities will ultimately provide a foundation for the new remote sensing capabilities needed to understand and monitor terrestrial ecosystems at regional to global scales.

Investigators associated with successful Arctic-Boreal Vulnerability Experiment (ABoVE) proposals become members of the NASA Terrestrial Ecology Science Team. Membership in this community carries the obligation to serve on NASA Peer Review Panels upon request.

2. Research Areas Included in This Program Element

To date, the ABoVE field campaign has been implemented through a series of ROSES program elements (https://above.nasa.gov/2018_NRA.html).

- Pre-ABoVE Phase (2013-2016): Prior to completion of the Concise Experiment Plan, the NASA TE Program funded six projects to provide data for the field campaign.

- Phase 1a (2015-2018): Initiated through ROSES-2014, this phase funded 22 projects focused primarily on field studies addressing ABoVE's ecosystem dynamics objectives, but also included a limited number of projects focused on modeling and ecosystem services objectives.
- Phase 1b (2017-2020): This phase, initiated through ROSES-2016, continued the focus on ABoVE's ecosystem dynamics objectives through projects that acquired and/or utilized the remote sensing data collected during the 2017 ABoVE Airborne Campaign.
- Phase 2 (2019-2021): NASA is initiating ABoVE Phase 2 by soliciting proposals that continue these ecosystem dynamics research objectives, with an increased interest in projects that advance its ecosystem services and modeling objectives.
- ABoVE Phase 2 research is solicited in four areas: (1) Analyzing remote sensing data collected during the 2017 ABoVE Airborne Campaign (AAC) to develop the data products required to improve understanding of ecosystem dynamics; (2) Developing a better understanding of the ecophysiological basis of the relationships between surface and satellite measurements of Solar Induced Fluorescence (SIF) for northern ecosystems and its link to ecosystem productivity; (3) Continuing research on the societal impacts of changes to Arctic and boreal ecosystems; and (4) Integrating research results from ABoVE into a coherent modeling framework to diagnose and predict ecosystem dynamics and the consequent societal impacts of changes to the ecosystem. Phase 2 also includes the (5) opportunity for a person (or persons) to serve as the ABoVE Science Team Lead(s).

2.1 Arctic-Boreal Vulnerability Experiment

Climate change in the high northern latitudes of the Arctic-Boreal Zone (ABZ) is occurring faster than anywhere else on Earth and the result is widespread transformation in landscape structure and ecosystem function. In addition to producing significant feedback to climate through changes in ecosystem processes, environmental change in this region is increasingly affecting society. For example, increased frequency and intensity of ecological disturbance can negatively influence forest resources and air quality, thawing permafrost can negatively change local water quality and human infrastructure, and alterations to wildlife populations can negatively reshape traditional and commercial hunting. Recognizing the sensitivity, vulnerability, and global importance of this region, this solicitation seeks proposals focused on developing better abilities to observe, understand, and model the complex, multiscale, and nonlinear processes that drive the region's natural and social systems. Figure 1 shows ABoVE's general conceptual basis and Figure 2 the ABoVE Study Domain, which encompasses much of the boreal and tundra areas of Alaska and western Canada.

The predictive capabilities of Arctic/Boreal Region ecosystem models are subject to large uncertainties, which limits our ability to predict biosphere/atmosphere feedback and its effect on future climate. Advancing knowledge about the potential responses northern ecosystems may have to environmental change is an important research priority at international (e.g., IPCC) and US interagency (e.g., IARPC, USGCRP) levels. Consequently, the NASA TE Program has developed the Arctic-Boreal Vulnerability Experiment (ABoVE) as a contribution to better understanding this critical region (http://above.nasa.gov).

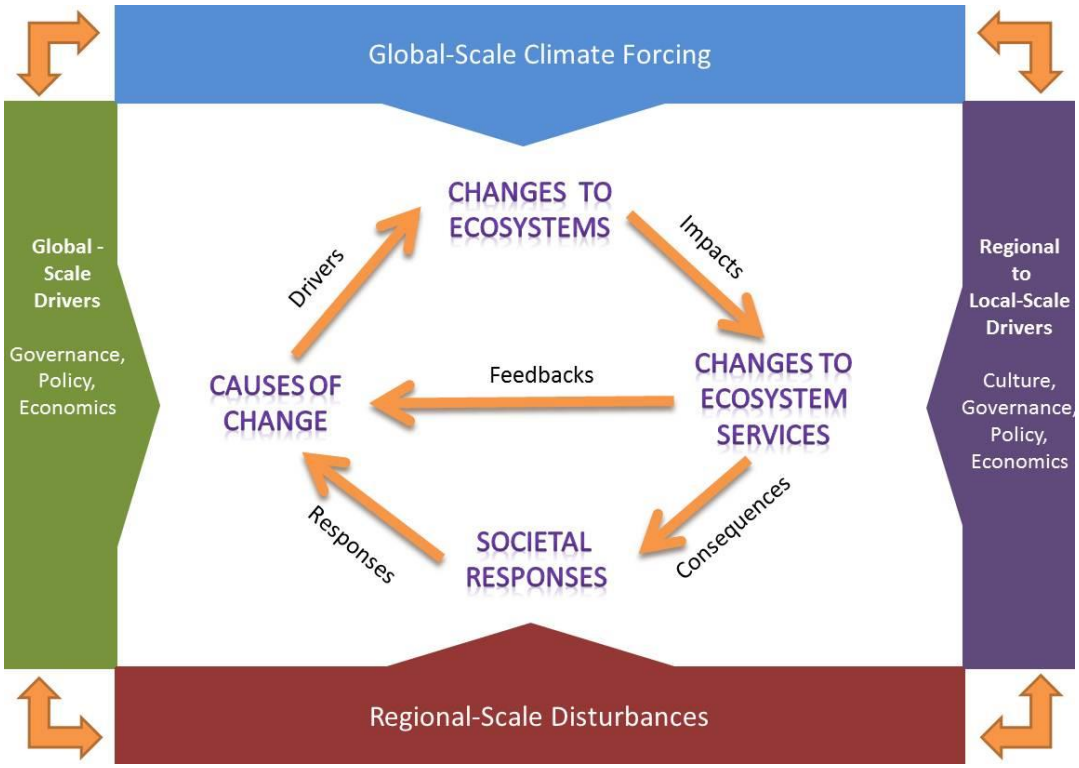

Figure 1. The ABoVE Vulnerability/Resilience Framework was used to organize the science questions and objectives to be addressed by proposed Phase 2 studies.

ABoVE's overarching science question is:

> "How vulnerable or resilient are ecosystems and society to environmental change in the Arctic and boreal region of western North America?"

All proposed Phase 2 ABoVE research projects must address the relevant Tier 2 Science Questions defined in Table 3.1 of the *ABoVE Concise Experiment Plan* (ACEP) at http://above.nasa.gov/acep.html:

1. How are environmental changes affecting critical ecosystem services and how are human societies responding?
2. What processes are contributing to changes in disturbance regimes and what are the impacts of these changes?
3. What processes are controlling changes in the distribution and properties of permafrost and what are the impacts of these changes?
4. What are the causes and consequences of changes in the hydrologic system, particularly the amount, temporal distribution, and discharge of surface and sub-surface water?
5. How are flora and/or fauna responding to changes in biotic and abiotic conditions, and what are the impacts on ecosystem structure and function?
6. How are the magnitudes, fates, and land-atmosphere exchanges of carbon pools responding to environmental change, and what are the biogeochemical mechanisms?

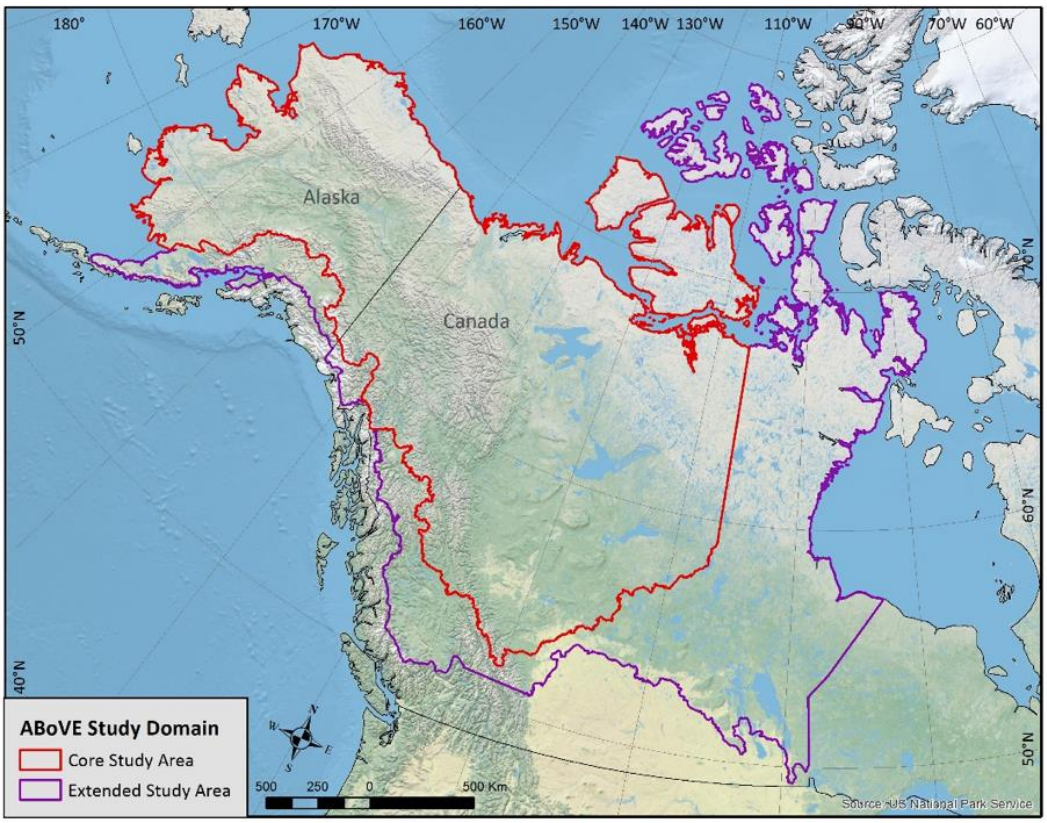

Figure 2. The ABoVE Study Domain includes both Core and Extended Study Areas. The Core Study Area is 4.1 million km^2, while the Extended Study Area encompasses an additional 2.2 million km^2. The 2017 airborne data, an important analysis subject for the current solicitation, collected data over specific portions of the entire Study Domain.

The *ABoVE Concise Experiment Plan* (ACEP) provides additional information about ABoVE. Solicitation respondents should familiarize themselves with the ACEP, which outlines the conceptual basis for ABoVE and articulates a rationale of the study's scientific and societal importance. The ACEP presents the science questions driving ABoVE research, as well as the top-level requirements for a study designed to address them. Additional relevant information is provided on the ABoVE web site (http://above.nasa.gov/2018_NRA.html).

This solicitation is open to new proposers and existing members of the ABoVE Science Team. For the modeling component of this solicitation, additional field measurements are not expected to be included unless proposers can make a convincing case the data is required to make a significant improvement in the representation of a fundamental ecosystem process or interaction. The 2017 ABoVE Airborne Campaign (AAC) component requires any new field work to be tightly linked to calibration, validation, and/or development of data products required to fulfill ABoVE's ecosystem dynamics objectives.

3. ABoVE Program Background

In previous ABoVE phases, 39 proposals were selected for funding. Field work based on these studies, and projects funded by other NASA programs and collaborating agencies (http://above.nasa.gov/cgi-bin/above/pi_list.pl), are ongoing. Section 3.1 provides important information for proposers, including unique aspects of the organization and management structure that supports ABoVE.

Research currently organized through ABoVE includes collaborations with researchers from government and non-government organizations in the US and Canada. NASA encourages proposed studies that include collaboration with researchers from other organizations, as detailed in Section 3.2 and https://above.nasa.gov/2018_NRA.html.

During the 2017 ABoVE Airborne Campaign, data were collected by multiple sensors flying on a variety of aircraft. These data are available to proposers for data fusion studies to support terrestrial ecosystem research. Additional, limited airborne data collection is scheduled in 2018 and 2019. Information about these upcoming campaigns and the data collected in 2017 is provided in Section 3.3.

Finally, a number of datasets available for use by researchers responding to this solicitation have been collected, produced, compiled, or identified within the ABoVE Science Cloud (Section 3.1.2).

3.1. ABoVE Organization and Management

3.1.1 *Carbon Cycle and Ecosystems Office*

NASA established an ABoVE Science Support Group within the Carbon Cycle and Ecosystems Office (CCEO) at NASA's Goddard Space Flight Center (GSFC). The CCEO is the primary source of information about existing ABoVE datasets, including field, airborne, and satellite data. All NASA-supported field activities and operations conducted within the ABoVE Study Domain are coordinated through the CCEO. Important CCEO aspects include coordination and support for field operations and logistics, safety and risk management, and interaction with local and regional stakeholders. The CCEO provides cyberinfrastructure for data analysis and management (e.g., ABoVE Science Cloud, Section 3.1.2). The CCEO assists Science Team members with submitting permit applications to appropriate authorities and helps coordinate ABoVE Airborne Campaigns.

Investigators should plan to work closely with the CCEO and rely upon guidance from its staff for planning field activities, communicating with local and regional stakeholders and authorities, and using ABoVE cyberinfrastructure. Proposers desiring specific information about the CCEO are encouraged to contact:

Dr. Peter Griffith
Chief Support Scientist, Hydrospheric and Biospheric Sciences
NASA's Goddard Space Flight Center, Code 618
Greenbelt, MD 20771
Email: peter.griffith@nasa.gov
Telephone: 301-614-6610

3.1.2 *ABoVE Science Cloud*

The NASA Center for Climate Simulation (NCCS) at GSFC partnered with the CCEO to create the ABoVE Science Cloud (ASC). The ASC combines high performance computing with emerging technologies to create an environment specifically designed for the large-scale modeling and analysis of remote sensing data. It features copious disk storage with integrated data management and integration of core variable data from *in situ* networks. The ASC:

- Provides a shared set of computational and data resources to the ABoVE Science Team,
- Enables access to large, common datasets (observation and model) relevant to ABoVE research,
- Provides a system by which results may be quickly and readily shared with the ABoVE research community,
- Enables researchers to successfully accomplish larger problems and more scientific analyses than typically would be possible using desktop computers, and
- Provides tailored computational, analysis, and data management environments to meet the needs of individual science investigations.

The ABoVE website summarizes and provides links to datasets that may be important for researchers responding to this solicitation. These datasets, many of which reside within the ASC, include:

- Information products derived from satellite remote sensing data as a part of ABoVE research,
- Remote sensing data collected by NASA during the ABoVE Airborne Campaign, other agencies (such as the National Ecological Observatory Network (NEON)), or previous projects sponsored by NASA,
- Field data from research sponsored by NASA as part of ABoVE and from partner projects, such as the Department of Energy's (DOE) Next Generation Ecosystem Experiment (NGEE) – Arctic and Polar Knowledge Canada,
- Data from longer-term monitoring activities, such as permafrost borehole data from the Global Terrestrial Network for Permafrost (GTN-P), eddy covariance flux data from AmeriFlux, and
- Data from other long-term research activities, such as NSF Long-Term Ecological Research sites, NEON, and a variety of programs sponsored by the US Department of Interior.

Instructions for accessing these datasets are provided on this solicitation's web page at https://above.nasa.gov/2018_NRA.html. Since ABoVE Phase 1a and 1b research is ongoing, not all data described are currently available for download. However, the ABoVE Science Support Group is working regularly with researchers to archive ABoVE data at the ORNL DAAC and import these data into the ASC. For this program element, researchers should assume that the scientific data identified on this solicitation's web page will be available for their proposed project.

Investigators may request assistance from the CCEO for: use of the ASC, identifying and providing key data products needed for their research, creation of appropriate metadata, generation of Digital Object Identifiers (DOIs) for publication-ready data

products, and preparation of finalized data products for archiving. Additional current information about the ASC, its capabilities, and potential use for ABoVE research is provided at http://above.nasa.gov/science_cloud.html.

3.1.3 *Data and Publication Policies*

Researchers from selected proposals become members of the ABoVE Science Team (ST) (https://above.nasa.gov/cgi-bin/above_science_team.pl). ABoVE ST members are expected to develop and comply with data and publication policies that respect and recognize the needs of partnering organizations and graduate researchers while being consistent with NASA data policies. The CCEO and ABoVE Science Leads (ASL), in consultation with the NASA Headquarters Program Manager and ABoVE partner organizations, oversee and manage implementation of ABoVE data and publication policies.

All collected data and science data products (including important model products) produced under NASA sponsorship is managed in accordance with NASA Earth Science Data and Information Policy (http://science.nasa.gov/earth-science/earth-science-data/data-information-policy/). Public release of all data shall conform to this policy. No significant period of exclusive access to the data or data products by an individual scientist or science team is permitted. A short period for calibration, correction, and quality assessment prior to public release is permissible. Some exceptions regarding full public access may need to be established for data obtained from sources that bind users to more restrictive data policies or that are inherently sensitive in nature (e.g., commercial satellite data, human-subjects data).

In keeping with NASA policy to make scientific results and data available to the public, investigators should plan to publish their work in open-access journals or budget appropriate publication costs to ensure their articles will be openly available. Researchers are expected to share their data using ABoVE's cyberinfrastructure (Sections 3.1.2, 3.1.4) and/or partner data system capabilities, as guided by the CCEO. For ABoVE investigations supported by NASA, a tailored, alternate Data Rights section is applied to the award document, under which scientific data and scientific software are exchanged without restriction as to its disclosure, use, or duplication.

3.1.4 *Data Archive*

The NASA-designated long-term archive for ecological and biogeochemical data from field campaigns is the Distributed Active Archive Center (DAAC) at the Oak Ridge National Laboratory (ORNL; http://daac.ornl.gov/). Thus, much of the data collected through ABoVE will ultimately be archived and distributed by the ORNL DAAC. This long-term archive is distinct from the short-term storage and analytical capabilities provided by the ASC (Section 3.1.2). NASA anticipates the possibility that some types of ABoVE data might be more appropriately archived at another NASA DAAC or other equivalent long-term archive, including those at ABoVE partner organizations. NASA managers and the CCEO will assist each investigator with identifying the appropriate archive for their data and products. Data and products are required to meet NASA archiving standards, including:

- Science data product formats shall conform to Earth Science Division (ESD) approved data system standards for data and metadata (https://earthdata.nasa.gov/data/standards-and-references).
- In keeping with NASA's need to ensure long-term data stewardship, awarded projects shall deliver all data products, including scientific algorithm software, coefficients, and ancillary data used to generate these products, to the DAAC by the end of the project term. The requirement to archive supporting algorithm software, coefficients, and ancillary data is applied primarily to satellite and airborne data products and is not usually applied to other types of data, such as the wide diversity of field data, process data, and social science data likely to be produced during ABoVE.
- All terms and conditions governing transfer of data products and associated information to the archive shall be documented in the project's Data Management Plan (Section 5.4.4).

3.2 Research Collaborations

NASA is interested in collaborations with other interested parties and stakeholders to advance the ABoVE research plan. Information about potential collaborating agencies is provided at http://above.nasa.gov/2018_NRA/collaborators.html. For example, NASA seeks to extend and expand existing collaborations with the DOE's Next-Generation Ecosystem Experiment – Arctic (NGEE-Arctic), US Department of Agriculture (USDA) Forest Service, US Geological Survey (USGS), Bureau of Land Management (BLM), National Park Service (NPS), Fish and Wildlife Service (FWS), and Alaska state agencies. Proposals that develop such collaborations are of interest; however, absence of a collaborator/partner is not counted against a proposal during panel evaluation.

Collaborations with Canadian scientists and stakeholders for work conducted in Canada are also encouraged. Polar Knowledge Canada, Canadian Forest Service, Canada Centre for Mapping and Earth Observation (formerly Canada Centre for Remote Sensing), Geological Survey of Canada, and governments of the Yukon, Nunavut, and Northwest Territories have expressed interest in fostering collaborations between Canadian and US scientists working on ABoVE.

While research with collaborating/partnering organizations is desirable, the absence of a collaborator/partner is not counted against a proposal during its panel evaluation. NASA is restricted to funding only research activities conducted by scientists directly affiliated with US institutions (https://science.nasa.gov/researchers/sara/faqs#14).

3.3 ABoVE Airborne Campaigns

In 2017, NASA sponsored the ABoVE Airborne Campaign (AAC), which collected the project's foundational remote sensing data using four NASA instrument systems: UAVSAR L-band SAR, P-band SAR, LVIS lidar, and AVIRIS-ng hyperspectral imager. These remote sensing data were collected over a range of geographically-distributed study sites where field data were being collected by ABoVE researchers. Additionally, ABoVE supported several PI-led airborne instruments (CFIS, AirSWOT, *in situ* atmospheric sampling, ASCENDS simulator). Detailed information about datasets collected by the foundational instruments during the AAC is provided at: https://above.nasa.gov/airborne_2017.html.

NASA expects to obtain additional airborne data over the next few years; however, the full nature of and schedule for obtaining these data is yet to be determined. However, limited flights of AVIRIS-ng during mid-summer and UAVSAR L-band during late summer or early autumn of 2018, 2019, and 2020 in the ABoVE Domain are expected. Schedules for planned 2018 flights are available at https://above.nasa.gov/2018_NRA.html. The program is also considering a more extensive ABoVE airborne campaign in 2020; however, application to fulfill this function is not included in this solicitation.

Remote sensing data were also collected by sensors associated with individual ABoVE projects (denoted as 'investigator instruments'). Data collected by investigator instruments are not the primary subject of this solicitation, but may be included as accessory data in proposed analyses. For example, fine-scale G-LiHT lidar data is available for Alaska's Tanana Valley region (https://gliht.gsfc.nasa.gov) and might be of interest for interpreting the foundational radar data.

4. Types of Investigations Solicited

The ABoVE research focus is four-fold: (1) Analyzing remote sensing data collected during the 2017 AAC to develop the data products needed to improve understanding of ecosystem dynamics; (2) Developing a better understanding of the ecophysiological basis of the relationships between surface and satellite measurements of Solar Induced Fluorescence (SIF) for northern ecosystems and its link to ecosystem productivity; (3) Examining the societal impacts of changes to Arctic and boreal ecosystems; and (4) Integrating research results from ABoVE into a coherent modeling framework for diagnosing and predicting ecosystem dynamics and the consequent societal impacts of changes to ecosystem services.

This solicitation aims to build upon and extend Arctic and boreal ecosystems research supported during earlier phases of ABoVE. NASA supported 22 investigations from ROSES-2014 (Phase 1a) and nine investigators from ROSES-2016 (Phase 1b), which together formed the initial ABoVE field program. In addition, NASA funded six projects prior to the start of the ABoVE field campaign or as part of activities to develop key datasets. While investigators associated with ABoVE Phase 1a and 1b projects are encouraged to propose for Phase 2, NASA also encourages new investigators to join the ABoVE Science Team. Finally, this solicitation also requests proposals for the position of Phase 2 Science Lead(s) of the ABoVE Science Team.

All proposed investigations shall make significant use of remote sensing data. Proposals that do not meet this criterion will be considered non-responsive or weakly relevant.

4.1 Airborne Science Using Data Collected During 2017 AAC

NASA requests proposals that advance use of airborne remote sensing data to help understand the vulnerability and resilience of northern ecosystems at regional scales within the ABoVE Study Domain. Specifically, we solicit proposals to analyze and interpret the foundational airborne remote sensing datasets collected during the 2017 ABoVE Airborne Campaign (Section 3.3). Proposals may include collection of new ground data to support analysis and interpretation of the airborne datasets, but only

when this is crucial to interpreting the airborne data or calibration/validation activities for development of new data products. Integrating other data sources into analyses is encouraged.

The foundational data collected during the 2017 AAC are intended to support studies that address four major ecosystem dynamics objectives:

(a) Improve understanding of active-layer thickness and permafrost state characterization and the effects of variations in permafrost on ecosystems at local to regional scales,
(b) Advance our ability to characterize the type, biomass, structure, and function of vegetation during the peak of the growing season and its relationship to ecological disturbance,
(c) Improve understanding of the drivers and effects of variations in surface hydrology (soil moisture and inundation) at local to regional scales, and
(d) Further our understanding of the dynamics and sensitivities of the regional carbon cycle.

NASA is soliciting research that utilizes foundational remote sensing data collected during the 2017 AAC (i.e., data collected by NASA's L-band (UAVSAR), P-band, AVIRIS-ng, and LVIS systems). Successful proposers shall explain how information products derived from the 2017 AAC airborne data will be used to study important ecosystem characteristics/processes and how this research addresses the ABoVE science objectives. Research contributions to ABoVE using the 2017 AAC data may focus on remote sensing product development, validation of ecosystem dynamics models, integrating field-based observations with the remote sensing products, modeling, and/or integration and scaling research (ACEP Table 4.1). NASA is not soliciting research redundant with or minor extensions of previous research activities funded under the 2016 ROSES A.4 Terrestrial Ecology program element. Proposers may request funds for limited, targeted field efforts to support planned ABoVE airborne data collection using AVIRIS-ng (mid-summer) and L-band (late summer or early autumn) in 2019 and 2020. However, analysis of existing 2017 AAC data is expected to be the primary research focus. Successful proposals will target one or more of five areas:

a) Further develop (including calibration and validation) the algorithms needed to map key Earth system characteristics and apply these algorithms to study key ecosystem processes in Arctic/boreal regions

NASA's airborne remote sensing systems provide a unique opportunity to develop new approaches for mapping important Earth surface characteristics and use these products to study ecosystem processes. However, while the potential to use the data collected by each remote sensing system to generate specific Earth surface characteristics has been demonstrated in numerous instances, validated algorithms for many land surface products have yet to be produced for Arctic/boreal ecosystems. Therefore, it is important that studies using data from the foundational 2017 AAC dataset include approaches for developing and validating specific information products and that these studies include research addressing the sources of uncertainty for the algorithm(s) used. The end result of an algorithm development activity should not simply be generation of a data product and validation of that product for specific areas of the

ABoVE Study Domain. Proposed research must also use the data product to study specific ecosystem processes. Such research could include integration of the remotely sensed data with field observations or using the airborne data products in models.

b) Study similar processes occurring in different geographic regions

ABoVE was designed to study variations in ecosystem characteristics and processes controlled by a range of environmental gradients (e.g., temperature, moisture, and other gradients derived from climate, such as permafrost), including gradients from variations in disturbance severity and recovery from disturbances. Based on this approach, the 2017 AAC was designed to collect data over a variety of sites located across the ABoVE Study Domain to provide opportunity for studies of ecosystem processes driven by these gradients. For example, seasonal permafrost thawing varies as a function of temperature, ground ice content, topography, vegetation cover, and organic layer thickness (which in many cases is controlled by disturbance, such as fire). Data collected during the 2017 AAC may allow for exploration of processes controlling this thawing throughout areas where permafrost exists. Similarly, questions regarding factors controlling changes in vegetation cover, soil moisture, or wetland inundation could be addressed using 2017 AAC data collected from multiple sites.

c) Combine information derived from data collected by multiple relevant sensors

Such research includes using information from multiple sensors to study specific ecosystem processes or characteristics. Combining data from multiple systems may provide opportunities to increase the accuracy of specific information products. For example, using canopy structure information from lidar may improve the ability to estimate surface and sub-surface soil moisture data from SAR or seasonal surface elevation changes in areas with permafrost using InSAR. Other options could include combining information products from multiple airborne sensors to investigate specific processes. For example, AVIRIS-ng products related to vegetation composition, productivity, or physiology could be combined with lidar vegetation structure products or SAR soil moisture products to understand factors controlling vegetation composition and growth. Or airborne and spaceborne data could be combined with longer-term vegetation change observations or disturbance severity measurements derived from satellite sensors for studies of variation in vegetation characteristics.

d) Extrapolate observations across multiple spatial scales

A key ABoVE component is using remote sensing data in scaling observations across multiple spatial domains. Data collected during the 2017 AAC are particularly suited to this. Research could be carried out to integrate the airborne remote sensing data with field observations to extrapolate to the landscape and sub-regional scale. This research could then use satellite observations for extrapolation to regional scales and/or over longer time periods. There are several unique research opportunities in this area based on new satellite datasets just becoming available (e.g., Sentinel 1a/b SAR data) or that will shortly be available with the launch of new missions (e.g., ICESat-2, Radarsat Constellation, SAOCOM).

e) Prepare for applying NISAR data to northern ecosystems

The NASA-Indian Space Research Organization (ISRO) SAR mission (NISAR) is scheduled for launch in 2021, just after completion of the studies supported by this program element. Although NISAR will collect S-band and L-band SAR data, only its NASA L-band SAR will collect data on a global basis. Over NISAR's planned three-year lifetime, the L-band SAR's 240 km swath will provide 12-day repeat coverage using a 12 x 8 m pixel. For land monitoring, NISAR will collect dual polarization (HH, HV) data. Several NISAR baseline requirements are relevant to NASA's TE Program, including: (a) measuring aboveground woody vegetation biomass (for areas of woody biomass less than 100 Mg/ha), and its disturbance and recovery globally at the hectare scale; and (b) measuring seasonally-inundated areas. There is also strong interest in using NISAR data to monitor the seasonal surface deformation associated with thawing ground in areas with permafrost and to estimate near-surface soil moisture.

Although previous research has demonstrated the potential of using L-band SAR data to measure important characteristics of terrestrial ecosystems, additional research is needed to fully prepare for NISAR. Investigations that utilize 2017 AAC data to address key areas of research needed to fully exploit future spaceborne SAR data, including NISAR, are of interest.

NASA is soliciting research to develop and refine data products from L-band SAR data and demonstrate their applicability to terrestrial ecosystem and carbon cycle science, including:

- Accounting for the effects of soil moisture on biomass signatures using polarimetric SAR data,
- Measuring surface soil moisture across a range of aboveground biomass using polarimetric SAR data,
- Mapping non-woody, low-biomass wetlands and their inundation using polarimetric L-band SAR data,
- Understanding the effects of biomass and soil moisture on InSAR measures of seasonal surface deformation in permafrost terrains,
- Understanding the effects of soil moisture on using polarimetric, L-band SAR data for near-realtime mapping of forest disturbances, and
- Tomographic processing of SAR data for mapping aboveground biomass and canopy structure.

In addition to L-band SAR data collected during the 2017 AAC, researchers can also use spaceborne L-band data collected by existing (ALOS PALSAR) or planned (SAOCOM, scheduled for 2018) missions. However, proposers should demonstrate they already have access to these data or include the cost of data purchases in their proposal.

Exploratory studies and projects that demonstrate new scientific applications are relevant to ABoVE. Studies to actively utilize such data and data products in ecosystem and carbon cycle modeling, synthesis activities, and diagnostic analyses are also of significant interest. Proposers are encouraged to partner with ecologists and carbon cycle scientists to strive for near-term assessment of the suitability of their analytical approaches. Successful proposals will focus on research providing a sound scientific

basis for new analytical approaches applying SAR to terrestrial ecosystems in preparation for the launch of NISAR.

4.2 Solar-Induced Fluorescence of Northern Ecosystems

The ability to retrieve Solar-Induced Fluorescence (SIF) of vegetation from satellite data has been a significant breakthrough in ecological remote sensing. SIF integrates complex physiological processes in a way that appears to provide direct indication of canopy photosynthesis, a key component of the global carbon cycle. SIF has the potential to help assess the drivers of inter-annual variability of the carbon cycle at large spatial scales. Several low Earth orbit satellites/instruments have had (SCIAMACHY) or currently have (GOSAT, GOME-2, OCO-2, TROPOMI) the capability to measure SIF, and a geostationary instrument, (GeoCarb) is in development. However, the link between the satellite signal of SIF and the physiological functioning of vegetation on the land surface is uncertain. NASA seeks to fund one or two projects to advance our understanding of how surface-level measurements of SIF relate to SIF satellite data for Arctic and/or boreal ecosystems in the ABoVE Study Domain, especially as applied to understanding ecosystem productivity and carbon cycling.

4.3 Societal Effects of Environmental Change in the ABoVE Study Domain

A key recommendation from the workshops that provided the conceptual foundation for ABoVE was that its research not only focus on the drivers of ecosystem change in Arctic/boreal regions, but also on the societal consequences of these changes. To address the societal effects of environmental change, the ABoVE Concise Experiment Plan (ACEP; http://above.nasa.gov/acep.html) identifies specific ecosystem services objectives to guide ABoVE research. In this program element, NASA seeks proposals that address ABoVE objectives to:

1. Determine the sources of variation in climate and carbon cycle feedback from Arctic and boreal ecosystems to assess the potential effects of future changes on climate regulating services at regional to global scales,
2. Analyze how changes to natural resources might affect local communities or influence larger scale land management policies and practices,
3. Assess how future climate warming is likely to affect infrastructure and transportation networks.

Research addressing these ecosystem services objectives is solicited in three areas:

Using field-based research. While studies addressing ecosystem services can utilize field-based observations, research funded through this program element is not intended to support collecting additional field data. Successful proposals will focus on data collected during previous ABoVE studies focused on ABoVE's Ecosystem Dynamics Objectives and/or by previous or ongoing studies funded by other agencies. The proposed research does not necessarily have to use data from previous studies, but could be based on results from studies that provide a foundation for understanding changes to a specific ecosystem service. Research may also include integration or synthesis of results from multiple studies conducted during ABoVE and/or other research programs. Other possible sources of data include important socio-economic and environmental databases (including those based on local and traditional

knowledge) compiled by government and nongovernment organizations (e.g., ACEP Tables B2 to B4).

Using remote sensing data products. Existing remote sensing data products, especially those developed from satellite data for ABoVE's Ecosystem Dynamics Objectives, may be used to address ABoVE's Ecosystem Services Objectives. In some cases, additional refinement of these existing products may be required to develop a specific product needed to address the proposed research objective.

Modeling. Modeling research is encouraged, as detailed in Section 4.4.

Research into societal drivers and responses should include direct engagement of policy makers and stakeholders to understand their information needs, as well as to gain insight into local and traditional ecological knowledge. Proposers shall show stakeholder engagement through letters of support and a clear plan that indicates how stakeholders will be directly involved in the proposed research.

Projects may be based on collaboration with ongoing research sponsored by other agencies, including using results from previous and/or ongoing research to better understand the changes to ecosystem dynamics and society's responses to environmental change. All societal impact studies shall make significant use of remote sensing data.

4.4 Advancing ABoVE Ecosystem Dynamics and Ecosystem Services Modeling

ABoVE Phase 2 modeling component proposals will facilitate integrating the large quantity of field data collected for ABoVE into a coherent modeling framework. This framework should enable researchers to address ABoVE science objectives related to Ecosystem Dynamics and Ecosystem Services. The ABoVE ST envisages a modeling framework that can be used by future researchers to further analyze and answer ABoVE's critical science questions (Section 2.1).

NASA seeks proposals that translate existing field, airborne, and satellite data into a modeling framework; translate field-measured variables into model variables; further develop functional relationships and benchmarks for modeling important processes and interactions; evaluate uncertainties in data and models; combine multiple datasets of similar variables into common model inputs; determine gaps in knowledge; and develop standardized forcing data. Model development proposals shall also answer one or more ABoVE Tier 2 science questions (ACEP Table 3.1). Integrated, efficient teams combining specialists in modeling, remote sensing, and field observations are encouraged to apply to this program element.

Projects are not expected to require additional field data collection. However, additional data collection will be considered if proposers make a thorough, compelling case that the additional field data will make a significant improvement in the representation of a fundamental ecosystem process or interaction within a specific class of models (e.g., vegetation dynamics, biogeochemical cycles, hydrology, etc.). The Budget Justification: Narrative and Details section shall clearly indicate the total cost per year of any field data collection.

Ecosystem Dynamics Modeling proposals may address any of the ABoVE Tier 2 science questions and Ecosystem Dynamics Science Objectives (ACEP Table 3.1).

Ecosystem Services Objectives proposals shall also address the objectives outlined in Section 4.3.

Several types of social systems modeling activities could be carried out under this program element. Examples include: research that improves existing models based on results from field-based studies to show how changes to ecosystem processes affect a specific ecosystem process or service; modeling activities using remote sensing data that provide model initialization, calibration, or validation; or, research that focuses on improving and applying socio-ecological models to enhance understanding of how ecosystem change affects society or illuminating how humans are driving changes to ecosystems.

While the focus should be on ABoVE science questions and data, proposed projects are not limited to data collected during previous or ongoing ABoVE research. Proposers are encouraged to make productive use of other data sources, such as but not limited to, the NSF-sponsored USArray (weather station or borehole temperatures), DOE NGEE-Arctic, European Space Agency's GlobPermafrost, Permafrost Carbon Network, International Soil Carbon Network, Northern Circumpolar Soil Carbon Database, Study of Environmental Arctic Change (SEARCH), Arctic System Reanalysis, the Polar Geospatial Center, National Ecological Observatory Network (NEON), Long-Term Ecological Research (LTER) Network, and AmeriFlux/FLUXNET sites.

Research may include integration and synthesis of results from multiple studies conducted during ABoVE or elsewhere, and then applied to the ABoVE region. Other potential data sources include socio-economic and environmental databases (including those based on local and traditional knowledge) compiled by government and non-government organizations (e.g., ACEP Tables B2 to B4).

4.5 ABoVE Science Lead(s)

NASA requests proposals for one or two ABoVE Science Lead(s) (ASL), with a term to begin in October 2019. Investigators offering an ABoVE research investigation and desiring to be considered for the ASL position must indicate their candidacy by answering the relevant cover sheet question and including a separate ASL section within their proposal (Section 5.4.8).

The ASL is responsible for providing scientific leadership and direction for ABoVE, providing scientific inputs regarding ABoVE priorities and activities to NASA management, compiling and synthesizing scientific results, and communicating about ABoVE to a wide variety of scientific, governmental, and public audiences. The ASL, in close coordination with the ABoVE Science Team, CCEO, ABoVE program management at NASA HQ, and ABoVE partner organizations, is responsible for writing and maintaining the ABoVE Implementation Plan detailing the research activities to be conducted and specifying roles and responsibilities for investigators involved in those specific activities during the execution of ABoVE. S/he is responsible for organizing ABoVE ST meetings and related activities in coordination with NASA HQ managers and CCEO staff. S/he should expect to meet with NASA HQ and CCEO management on a regular basis to review progress, resolve problems, and discuss next steps for implementation.

ASL proposers should indicate their ability and willingness to serve in this role for the remainder of ABoVE (estimated as 4 to 5 years beginning in October 2019), but recognize that their performance in this role will be reviewed periodically and is subject to change – through mutual agreement, as a result of inadequate performance, or because of change in NASA programmatic priorities. The initial ASL period of performance is four years beginning in October 2019. NASA estimates the time commitment necessary to perform as ASL to be between 0.25 and 0.5 FTE, but recognizes the time commitment may vary over the period of performance and/or based on the particular candidate. NASA is seeking candidates with expertise in terrestrial ecology, remote sensing, ecological modeling, and/or large field and airborne campaign management.

Budget Justification. Candidate proposals must include a detailed budget for only ASL activities, as well as a narrative and justification for ASL work separate from those for research activities, in the Budget Justification: Narrative and Details section. NASA wishes to track the ASL budget separately; therefore, budget associated with the ASL should be listed on Line 9 in Section F Other Direct Costs in the budget information provided on the NSPIRES proposal cover page.

NASA reserves the option to select an ASL through an alternative process (e.g., from among the Science Team members).

5. Required Proposal Elements

Proposals submitted in response to this program element shall respond to all requirements in Sections 5.1, 5.2, and 5.3. The standard ROSES Scientific/Technical/Management section is superseded by a structure that includes a Scientific/Technical section and the seven Management-related sections described in Section 5.4. Proposals responding to the call for ABoVE Science Lead (Section 4.5) require an additional section, as described in Section 5.4.8.

5.1 Requirement to Address Errors and Uncertainties

All proposals submitted in response to this program element shall include (1) a discussion in the Scientific/Technical section describing how the team will address errors and uncertainties, and (2) a description in the Data Management Plan (Section 5.4.4) describing how uncertainties will be reported with the data and products to be shared and archived. Investigations are expected to characterize uncertainties and quantify errors associated with data, analytical approaches, model results, and scientific interpretations.

5.2 Requirement to Attend Meetings and Workshops

ABoVE Science Team Meeting. NASA expects at least one representative from each selected investigation to attend each ABoVE Science Team (ST) meeting (normally one per year) to promote coordination of research activities and timely exchange of findings. Co-Investigators, Collaborators, and students are welcome to participate in all meetings, as space permits. Support for travel must be included in the proposal budget and the PI may determine who attends.

ABoVE Phase 2 Proposal Outline for Scientific, Technical & Management Sections **Corrected June 26, 2018. New text is in bold**	
Section	Notes
Scientific/Technical	Not to exceed 15 pages
ABoVE Science Lead Plan (optional)	Not to exceed 5 pages
References and Citations	No page limit
Progress of Previous ABoVE Projects (depending on circumstances)	Up to 1 to 2 pages per previous ABoVE project likely to be adequate
Project Management Plan	No page limit; ~2 pages likely to be adequate
Resource Needs and Utilization Plan	No page limit; ~1-3 pages likely to be adequate
Data Management Plan	No page limit; ~2 pages likely to be adequate
Training and Communications Plan	No page limit; ~0.5 page likely to be adequate
Stakeholder Engagement and Interactions Plan	No page limit; ~0.5-1 page likely to be adequate
Statement: Science Team Member Commitment	No page limit; ~0.5-1 page likely to be adequate
Biographical sketches	**2 pages for the PI, 1 page for each Co-I**
Table of Personnel and Work Effort	**No page limit. See example in Section IV(b)iii on page 17 of the ROSES Summary of Solicitation**
Current and Pending Support	**No page limit**
Letters of Commitment from Collaborating Institutions	No page limit
Detailed Budget and Budget Justification:	No page limit

ABoVE Science Team Workshop. Proposers must budget for one three-day ABoVE Science Team meeting per year for all three funded years and for travel to one additional workshop per year. Proposers should assume a mix of ABoVE Science Team Meeting locations, to include Alaska and the conterminous United States. Workshop activity is intended to support specialized ABoVE Science Team coordination activities and/or for subgroups to meet (purposes and locations to be determined at a later date by the ABoVE Science Team).

5.3 Requirement to Attend NASA Terrestrial Ecology Science Team Meeting

NASA's Terrestrial Ecology Program Meeting. The TE Program and Carbon Cycle and Ecosystems Focus Area periodically convene meetings for all funded investigators. The next TE Science Team meeting is planned for autumn 2019. Proposers must budget to participate in one three-day meeting per proposal period for at least one investigator.

5.4 Required Plans and Statements

All proposals shall include the seven management-related plans detailed in Sections 5.4.1 to 5.4.7, which must be presented as separate sections of the proposal, to follow References and Citations. Proposals lacking any or all of these required plans will not be considered for selection and will be returned without review. These seven plans are in addition to the Scientific/Technical section and are not included in its 15-page limit. Concise, informative plans are strongly encouraged.

5.4.1 *Progress of Previous ABoVE Projects*

For teams with one or more investigators (but not collaborators) who have previously participated in ABoVE research, proposals shall include a 1-2 page report (per previous ABoVE project) detailing past ABoVE activities, progress, and research results, including a list of peer-reviewed publications. If no proposal participant has previously been involved in ABoVE, include a brief statement to that effect.

5.4.2 *Project Management Plan*

Proposals shall include a Project Management Plan (PMP) 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. The Project Management Plan and does not have a page limit (in most cases, 2 pages is likely to be adequate).

5.4.2.1 *PMP: Roles and Responsibilities of all Investigators*

NASA requests a reasonable Science Team for all proposals (i.e., every participant must play a significant role, beyond merely providing access to data).

The PMP must present a management structure describing roles and responsibilities for the Principal Investigator and all Co-Investigators and Collaborators, as well as how research activities will be coordinated and integrated. If students and postdoctoral scientists are involved, their roles should also be described. Consistent with this section, the Budget Justification: Narrative and Details section and proposal cover page must include budget information for all personnel funded through the proposal.

5.4.2.2 *PMP: Summary of Institutional Collaboration(s)*

To facilitate proposal analysis by NASA, proposers must briefly summarize the number and nature of all institutional collaborations integrated within their proposed research investigation. The relationship(s) with the collaborating institution(s) and the terms and conditions of their participation should be clearly described. This section should include a summary of any resources provided by these collaborating institutions (i.e., cost-sharing; in-kind resources, such as access to research infrastructure or equipment, personnel time, data or data products; and/or matching funding). In support of this summary information, letters of commitment from each collaborating institution documenting their role in and specific contributions to the investigation should be included as described at the beginning of Section 5. The generic statement of commitment provided in Section 3.17 of the *NASA Guidebook for Proposers* does not provide an acceptable level of detail for this program element and should not be utilized. Letters of commitment for collaborations are in addition to individual team member commitment notices completed via NSPIRES.

The Summary of Institutional Collaboration(s) element is required for all proposals. Although collaborations of all types are encouraged and are viewed favorably, collaborations are not required. An acceptable Summary of Institutional Collaboration(s) may simply state: "No institutional collaborations are proposed."

5.4.2.3 *PMP: Safety and Risk Management*

For investigations involving field operations, the PMP should address risk management under applicable institutional, state, and national requirements, with respect to ensuring team participants are aware of hazards related to airborne and/or field work and have or plan to acquire the equipment and training to mitigate against those hazards. Proposers may assume the CCEO will assist with this process through Web-based hazard analysis and will work with each team to identify appropriate training. The CCEO will provide basic safety orientations, site-specific safety plans for multiuse areas, and a variety of basic training for general hazards, wildlife safety, boat operation, and use of off-road vehicles. While NASA intends to assist with risk management, safety planning, and training, proposers are advised that it is the legal responsibility of the investigators and their home institutions to address the health and safety needs of their employees and students. Specialized safety training needs may not be provided by the CCEO, so it is important for proposers to identify such needs and include them in the planned budget.

5.4.3. *Resource Needs and Utilization Plan*

Proposals shall include a Resource Needs and Utilization Plan that describes the research infrastructure and logistical support needed for the investigation. The CCEO provides some logistical support to the ABoVE ST and will work to efficiently arrange for field infrastructure and seek economies of scale to minimize costs and maximize utilization. The CCEO will provide special support for individual investigations when it is more efficient and cost effective. Selected scientists should expect a dialog with the CCEO, the ABoVE Science Leads, and NASA HQ to ensure their infrastructure and logistical needs are adequately met in a cost-effective manner – either through the CCEO or through their funding award.

Requirements for *in situ* observations, logistical support, NASA computer use, etc., must be detailed. Describe all special support likely to be unique to the proposed investigation. Proposers are urged to delineate such needs specifically in the Budget Justification: Narrative and Details section, item by item if possible. Proposers should clearly state what support exists within their funded investigation and what they expect the CCEO or other investigators to provide. CCEO support is limited and proposers should not make unreasonable assumptions about the level of available resources.

Clearly detail all ABoVE Science Cloud (ASC) use in this section, including for analysis and collaborative sharing of data and results. Although ASC use for data analysis and modeling is not required, proposers are encouraged to request use of the ASC when existing computational resources are not available. NASA will not view favorably requests to purchase new computational equipment or time on other systems without a compelling rationale why the ASC would be unsuitable to meeting the needs of the proposed investigation.

Consistent with the Resource Needs and Utilization Plan, costs for all logistical and infrastructural support items must be included in the budget. However, proposers are advised that some or all of these costs may be pulled out post-selection and funded directly through the CCEO. If difficulties arise in estimating costs for requested logistical and infrastructural support, proposers should describe their needs in sufficient detail

that CCEO staff can evaluate the requirement. Questions regarding planned CCEO support may be directed to Dr. Peter Griffith (Section 3.1.1).

The Resource Needs and Utilization Plan should be included in the proposal after the Project Management Plan and does not have a page limit (in most cases, 1-3 pages is likely to be adequate).

5.4.4. *Data Management Plan*

Proposal PDFs shall include a Data Management Plan that addresses dissemination and sharing research results and compliance with NASA Earth Science data policy (http://science.nasa.gov/earth-science/earth-science-data/data-information-policy/). The Data Management Plan will be evaluated as part of Intrinsic Merit (Section 6.3).

The Data Management Plan must include, when relevant to the type of study being proposed, existing data and data products or other materials to be utilized or produced in the course of the project, standards to be used for data and metadata formats, and plans for providing access to and archiving the data and other research products consistent with ABoVE data policies and management practices. Any use of proprietary or sensitive information requiring protection or constraints on redistribution should be identified, and plans/processes for sharing research findings or derived products and for others to secure access to the data should be described.

The Data Management Plan must describe how errors and uncertainties will be reported with the data and products to be shared and archived.

An outline describing in greater detail the desired content for all ABoVE Data Management Plans is provided at http://above.nasa.gov/2018_NRA/data_management_plan.html. Additional information about data management is available at http://daac.ornl.gov/PI/pi_info.shtml.

All ABoVE researchers are strongly encouraged to use the ASC for data and product sharing. The system has been designed to facilitate early availability of data and to make the transition to a long-term archive less burdensome for the investigator.

NASA intends the Data Management Plan to become a living document; successful proposers will be requested to update their Data Management Plan annually, including status of and schedule for dataset production, sharing, and archive. Consistent with the Data Management Plan, costs for all data management activities, including quality assessment, documentation, data and product sharing, and preparation for long-term archive, must be included in the budget. The Data Management Plan section does not have a page limit (in most cases, two pages is likely to be adequate).

5.4.5. *Training and Communications Plan*

Proposals shall include a Training and Communications Plan that details any training and knowledge transfer undertaken as part of the proposed investigation. The proposal should include an acknowledgment that the investigators are willing to provide input to ABoVE management for centralized public communications efforts and will make their best effort to participate. If some dissemination activities are best addressed by individual investigators, a description and budget for these activities should be included in the proposal. Activities that provide training opportunities to people from indigenous

populations are encouraged. Graduate students from Canada or other countries who are enrolled at US institutions may be supported by project funds. Travel support, including per diem for scientific exchanges (e.g., internships) between US and Canadian institutions, is also permitted if scientifically justified.

Opportunities for capacity building and public outreach abound across the ABoVE Study Domain, including communications activities necessary to inform and fully engage important stakeholders at all project stages. In addition to participating in meetings or public presentations, researchers should also expect to meet with members of the local print and broadcast media. Proposers can assume the CCEO will be available to coordinate these activities.

The Training and Communications Plan does not have a page limit (in most cases, one-half page or less is likely to be adequate). The Training and Communications Plan will be evaluated as part of Intrinsic Merit (Section 6.3).

5.4.6. *Stakeholder Engagement and Interactions Plan*

As is essential in all airborne and field campaigns, ABoVE investigators will need to develop courteous, open, and constructive relationships with the people within the study area, as well as with other relevant stakeholder groups and organizations. These interactions will require full and open communications, sustained attention, and appropriate acknowledgment – and should begin early in the planning of the research activity. In some cases, these interactions may need to be coordinated with those of groups with existing activities in the same area.

Proposals shall include a Stakeholder Engagement and Interactions Plan that simply describes how researchers plan to interact with and/or develop partnerships with stakeholders pertinent to their investigation. Stakeholders may include the indigenous/aboriginal peoples on or above whose land the research will take place, as well as others with land ownership/usage rights; local communities; local, regional, and national government organizations; and partner organizations with specific decision support needs. Information sessions at or nearby to airports where aircraft are located should be considered.

Proposers can assume the CCEO will be responsible for organizing and coordinating many of these stakeholder interactions so contacts are efficient and respectful of stakeholder time and interests and that the purpose and intent of ABoVE research and its activities are clearly, accurately, and consistently communicated. ABoVE investigators may engage in direct communications with stakeholders, keeping the CCEO informed.

The Stakeholder Engagement and Interactions Plan does not have a page limit (in most cases, one-half to one page is likely to be adequate). The Stakeholder Engagement and Interactions Plan will be evaluated as part of Intrinsic Merit (Section 6.3).

5.4.7. *Statement of Science Team Member Commitment*

In addition to the online confirmation of participation that is built into NSPIRES, proposals shall include a brief Statement of Science Team Member Commitment by the PI on behalf of all the proposal’s investigators describing the proposing team’s understanding of and qualifications for the role(s) they will play as members of the

ABoVE ST. Many ABoVE ST member commitments are covered within the required plans (Sections 5.4.1-5.4.6) and do not need to be repeated in this statement. This statement should be a clear declaration of the team's commitment to becoming active, productive, and constructive members of the ABoVE ST and include a description of any unique contributions specific to the proposing team. Documentation and/or descriptions of past performance on relevant science teams or similar group activities should be presented in this section.

The Statement of Team Member Commitment section must be inserted after the Stakeholder Engagement and Interactions Plan section of the proposal and does not have a page limit (in most cases, 0.5 to one page is likely to be adequate).

5.4.8 *ABoVE Science Lead Plan (optional; required only if proposing for this position)*

Proposals requesting consideration for the ABoVE Science Lead (ASL) position must include a separate ABoVE Science Lead Plan that addresses aspects of ABoVE science leadership, including, but not limited to, the proposer's:

- Scientific knowledge of and research experience in Arctic-boreal ecosystems (social-ecological systems),
- Management experience and scientific leadership skills, including ability to find solutions to problems and work constructively with others to resolve issues,
- Time for and priority commitment to the role as ASL, if selected,
- Clear vision for ABoVE and its contribution to science and society,
- Ability to represent ABoVE's overall goals and objectives to the broader scientific community, constructively interact with a wide variety of stakeholders, and understand the need for scientific information and data products that could be provided through ABoVE research, compile, synthesize and communicate ABoVE's scientific results for a wide range of audiences,
- Management plan, including approach to ABoVE leadership and interactions with the ST and ABoVE management (i.e., CCEO, NASA HQ, partner organizations), and plan for organizing and conducting ABoVE ST business and meetings.

The ABoVE Science Lead Plan may not exceed five pages. This five-page allotment is in addition to the 15 pages allocated to the Scientific/Technical section. The proposer must also answer the relevant proposal cover sheet question indicating his or her wish to be considered for the ASL position and include a detailed budget and narrative broken out by proposed ASL activities (Section 4.4) in the Budget Justification: Narrative and Details section.

6. Programmatic Information

6.1 Eligibility

This program element is open to all categories of institutions. Proposals from non-US organizations may propose to participate on a no-exchange-of-funds basis (following guidelines in the NASA *Guidebook for Proposers* Section 3.2). Collaborations between researchers at US and non-US organizations are welcome, but the portion of work to be conducted by the non-US institution must be funded through other sources to comply with NASA's no-exchange-of-funds policy.

6.2 Available Funds, Budget Profiles, and Periods of Performance

Funding available for this program element is ~$4.25M/year for a three-year period from 2019 to 2022. This does not include funding to support CCEO activities.

6.3 Proposal Evaluation Criteria

Proposals are evaluated according to the criteria in *ROSES Summary of Solicitation* Section VI (a). In addition to those factors, determining a proposal's Intrinsic Merit shall include the:

- Quality and completeness of the required plans (Progress of Previous ABoVE Projects – if applicable, Project Management Plan, Resource Needs and Utilization Plan, Data Management Plan, Training and Communications Plan, Stakeholder Engagement and Interactions Plan), and
- Proposer's ability to serve as a productive ABoVE ST member, as demonstrated in the proposal, Statement of Science Team Member Commitment, and list of other relevant projects.

In addition to responsiveness to the goals, objectives, and requirements described in this program element, a proposal's relevance should take into account the:

- Degree to which the investigation will contribute to an understanding of regional-scale responses of social-ecological systems to environmental change, taking into account vulnerability and resilience and the complex interactions within the Arctic-boreal system and its tightly coupled nature, and
- Quality and desirability of any collaborations with potential partner organizations, including the reasonableness and desirability of any cost-sharing arrangements (while appropriate collaborations are viewed favorably, a lack of collaborations is not viewed unfavorably).

NASA requests a reasonable Science Team size for all proposals; every proposed Science Team member must play a significant role, beyond merely providing access to data.

7. Summary of Key Information

Expected Program Budget	~$4.25M/year for three years (spanning 2019-2022)
Expected Number of Awards	16 to 20 (including one or two SIF studies) Assumes adequate proposals of merit
Maximum Duration of Awards	3 years
Due Date for Notice of Intent	See Tables 2 and 3 of this ROSES NRA.
Due Date for Proposal	See Tables 2 and 3 of this ROSES NRA.
Investigation Start Date	Approximately four to five months after proposal due date
Science/Technical Section Page Limit	15 pages. Management section requirements provided in Sections 5.4.1-5.4.8 (additional pages permitted to fulfill the Management section requirements). 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*.
Detailed Instructions for Proposal Preparation and Submission	Please see *ROSES Summary of Solicitatio*n 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 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	NNH18ZDA001N-TE
NASA Point of Contact	Hank Margolis Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 (202) 358-4760 hank.a.margolis@nasa.gov

A.5 CARBON CYCLE SCIENCE

NOTICE: The carbon cycle science program will not solicit proposals in ROSES-2018. All funds currently available for a dedicated carbon cycle science opportunity are committed to the support of awards selected through the 2016 carbon cycle science solicitation. The agency's timeline for competition of carbon cycle science funds is ROSES-2020. NASA expects to continue to solicit some carbon cycle research through its core research and analysis programs, in particular, the Terrestrial Ecology, Ocean Biology and Biogeochemistry, Land Cover and Land Use Change, and Atmospheric Composition programs. Interested researchers are encouraged to consult these other program elements for potential funding opportunities.

NASA's carbon cycle science research opportunity is offered every three years and usually in partnership with one or more U.S. government agencies, most recently with the U.S. Department of Agriculture (USDA) National Institute of Food and Agriculture (NIFA), the U.S. Department of Energy (DOE) Terrestrial Ecosystem Sciences Program, and the Ocean Acidification Program within NOAA. Proposals were sought to improve understanding of changes in the distribution and cycling of carbon among the active land, ocean, and atmospheric reservoirs and how that understanding can be used to establish a scientific foundation for societal responses to global environmental change.

The goals of the NASA Earth Science Program 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 storage in response to fossil fuel combustion, land use and land cover change, and other human activities and natural processes. NASA carbon cycle research encompasses multiple temporal and spatial scales and addresses atmospheric, terrestrial, and aquatic carbon reservoirs, their coupling within the global carbon cycle, and interactions with climate and other aspects of the Earth system. A focus on observations from space guides carbon cycle research by NASA and is a foundation for partnerships with other U.S. Government agencies and institutions. NASA carbon cycle research contributes toward the goals of major US 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 Climate Change Program (OCCC) (http://www.globalchange.gov/, https://www.carboncyclescience.us/, http://www.nacarbon.org/nacp/, and the Ocean Carbon and Biogeochemistry Program (OCB) https://www.us-ocb.org). NASA carbon cycle research also contributes toward the goals of the federal oceans related planning.

For further information on this program, contact:

Paula Bontempi
Earth Science Division
Science Mission Directorate
NASA Headquarters

Washington, DC 20546-0001
Telephone: (202) 358-1508
Email: Paula.Bontempi@nasa.gov

A.6 BIODIVERSITY

NOTICE: The Biodiversity program element will not be competed ROSES 2018. See A.8 Sustaining Living Systems in a Time of Climate Variability and Change for a related effort.

1. Scope of Program

Biodiversity is the variety of life on Earth at all levels of organization, from ecosystems to species to genes. It incorporates the compositional, structural, and functional aspects of life at these different levels. Biodiversity both enables and represents life's responses to the changing environments of our dynamic planet, while also serving as a driver of environmental change. Biodiversity encapsulates life's evolutionary history. In doing so, it provides humanity, indeed all life, with a tremendous resource of opportunities to survive and thrive in an uncertain future.

Recent efforts to track the status of biodiversity globally have consistently reported significant declines throughout its levels of organization. A growing scientific consensus posits that we are losing biodiversity at rates comparable to those seen in the major extinction events documented in the geologic record. Humanity's role in this decline and our concerns over the subsequent loss of the many benefits, goods, and services we derive from biodiversity demand efforts to understand the condition of biodiversity and its changes in space and time. In addition, there is a need to understand biodiversity because it drives changes in the wider Earth system. Thus, NASA seeks tools to understand the condition of biodiversity and how it is changing over time.

Biodiversity is often studied and addressed locally, especially with regard to the spatial scales at which we seek to understand the causes and consequences of change. To address biodiversity loss as a global issue requires integrating research efforts across multiple spatial and temporal scales and observing biodiversity at all of its levels of organization. Accomplishing this integration of dynamic biodiversity patterns and processes across multiple scales is easier said than done and continues to be one of the major challenges for all of the biological sciences.

The NASA Earth Science Division approaches biodiversity science from the standpoint of two of its key aspects: pattern and process. Using observations from satellites, airborne and seaborne platforms, and *in situ* efforts, NASA explores patterns of biodiversity extant upon the land and within the water. Our tools are ideally suited for detecting many of biodiversity's patterns, especially at the ecosystem level, but also at finer levels such as species. Biodiversity pattern often follows process. Thus, we also seek to understand the geophysical and ecological processes that result in the patterns of biodiversity our observations detect. Understanding these processes requires observations, with some of these observations at finer spatial scales than available from NASA satellites. It also requires models, essentially simplified representations of our knowledge of how certain systems work that in turn allow us to test the validity of this knowledge. Process-oriented research offers the additional benefit of connecting the Biodiversity program to the activities of other NASA Earth Science programs.

2. Programmatic Information

Questions or comments may be directed to the Biodiversity Program Manager using the information below:

Woody Turner
Earth Science Division
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546-0001
Telephone: (202) 358-1662
Email: woody.turner@nasa.gov

A.7 ECOSTRESS SCIENCE AND APPLICATIONS TEAM

NOTICE: Amended April 24, 2019. Because of an IT issue NSPIRES was not available to some organizations yesterday, which was to have been the due date for A.7 ECOSTRESS ST. To allow submission from those organizations that were unable to connect to NSPIRES yesterday, the response structure has been kept open and the cut off for proposal submission for this program element will be 11:59 pm eastern time today, April 24, 2019.

Amended February 12, 2019. Because important ECOSTRESS data sets were not available during the partial government shutdown, the proposal due date for this program element has been delayed to April 23, 2019. NOIs are still requested by February 27, 2019.

Amended January 31, 2019. The proposal due dates for this program element were previously temporarily changed to "TBD" as a result of the partial government shutdown. This amendment releases new due dates for the effected program elements in Appendix A. For this program element, Notices of Intent are now requested by February 27, 2019, and ~~the due date for proposals is now March 29, 2019~~.

Amended on December 18, 2018. This amendment releases final text for this program element, which was previously TBD. ~~NOIs are requested by February 4, 2019, and proposals are due on March 19, 2019~~.

1. Scope of Program

NASA launched the ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS) instrument to the International Space Station (ISS) on June 29, 2018. This program element solicits proposals for membership on the ECOSTRESS Science and Applications Team. This team supports basic research and analysis activities as well as applications activities associated with the production, validation, and utilization of ECOSTRESS data products. Funding for research projects will come from the Research and Analysis Program of the NASA Earth Science Division while funding for applications projects will come from the Applied Sciences Program of the NASA Earth Science Division.

NASA selected the ECOSTRESS instrument through the Earth Venture Instrument-2 solicitation in July 2014. ECOSTRESS is a multispectral thermal radiometer acquiring coincident thermal infrared (TIR) emission measurements of the Earth's surface in five separate spectral bands, covering the 8 to 12.5 micron wavelength range. ECOSTRESS measures the brightness temperature of the Earth's surface at sensor with an accuracy of 1 Kelvin (K) and a precision of 0.3 K at 300 K. The mission acquires brightness temperatures at a ground sampling distance of approximately 40 m by 70 m over a continuous ground swath width of 360 km, from the 385 to 415 km ISS altitude range. The ISS precessing orbit (orbital inclination of 51.5 degrees) does not allow observations over high-latitude regions but does have the advantage of enabling measurements at different times of the diurnal cycle, with coverage of the contiguous

United States (CONUS) every few days depending on latitude. The planned ECOSTRESS mission lifetime is one year. Data collection plans include the entire CONUS, twelve 1,000 x1,000 km areas in key climate zones, and multiple Fluxnet sites.

The ECOSTRESS website at https://ecostress.jpl.nasa.gov provides additional information about the mission, including a map of ECOSTRESS data currently available through https://ecostress.jpl.nasa.gov/gmap/. To gain access to these data through the ECOSTRESS Early Adopters program, please go to https://ecostress.jpl.nasa.gov/applications/app_request and follow the steps requested.

A key ECOSTRESS measurement is evapotranspiration (ET), derived from the TIR brightness temperatures of plants. ET is a key climate and ecosystem variable, as it integrates life with the water, carbon, and energy cycles—incorporating elements of the sun, atmosphere, hydrosphere, and biosphere. ECOSTRESS's diurnal sampling captures the shape of the daily ET cycling as plants open and close their stomata over the course of a day.

ECOSTRESS addresses scientific and management-oriented questions about plant-water dynamics and how ecosystems respond to climate variability and change. The ECOSTRESS science objectives are to:

1. Identify critical thresholds of water use and water stress in key climate-sensitive biomes;
2. Detect the timing, location, and predictive factors leading to plant-water uptake decline and/or cessation over the diurnal cycle; and,
3. Measure agricultural water consumptive use over CONUS at spatiotemporal scales applicable to improve drought estimation accuracy.

Existing ECOSTRESS data products are:

Level 0	Raw Collected Telemetry
Level 1	Calibrated Geolocated Radiances
Level 2	Surface Temperature and Emissivity
Level 3	Evapotranspiration
Level 4	Water Use Efficiency and Evaporative Stress Index

The listed, existing data products are being produced through direct funding to the ECOSTRESS Principal Investigator team.

2. Science and Applications Team for the ECOSTRESS Mission

This program element seeks proposals for membership on the ECOSTRESS Science and Applications Team under the leadership of the ECOSTRESS Principal Investigator. Proposals should focus on utilization of ECOSTRESS Level 2 (Surface Temperature and Emissivity), Level 3 (Evapotranspiration), and/or Level 4 (Water Use Efficiency and Evaporative Stress Index) data products for basic research of importance to Earth system science and applications relevant to management activities. The program element is also open to production of new higher-level (Levels 3 and 4) data products.

NASA particularly encourages proposals in the following areas:

- Efforts that advance the three ECOSTRESS science objectives;

- Evaluation and improvement of existing ECOSTRESS data products;
- New research and innovative analyses using ECOSTRESS data products alone or in combination with data products from other sensors (e.g., those from NASA, other U.S. entities, or international providers) that advance the understanding of the climate system, the water cycle, the carbon cycle, ecosystems and their biodiversity, and/or extreme weather events;
- Applications of ECOSTRESS products alone or in combination with data products from other sensors (e.g., those from NASA, other U.S. entities, or international providers) for agriculture, water management, disaster response and mitigation, public health, managing ecosystems for conservation and more sustainable resource use, and the forecasting of weather and extreme events; and
- Enhanced validation strategies, techniques, and data products.

Please note that any proposers responding to this program element who are currently members of the funded ECOSTRESS Principal Investigator 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.

3. Applications Proposals

Applications proposals to develop products for agriculture, water management, disaster response and mitigation, public health, managing ecosystems for conservation and more sustainable resource use, and forecasting of weather and extreme events have additional requirements. Applications proposals must:

1. Identify and describe clearly at least one specific management need to be addressed through the use of ECOSTRESS data;
2. Identify the end user(s) associated with the management need(s);
3. Include an individual from an end-user organization as a team member on the proposal;
4. Explain how ECOSTRESS-derived products will be incorporated in the end-user's decision-making activity;
5. Outline plans - including a schedule - for the transition of these products to the end-user organization(s) for deployment and long-term sustained use by no later than the final project year, and include an end-of-project event to announce results in this regard; and,
6. Contain an assessment of the Applications Readiness Level (ARL) at the time of the proposal for any method, tool, or product to be developed through a proposed project, as well as an expected end point ARL at the conclusion of the project. For information about NASA ARLs, please see http://www.nasa.gov/sites/default/files/files/ExpandedARLDefinitions4813.pdf.

In addition, applications proposals should consider as Principal Investigator (PI) someone who is very familiar with the needs of end-user (i.e., decision-making) organizations.

4. Science and Applications Team Meeting

All proposers should budget for one two-day annual Science and Applications Team Meeting to be held on the West Coast of the U.S. each year (for costing purposes, assume the meeting will take place in the Los Angeles, CA area). In consultation with the Headquarters program scientist for ECOSTRESS, the ECOSTRESS Principal Investigator will be responsible for calling and organizing science team meetings and related activities.

5. Summary of Key Information

Expected annual program budget for each year of new awards	$1.1 M
Number of awards	~7 to 15
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	Assume 6 months after receipt of proposals.
Page limit for the central Science-Technical-Management section of proposal	15 pages; see also Table 1 of ROSES and *NASA Guidebook for Proposers*.
Relevance to NASA	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 *ROSES Summary of Solicitation* Order of Precedence and *NASA Guidebook for Proposers*.
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	NNH18ZDA001N-ESAT

Point of contact for 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 SUSTAINING LIVING SYSTEMS IN A TIME OF CLIMATE VARIABILITY AND CHANGE

1. Overview

In 2015, the United Nations adopted a resolution promulgating 17 Sustainable Development Goals (SDGs) as part of an agenda to end poverty and hunger, promote prosperity, and protect the planet from degradation. These goals are to be implemented through a series of global targets associated with each goal. Target implementation is to take place between now and 2030. Two SDGs focus on the conservation and sustainability of Earth's ecosystems and biodiversity. Goal 14 (given the short title of "Life Below Water") seeks to conserve and sustainably use the oceans, seas and marine resources. Goal 15 (short title "Life On Land") seeks to protect, restore, and promote the sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss. While the SDGs and targets apply globally, individual countries are to report on them and each country decides how best to address them through its national planning and strategies. Data for some targets are missing or incomplete so the UN resolution calls for strengthening data collection along with the capacity to use existing data. Furthermore, implementation of the SDGs and their targets will take place within the context of ongoing climate variability and change. A changing climate complicates implementation and raises a concomitant need for improved understanding of the impacts of climate variability and change on species and ecosystems, especially to support countries' and regional long-term planning.

Earth science research, Earth observations, climate models, and derived information have already played key roles in supporting sustainable development. These roles include: increasing understanding of physical and biological Earth system phenomena, monitoring development targets, tracking progress in meeting targets, and helping nations and other stakeholders make informed decisions and on-going adjustments that will contribute toward achieving sustainable development and the SDGs. Combined with demographic and statistical data, these Earth science information sources enable nations to: gain insights through investigations, analyze and model conditions, create maps and other visualizations, evaluate impacts across sectors and regions, monitor change over time in a consistent and standardized manner, assess alternatives to support planning and policy decisions, and formulate new research priorities.

Combining observations, such as climate and biological measurements, in climate and ecological models allows us to incorporate existing and new knowledge of connections between physical and biological components of the Earth system and detect how these connections drive ecosystem responses to change. Thus, doing so enables better understanding of causality. With such improved understanding, managers, policy analysts, businesses, government officials, and the general public can craft practical strategies for managing to the SDGs while also considering climate risks and the impacts of climate variability and change.

This solicitation seeks proposals supporting the implementation of selected targets under SDGs 14 and 15. Moreover, it calls for proposals to address these SDG targets

within the context of climate variability and change. Proposals may support the implementation of the selected targets in one of two ways.

Research proposals must propose research to advance the knowledge necessary to address a specific target(s) and/or report on an associated indicator or indicators listed below within the context of ongoing climate variability and change, e.g., by identifying a knowledge gap with regard to how climate variability and change may impact how a country or countries would address a certain target/indicator and proposing research to provide information to fill this gap.

Applications proposals must support the use and integration of Earth observations or models in a country's/countries' activities and processes to meet an SDG target(s) and/or report on an associated indicator or indicators, also within the context of ongoing climate variability and change. For example, applications proposals might propose development of a particular decision support tool, procedure, or process to enable managers to meet a target(s) and/or report on an indicator(s).

This program element aims to provide avenues for both types of proposals—furthering basic scientific knowledge or developing necessary tools and approaches—in order to enhance the state of understanding necessary to implement a target or to assemble practical applications to allow managers and the broader public to meet a target. Please note that all proposals must seek to meet the needs of a particular country or countries based on how the country (or countries) intends to respond to a target(s).

All proposals must use satellite remote sensing to address a SDG 14 or 15 target(s) and/or report on an associated indicator or indicators specifically listed below, in a manner that makes clear the implications of climate variability and change for addressing or managing to that target(s) and/or reporting on an associated indicator or indicators. For the purposes of this program element, "satellite remote sensing" includes: measurements (i.e., data and information products) from NASA on-orbit satellites; simulated measurements from planned NASA satellites; measurements from commercial, foreign, and other U.S. Government satellites (the use of other satellite products is welcome though proposals must include specific NASA satellite products in the overall mix of data products proposed); outputs and predictive capabilities from models associated NASA products; NASA algorithms; NASA visualizations; and other NASA geospatial products, including airborne products.

Two NASA Earth Science Division program elements are providing funding for this program element: the Biological Diversity program element of the Research and Analysis Program and the Ecological Forecasting program element of the Applied Sciences Program (please see Section 6 for background information on these two NASA program elements). Therefore, the program element is open to two types of proposals: (a) basic Research proposals funded through the Biological Diversity program element and (b) Applications proposals funded through the Ecological Forecasting program element. Both types must apply NASA satellite remote sensing products along with other observations and relevant models to support implementation of SDGs 14 and 15 within the context of climate variability and change.

2. SDG 14 and SDG 15 Targets

This program element only addresses the specific SDG 14 and 15 targets listed below. All proposals must identify the SDG and specific SDG target(s) being addressed from this list. Addressing targets not listed below is non-responsive to this program element. While this program element is focused on particular SDG 14 and 15 targets, the United Nations also has indicators for each of these targets. Therefore, proposals should account for an indicator(s) associated with a particular target addressed by the proposal. However, proposals may well suggest activities going beyond an associated indicator in order to fulfill broader objectives contained in a target, based upon how a country is (or countries are) approaching a target. It is imperative to approach both basic Research proposals and Applications proposals from the perspective of and in concert with one or more countries working to address selected SDG 14 or 15 targets and also to incorporate climate variability and change risks. More information about the SDGs, targets, and indicators is available at the following website: https://sustainabledevelopment.un.org/sdgs.

2.1 SDG 14 - Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Target 14.2

- By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans

Indicator 14.2.1

- Proportion of national exclusive economic zones managed using ecosystem-based approach

Target 14.4

- By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics

Indicator 14.4.1

- Proportion of fish stocks within biologically sustainable levels

Target 14.5

- By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information

Indicator 14.5.1

- Coverage of protected areas in relation to marine areas

Target 14.a

- Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries

Indicator 14.a.1

- Proportion of total research budget allocated to research in the field of marine technology

2.2 SDG 15 – Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Target 15.1

- By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements

Indicator 15.1.1

- Forest area as a proportion of total land area

Indicator 15.1.2

- Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type

Target 15.2

- By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally

Indicator 15.2.1

- Progress towards sustainable forest management

Target 15.5

- Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species

Indicator 15.5.1

- Red List Index

Target 15.7

- Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products

Indicator 15.7.1

- Proportion of traded wildlife that was poached or illicitly trafficked

Target 15.8

- By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species

Indicator 15.8.1

- Proportion of countries adopting relevant national legislation and adequately resourcing the prevention or control of invasive alien species

Target 15.9

- By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts

Indicator 15.9.1

- Progress towards national targets established in accordance with Aichi Biodiversity Target 2 of the Strategic Plan for Biodiversity 2011-2020

3. Scope

This program element seeks two types of proposals: Research proposals and Applications proposals. Proposal teams must identify which type is addressed by their proposed activities. Teams should focus on one type of proposal. Teams interested in proposing both types must submit a separate proposal for each type.

3.1 Type A: Research Proposals

Research proposals advance the fundamental scientific knowledge necessary to inform the target(s). Research proposals must respond to a specific target(s) above, while being mindful of associated indicators. They also must address issues and challenges affecting abilities to accomplish the target(s) within the context of climate variability and change risks. Research proposals advance the scientific basis for one or more country's responding to a particular target and associated indicator(s). They provide environmental context for the specific targets, focusing on the underlying natural and human-induced processes that affect environments and the communities within them. Today's research informs tomorrow's applications. Therefore, Research proposals must propose research to enable a country to address the listed targets and indicators within the context of ongoing climate variability and change.

Research proposals must include:

1. Time series of existing climate-relevant observations from satellite remote sensing (for example—but not limited to—temperature, precipitation, sea ice, snow cover, insolation, clouds, water vapor, aerosols, fires, floods, droughts, sea-level rise, etc.);
2. Time series of biological observations from *in situ* (i.e., ground-based or in-water) devices, airborne platforms, and/or satellite remote sensing; and
3. Ecological models (e.g., correlative or mechanistic distribution models, abundance models, spatially-explicit individual-based models, biogeographic models, dynamic global vegetation models, etc.).

Research proposals may wish to integrate the following:

1. Climate models or their outputs (e.g., through general circulation model downscaling, regional climate models, etc.); and
2. Biophysical data (e.g., soils, topography, geology, biogeochemistry) that may account for variations in response to climate variability within and among geographic areas.

3.2 Type B: Applications Proposals

Applications projects support the use and integration of Earth observations and ecological forecasting in countries' activities and processes to manage the targets and/or report on the indicators. Applications proposals must respond to a specific target(s) listed above, while being mindful of associated indicators. Proposals must also identify at least one specific management need/challenge directly associated with one or more country's meeting the selected target(s), and proposals must identify the role(s) for ecological forecasting methods, tools, or products in addressing these challenges. Proposals must also address climate risks and sustainable achievement of the target(s) within the context of climate variability.

Selected projects must conduct applied research and applications activities in conjunction with end users to develop, demonstrate and enable sustained uses of Earth observations to support the SDG 14 or 15 targets and indicators. Proposed projects must enhance a method(s), tool(s), or product(s) of an end-user organization(s) (i.e., a national or international institution) to support management of and track progress toward fulfillment of an SDG 14 or 15 target in the context of climate variability and risks. Projects must enable countries and international organizations to apply Earth observations and insights on climate variability and risks to support the implementation, planning, measuring, monitoring, and reporting on the SDG 14 and 15 target topics. The primary objective should be to enable sustained use of satellite remote sensing in measuring and reporting on the SDGs, tracking progress, supporting planning efforts, and informing policy and management decisions that contribute toward achieving the SDGs.

The work must be done in coordination and collaboration with the entities responsible for the management challenge and for reporting on the SDGs. Proposals must articulate plans to engage national statistical offices, line ministries, or other appropriate entities in the respective countries where the proposed work is focused or appropriate inter-governmental organizations. Selected projects should expect to inform and/or coordinate with the relevant Custodial Agencies for SDG 14 and 15. Proposal teams must engage such entities in the design and development of proposals and include them directly in the project work.

Applications proposals must identify the end user(s), clearly define their SDG target and indicator activities and processes, and articulate the need for the application (method, tool, or product) to be pursued to enhance the activities and processes. Proposals should provide statements from the end user(s) describing the problem to be addressed by the method, tool, or product to be developed by the project and how satellite remote sensing will be included in the end-user's decision-making activity.

The end-user organization(s) implementing the method, tool, or product must be included as a team member on all Applications proposals. Applications project teams should consider having the Principal Investigator (PI) be someone who is very familiar with the needs of the end-user(s) (i.e., decision-making) organization(s).

Furthermore, Applications proposals must outline plans—along with a schedule—for the transition of the tools or products to the end-user organization(s) for deployment and long-term sustained use.

The final project year for Applications projects must include transition activities and an end-of-project event to announce results.

Applications proposals must include:

1. Time series of existing climate-relevant observations (please see 3.1 above for examples) from satellite remote sensing;
2. Time series of biological observations from *in situ* (i.e., ground-based or in-water) devices, airborne platforms, and/or satellite remote sensing; and
3. Ecological models or their outputs (e.g., correlative or mechanistic distribution models, abundance models, spatially-explicit individual-based models, biogeographic models, dynamic global vegetation models, etc.).

Applications proposals may wish to integrate the following:

1. Climate models or their outputs (e.g., through general circulation model downscaling, regional climate models, etc.); and
2. Biophysical data (e.g., soils, topography, geology, biogeochemistry) that may account for variations in response to climate variability within and among geographic areas.

The Group on Earth Observations (GEO) has developed a seven-stage metric to track the maturation of SDG methods, tools, and products that use satellite remote sensing. It is the Method Useability Level (MUL) index. This index provides a scale for the expected advance of SDG methods, tools, and products from an initial idea through development and field testing to adoption and sustained use. Its purpose is to convey expectations for project and method development, assess progress over time, and diagnose problems as they occur. The MUL index reflects three main stages in method development. Generally, MULs 1-2 encompass conception and feasibility; MULs 3-5 address development, testing, and demonstration; and MULs 6-7 focus on deployment and adoption. NASA expects to use the MUL index to track the progress of applications projects arising from this program element. Thus, applications projects will report routinely using this index. Please see Appendix C in the draft *GEO Initiative 18: Earth Observations in Service of the 2030 Agenda for Sustainable Development* for more information about the MULs (https://www.earthobservations.org/documents/pb/me_201701/pb07_201701_4th_pb_gi_sdg_implementation_plan.pdf).

Applications proposals must contain an assessment of the MUL at the time of the proposal for any method, tool, or product to be developed through a proposed project.

4. General Requirements for all Proposals

All proposals must significantly incorporate satellite remote sensing as defined in the Overview section of this program element. As stated therein, the use of non-NASA satellite products is welcome but proposals must include specific NASA satellite products in the mix of data products proposed.

Proposals involving international participants should carefully read Section III(a) of the *ROSES Summary of Solicitation* and Appendix A of the *NASA Guidebook for Proposers* on "Proposals Involving Non-U.S. Organizations."

The program element allows and encourages private sector companies (and teams of companies) to submit proposals and/or be involved in project teams.

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).

Proposers are also invited to explore avenues for engaging the GEO Biodiversity Observation Network or GEO BON (http://geobon.org) and its components (especially the Essential Biodiversity Variables, BON in a Box approaches, and existing BONs—or possibly new BONs) in meeting SDG targets.

All proposals must indicate whether they are Research (Type A) or Applications (Type B) proposals on the proposal cover page in NSPIRES.

All selected project teams, whether Research or Applications, must plan on and budget for participation in annual NASA Biodiversity and Ecological Forecasting team meetings, which will bring together both Research and Applications project personnel.

The NASA Earth Science Division serves as a United States Chair of the GEO initiative Earth Observations for the Sustainable Development Goals, is involved with the Committee on Earth Observation Satellites (CEOS) ad hoc SDG team, and is involved with several elements in the GEO Work Programme that may relate to the SDG 14 and 15 targets in Section 2. Awardees will be expected to support overall U.S., NASA, CEOS, or GEO activities on the SDGs.

5. Cost Sharing: Changes to Section III(d) of the *ROSES 2018 Summary of Solicitation*

Cost sharing, contributions from proposing institutions, and external resource contributions to a venture are encouraged, though not required nor part of the evaluation criteria. NASA accepts explicit financial contributions and in-kind contributions during the course of the venture as cost sharing. Relevant past work, prior results, or previous support and accomplishments may be described, but NASA does not consider these as cost sharing or in-kind contributions for proposals to this program element. Ventures involving commercial organizations are encouraged to read Section D, §1274.204, "Costs and Payments" of the NASA grant and cooperative agreement manual.

6. Background Information on the NASA Biological Diversity and Ecological Forecasting Program Elements

Using the global vantage point of space, the NASA Earth Science Division furthers knowledge of how Earth functions and how it is changing. In particular, the Division advances understanding of the planet as an integrated system and develops and tests applications that deliver direct societal benefits.

The NASA Research and Analysis Program is the component of the Earth Science Division responsible for conducting and sponsoring research to advance scientific understanding of Earth as a system using NASA satellites and associated technologies. It funds basic research on biodiversity through its Biological Diversity program element.

Biological diversity or biodiversity is the variety of life on Earth at all levels of organization, from ecosystems to species to genes. It incorporates the compositional, structural, and functional aspects of life at these different levels. NASA approaches biodiversity science from the standpoint of two key aspects: pattern and process. Using observations from satellites, airborne and seaborne platforms, including both remote sensing and *in situ* efforts, NASA explores patterns of biodiversity on the land and within the water, and recently in the atmosphere. NASA's tools are well suited for detecting many biodiversity patterns, especially at the ecosystem level but also at the levels of species and even genes. For biodiversity, we seek to understand the geophysical, biogeochemical, and ecological processes that result in the patterns of biodiversity detected by NASA remote sensing. Understanding these processes often requires complementary observations at finer spatial scales than those available from NASA satellites. It also requires models, simplified representations of our knowledge of how certain systems work that in turn allow us to test the validity of this knowledge.

The Earth Science Division Applied Sciences Program promotes efforts to discover and demonstrate innovative, practical, and beneficial uses of NASA satellite remote sensing. It supports applied science projects to enable uses of remote sensing that inform organizations' decisions and resulting actions, identify and enhance societal benefits, and develop key capabilities in the Earth science community and broader workforce. The projects are carried out in partnership with private- and public-sector organizations to achieve measureable and sustained uses of and benefits from NASA satellite remote sensing. The Applied Sciences Program funds applications related to the conservation and sustainable use of natural systems through its Ecological Forecasting program element.

The NASA Ecological Forecasting program element fosters the use of satellite remote sensing and related models to analyze and forecast changes that affect ecosystems and develop effective resource management strategies. Primary user communities are natural resource managers (both land and marine) and those involved in conservation and ecosystem restoration. This program element operates through the development, improvement, and application of predictive tools, with associated uncertainties, that enable effective decision support strategies for managers. It applies current scientific understanding and modeling capabilities about how ecosystems and their components (e.g., species, genes) are changing to support management strategies and practices.

7. Award Information

Maximum Period of Performance	36 months
Expected Project Start Date	~4 months after the proposal due date
Total Amount of NASA Funding (FY18-20)	$12M = ~$4M per year ~$2M per year for Research proposals ~$2M per year for Applications proposals
Anticipated Number of Awards	14 to 28 Assumes 7 to 14 Research projects and 7 to 14 Applications projects
Expected Annual Funding Level of Awards	$140,000 to $285,000 per year
Contributions from Other Organizations	See Section 5 Note: Contributed funding is in addition to NASA funding; it does not count toward funding level guidelines.

NASA periodically assesses the record of financial billing and uncosted carryover and may adjust the timing of funding renewals based on the history of costing. Renewals are also based on other factors, including progress and achievement of milestones.

NASA may use one or separate peer review panels for the Research and Applications type proposals. NASA will assign proposals to a panel based on the type specified by the proposing team and NASA's assessment of the proposal content. While NASA is soliciting proposals for each element, NASA reserves the right to select proposals in none, one, or both elements depending on the nature and distribution of proposals received and the outcome of the peer review process. NASA will notify all proposers of the outcome of the evaluation process.

8. Summary of Key Information

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	~4 months after the proposal due date
Page limit for the central Science-Technical-Management section of proposal	15 pp
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*.
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.
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	NNH18ZDA001N-SLSCVC
Point of contact	Woody Turner Biological Diversity Program Scientist Ecological Forecasting Program Manager Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1662 Email: woody.turner@nasa.gov

A.9 PHYSICAL OCEANOGRAPHY

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 general ocean 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 intends to contribute significantly to the World Climate Research Program's Climate Variability and Predictability (CLIVAR) Program (http://www.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). Proposals focused on one of these variables are better submitted to those competitions. In this program element, NASA is looking for work that cuts across multiple variables and focuses on the ocean's role in climate.

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. Compelling proposals that address the physical oceanographic characteristics of coastal seas in a global context are, therefore, welcome. 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). Tailoring such proposals to support the objectives and priorities the U.S. CLIVAR Program is encouraged. NASA recommends that proposals focused on a single variable (e.g., sea level, ocean vector winds, salinity) that is already supported by a dedicated science team be submitted to those science team elements in ROSES.
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.

2. 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. 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 scale. Modeling of the Earth system, including physical oceanography aspects, is ably covered but not annually by NASA's Modeling, Analysis and Prediction Program (the most recent active solicitation was as program element A.15 of ROSES-2017) 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. Proposals outside these research themes may be considered but must be highly meritorious.

3. 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 1, 2019
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 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*.
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	NNH18ZDA001N-PO
NASA point of contact concerning this program	Eric Lindstrom Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-4540 Email: eric.j.lindstrom@nasa.gov

A.10 OCEAN SALINITY FIELD CAMPAIGN – SPURS-2 PROCESSING AND SYNTHESIS

1. Objective

The objective of this program element is to complete data processing collected during the salinity field campaign, known as the second Salinity Processes in the Upper-Ocean Regional Study (SPURS-2). This program element is open to individuals who were directly involved in data collection during the 2016-2017 SPURS-2 field work and seeks proposals supporting the validation, processing, synthesis, and archiving the data they collected. Other investigators not involved in the acquisition of data during SPURS-2 looking to submit proposals related to scientific analysis and exploitation of SPURS-2 data should respond to Ocean Salinity Science Team (OSST) in ROSES-2018 solicitation (see research topic 4 in A.11 program element). Investigations selected under both announcements will be incorporated into OSST meetings and activities.

2. Background Information

As articulated in the report of the U.S. Climate Variability and Predictability Research (CLIVAR) Salinity Working Group (2007), no part of the climate system is as important to society as the global hydrological cycle; yet we lack key understanding of its major element, the ocean. Thus, it is of great importance to improve our abilities to monitor, understand, and model the water cycle over and within the oceans. As upper ocean salinity (UOS) is an important variable that indicates the intensity of water exchange between ocean and atmosphere and has direct impact on the ocean's mass distribution, mixing rates, and associated interior circulation, improved observation systems for salinity and better understanding of the processes that control it are needed for progress in understanding the oceanic water cycle.

A Salinity Processes in the Upper Ocean Regional Study (SPURS) workshop in December 2009 laid out the framework for a study of UOS in the subtropical North Atlantic in 2012-13 (completed) and a follow-on program (A.9 element of ROSES-2014 solicitation; SPURS-2). SPURS-2 complements the earlier studies by moving to a low salinity/high precipitation regime in the eastern tropical Pacific Ocean. SPURS-2, in concept, consisted of a set of nested experiments, with investigations sponsored by multiple U.S. agencies and with international contributions, designed to sample the characteristics of the salinity field on large scales (2000 km or larger) and scales associated with eddy variability (~200 km and smaller) during the 2016-17 observational period.

Research questions that were to be addressed in SPURS-2 are:

1. What are the physical processes responsible for the location, magnitude, and maintenance of the low surface salinity region in the eastern tropical Pacific Ocean?
2. How will the ocean respond to changes in thermal and freshwater forcing associated with a changing climate?
3. What is the nature of the cascade of salinity variance from the largest (climate) scales down to dissipation scales of a few millimeters?

4. What new information must be supplied to ocean models in order for these questions to be adequately examined?

To address these questions, an observational and modeling program was carried out throughout an annual cycle, beginning in August 2016 and completed in November 2017. The satellite salinity measurements from SMAP and SMOS missions, with footprint resolution of ~40 km, provide large-scale sea surface salinity (SSS) fields surrounding the study region during the time of the SPURS-2 campaign. In combination with surface currents derived from satellite sea surface height and vector wind data, the satellite SSS data were used to compute the advective terms in the salinity balance, as well as the large-scale temporal evolution of sea surface salinity.

In addition to the satellite capabilities, hardware elements of the field program include ship-based observations: underway data (sea surface temperature (SST), SSS, Chlorophyll-a and hull mounted Acoustic Doppler Current Profiler); shipboard Conductivity-Temperature-Depth (CTD) stations, surface flux measurements, microstructure profilers, and towed surface salinity measurements; profiling floats equipped with surface salinity sensors (some with wind speed and rainfall capability, some with microstructure sensors); surface drifters equipped with salinity sensors; gliders (some equipped with microstructure sensors); and one mooring heavily instrumented with upper ocean velocity, temperature, and salinity sensors, plus measurements of surface air-sea fluxes.

Proposals are sought with scope to complete processing and validation of the SPURS-2 data, documentation of the initial results in technical journals, and archive of a well-documented, complete SPURS-2 data set at NASA PODAAC available for research community. The result of the work done in response to this solicitation should be that the processed, validated, and archived data will be suitable for the initial analysis and synthesis of the thematic science areas, including scales (e.g., large scale/seasonal, mesoscale/weekly, small scale/diurnal) and/or processes (e.g., air-sea interaction, upper ocean stratification, mixing), etc.

3. Programmatic Information

Total funds available for work selected under this solicitation are approximately $1M over 18 months. It is expected that there will be a workshop to report and discuss the results of SPURS-2 approximately one year after the start of grants and that work under these grants will finish 18 months after the start date. A journal (*Oceanography*) special issue dedicated to SPURS-2 is planned for March 2019 to capture highlights of field program results.

4. Summary of Key Information

Expected program budget for first year of new awards	~ $650K
Number of new awards pending adequate proposals of merit	~ 4-6
Maximum duration of awards	18 months

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	September, 2018
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 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*.
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. 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	NNH18ZDA001N-OSFC
NASA point of contact concerning this program	Eric Lindstrom Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-4540 Email: eric.j.lindstrom@nasa.gov

A.11 OCEAN SALINITY SCIENCE TEAM

NOTICE: NASA does not intend to offer this program element in ROSES this year. This program is tentatively scheduled to next solicit proposals in ROSES 2019.

The NASA Ocean Salinity Science Team (OSST) supports basic research and analysis activities associated with production, improvement, and understanding of sea surface salinity data. The objective of this program element is to renew or select additional members for the OSST to support the salinity science within NASA's Physical Oceanography Program and contribute to NASA's Climate Variability and Change Focus Area and Global Water and Energy Cycle Focus Area.

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. The team assures that data made available are of the highest quality and validated for scientific exploitation. It also conducts ocean science investigations that are possible only through exploitation of remotely sensed sea surface salinity.

NASA point of contact concerning this program	Eric Lindstrom Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-4540 Email: eric.j.lindstrom@nasa.gov

A.12 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-2019.

This solicitation calls for proposals to improve the accuracy and spatial resolution of sea level change estimates and communicate these results in a simplified manner to the scientific community and general public. It serves to continue the work of the NASA Sea Level Change Team initiated in 2014 and continued in 2017. 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.

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A.13 OCEAN SURFACE TOPOGRAPHY SCIENCE TEAM

NOTICE: NASA does not intend to offer this program element in ROSES this year. The next expected solicitation for this element will be in ROSES-2020.

The joint NASA/National Oceanograpic and Atmospheric Administration (NOAA)/Centre National D'Etudes Spatiales (CNES) Ocean Surface Topography Science Team (OSTST) supports basic research and analysis activities associated with joint satellite altimetry missions (TOPEX/Poseidon (TP), Jason-1, Ocean Surface Topography Mission/Jason-2, and Jason-3) and other ocean altimetry data sets. The team is recompeted every four years.

The goals of the OSTST are to provide the scientific underpinning for production of the best possible satellite-derived altimetry data sets and to demonstrate the Earth science and applications arising from analyses of ocean surface topography data. The team is also involved in the calibration and validation of the cooperative altimetry mission between NASA, CNES, NOAA, and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) and the European Space Agency.

NASA point of contact concerning this program	Eric Lindstrom Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-4540 Email: eric.j.lindstrom@nasa.gov
NOAA point of contact concerning this program	Laury Miller NESDIS/STAR Laboratory for Satellite Altimetry NOAA Center for Weather & Climate Prediction E/RA3 5830 University Research Court College Park, Maryland 20740 Telephone: (301)683-3331 Email: laury.miller@noaa.gov

A.14 OCEAN VECTOR WINDS SCIENCE TEAM

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

1. Scope of Program

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. Every four years, this program element solicits scientific investigations that require the accurate and extensive vector wind and backscatter measurements provided by a range of NASA and international missions that provide such data. Notable NASA data sets for research analysis include:

- NASA launched the QuikSCAT satellite instrumented with the SeaWinds scatterometer on June 19, 1999. This instrument is a copy of the dual conically-scanning pencil beam Ku-band SeaWinds scatterometer that flew on JAXA's Midori-2 mission. QuikSCAT is no longer fully functional, but still collects Ku-band backscatter measurements to assist in calibration of other Ku-band scatterometers.
- NASA RapidScat mission (http://winds.jpl.nasa.gov/missions/RapidScat/), was installed on the International Space Station (ISS) in September 2014 and suffered a mission ending power anomaly in August 2016. RapidScat's unique non-Sun-synchronous sampling from the ISS can be used to characterize diurnal and subdiurnal wind variability.
- The Compact Ocean Wind Vector Radiometer (COWVR) is a new U.S. Air Force mission built by the NASA Jet Propulsion Laboratory (JPL) to provide ocean vector winds from a small satellite microwave radiometer system. COWVR is a fully polarimetric conically imaging radiometer operating at 18.7, 23.8 and 33.9 GHz with a full fore/aft viewing geometry providing observations at two azimuth angles for each point on the ground. It is designed to provide wind vector data over a 1200km swath, at 35km spatial resolution, with an uncertainty at least equivalent to data produced by the Naval Research Laboratory WindSat sensor. COWVR is planned to be launched in Calendar Year (CY) 2018. Investigators wishing to use the data will be able to acquire it from the Jet Propulsion Laboratory.

Extensive background on NASA's ocean vector winds science team and missions are available at http://winds.jpl.nasa.gov/.

2. NASA points of contact

NASA 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	Eric Lindstrom Telephone: (202) 358-4540 Email: eric.j.lindstrom@nasa.gov Nadya Vinogradova-Shiffer Telephone: (202) 717-1331 Email: nadya.vinogradova-shiffer@nasa.gov

A.15 MODELING, ANALYSIS, AND PREDICTION

NOTICE: The Modeling Analysis and Prediction (MAP) program will not be competed in ROSES 2018. The MAP program is tentatively scheduled to next solicit proposals in ROSES 2019.

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?

Within Earth Science Research, the Modeling, Analysis, and Prediction (MAP) program seeks to develop an understanding of the Earth as a complete, dynamic system. In order to accomplish this objective, the program funds the development of comprehensive, physically-based models of the Earth system, observation/model syntheses, and supporting research.

The modeling and data assimilation supported by the MAP program is observation-driven. That is, the direction of the modeling/assimilation work is guided by available and anticipated observations and its goal is to extract from the observations as much value as possible. 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 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. An overview of the current program may be found at http://map.nasa.gov/.

For more information about the MAP program, please contact:

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A.16 CRYOSPHERIC SCIENCE

NOTICE: NASA does not intend to solicit research proposals under the Cryospheric Science program element in ROSES-2018. This element is planned to be offered in ROSES-2019.

Appended below is the most recent version of the solicitation to provide a general context for the program. Specific details are likely to change when it is solicited again.

1. Background

NASA's Cryospheric Sciences Program supports remote sensing research on the Earth's polar ice sheets to understand their connections to the global system. Increases in ice loss from the glaciers of Antarctica, Greenland, and the Arctic are contributing to sea level rise, while similarly dramatic changes are occurring in sea ice of the Arctic and Southern Oceans. Characterizing these changes to understand the processes controlling them is required to improve our understanding of the Earth system and forecast the impacts of continued change.

The Earth's polar ice sheets cover continent-sized areas in the most inaccessible and inhospitable regions of the globe. NASA's capabilities in satellite and aircraft remote-sensing are critical tools for understanding the changes occurring there.

2 Scope of Program

This program element supports investigations that use remote sensing to study the land-based ice sheets of Antarctica, Greenland, and the Arctic, and the sea ice of the Arctic and Southern oceans. Supported studies are based on satellite and aircraft remote sensing observations to understand the factors controlling changes in the ice and its interaction with the ocean, atmosphere, solid Earth, and solar radiation.

The polar ice sheets represent one of the best time-integrated records of change in the Earth system that can be quantitatively characterized. New for this year, this program element seeks proposals that exploit the polar ice sheets as unique records of the global system that can improve understanding of poorly constrained aspects of the polar oceans and atmosphere. The program is open to proposals in any area, but proposers are reminded that their work must be founded upon remote sensing observations of the ice.

In addition, the program seeks to continue its longer-term goals to:

- Determine the mechanisms controlling sea-ice cover, such as quantification of the connections between sea ice and the ocean and atmosphere;
- Characterize sea ice properties—such as ice and snow thickness, roughness, melt ponds, and albedo—and physical processes—such as deformation and rifting—such that they can be incorporated into sea ice models;
- Use remote sensing products to validate and improve models of changes in sea-ice cover to elucidate connections to the global system;

- Determine the mechanisms controlling mass balance and dynamics of the Greenland and Antarctic ice sheets, including studies aimed at improving fundamental understanding of the connections to the ocean, sea-ice cover, and atmosphere;
- Characterize land ice properties—such as thickness, surface mass balance, englacial and surface water, layering, bed and grounding line properties, and albedo—and physical processes—such as flow, crevassing, ice shelf behavior, melt water fate, and calving—such that they can be incorporated into models;
- Use remote sensing data to validate and improve models of land-based ice and their contributions to sea-level change; and
- Study of polar and nonpolar mountain glaciers and small ice caps to understand systemic impacts of global change and contributions to sea-level rise.

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:

- *Understanding the Dynamic Response of Greenland's Marine Terminating Glaciers to Oceanic and Atmospheric Forcing* (2014) from U.S. CLIVAR, available at http://www.usclivar.org/sites/default/files/documents/2014/2013GRISOWorkshopReport_v2_0.pdf
- *Seasonal-to-Decadal Predictions of Arctic Sea Ice: Challenges and Strategies* (2012) from the National Research Council, available at http://www.nap.edu/catalog.php?record_id=13515
- *Future Science Opportunities in Antarctica and the Southern Ocean* (2011) from the National Research Council, available at http://dels.nas.edu/Report/Future-Science-Opportunities-Antarctica/13169
- *SEARCH 5-year Science Goals* from The Study of Environmental Arctic Change (SEARCH), available at http://www.arcus.org/search/goals
- *Climate and Cryosphere (CLiC)* of the World Climate Change Research Program, available at http://www.climate-cryosphere.org/
- *IARPC Research Plan* from the Interagency Arctic Policy Committee (IARPC), available at http://www.nsf.gov/od/opp/arctic/iarpc/start.jsp

Proposers are reminded that use of satellite and or airborne remote sensing is required. Data from any NASA or non-NASA satellite or aircraft mission is appropriate. Proposers are encouraged to consider the extensive data holdings of 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 those from NASA's ICESat (https://nsidc.org/data/icesat) and Operation IceBridge (OIB) (http://www.nasa.gov/mission_pages/icebridge/index.html). 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.
- Oceans Melting Greenland (OMG) mission portal (https://omg.jpl.nasa.gov/portal/). OMG is a new NASA *Earth Ventures Suborbital* mission collecting radar altimetry, gravity, bathymetry and other oceanographic data in and around Greenland.
- MEaSUREs Program (https://earthdata.nasa.gov/community/community-data-system-programs/measures-projects). MEaSUREs (Making Earth System Data Records for Use in Research Environments) supports the development of satellite radar records of land ice flow velocities and sea ice motion.

Finally, while this program element is open to the utilization of any form of remote sensing, proposers should note that NASA prioritizes unique contributions and has two other ROSES program elements that specifically support remote sensing research over the polar ice sheets using airborne and satellite altimetry, as follows:

A.17 IceBridge Research focusses on altimetry from the IceBridge Mission, and is competed this year; and

A.18 Studies with ICESat and CryoSat-2 focusses on satellite altimetry using ICESat and CryoSat-2, and was competed in 2016 with selected proposals posted in NSPIRES.

2.1 Arctic Studies

For Arctic sea ice, the program's focus is to characterize and understand sea ice processes and the observed changes—in extent, concentration, thickness, character, and dynamics—in the context of their couplings to the Earth system. Extensive remote sensing records of Arctic sea ice extent extend back to the 1970s. Understanding the feedback mechanisms associated with sea ice—and the atmosphere, ocean, land, and incident sunlight—is intended to improve models of the Arctic, and potentially support other projects linking high- and low-latitude climates. NASA's OIB mission has performed extensive studies of Arctic sea ice (https://nsidc.org/data/icebridge).

For Arctic land ice, characterizing the Greenland ice sheet and other northern hemisphere glaciers is essential to understanding and modeling their mass balance, dynamics, and contributions to sea level. The program's focus is to advance understanding of land-ice processes, especially connections among the warming ocean and increases in glacial flow rates; determining how the ice sheet interior is tapped by outlet glaciers; and determining the connections between glacial dynamics, bed characteristics, and melt water. The program also focuses on determining surface mass balance and the fate of surface melt to support overall ice sheet and Arctic glacier mass balance estimates. Some unique data resources available to support this work include the altimetry, radar, and other data collected by NASA's Operation IceBridge mission, as well as data available from ICESat, GRACE, and various international radar satellites.

Projects requiring Arctic fieldwork in Greenland, utilizing the National Science Foundation's (NSF's) Arctic Program resources, must obtain a cost estimate as

discussed in NSF's *Arctic Research Opportunities* solicitation located at https://www.nsf.gov.

2.2 Antarctic Studies

For the Southern Ocean and the Antarctic ice sheet, the program focuses on the dynamics and mass balance of the overall ice sheet, the potential instability of the West Antarctic ice sheet, the interaction of the warming ocean with ice shelves, characteristics and changes of the glacial grounding lines, subice-sheet hydrology, and changes in the extent of sea ice. There is also a need to assess the likelihood of rapid ice-sheet response to large changes in elevation and mass loss observed in some outlet glaciers and ice shelves – by ICESat, GRACE, Operation IceBridge, and radar satellites – and how changes in these outlet glaciers may affect the stability of the interior ice sheet.

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 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."

3. Summary of Key Information

Expected program budget for first year of new awards	~$1.5M
Number of new awards pending adequate proposals of merit	~10
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	Not solicited this year
Due date for proposals	Not solicited this year
Planning date for start of investigation	Not solicited this year
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 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*.
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	Not solicited this year
NASA point of contact concerning this program	Thomas Wagner Earth Science Division Science Mission Directorate National Aeronautics and Astronautics Administration NASA Headquarters Washington, DC 20546 Telephone: (202) 358-4682 Email: thomas.wagner@nasa.gov

A.17 ATMOSPHERIC COMPOSITION: UPPER ATMOSPHERE RESEARCH PROGRAM

NOTICE: The Upper Atmosphere Research Program (UARP) will not solicit proposals in ROSES-2018. All funds currently available for UARP are committed to the support of awards selected through the 2016 and 2017 UARP related solicitations. The next UARP related solicitation will be competed again in ROSES-2020.

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.

UARP solicitations concentrate on field observations which were selected for 4 years in ROSES-2016 (https://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={B554F971-2BDF-A8A0-A909-8CF7C07DB175}&path=closedPast) and laboratory research selected for 3 years in ROSES-2017 (https://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={F0BC4C45-C828-FA58-E900-414F71C81DB1}&path=closedPast). The next solicitation for each of these is expected in ROSES-2020.

For further information on this program, contact:

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A.18 ATMOSPHERIC COMPOSITION: RADIATION SCIENCES PROGRAM

NOTICE: The Radiation Sciences program will not solicit proposals in ROSES-2018. Funds currently available in Fiscal Year 2018 for the Radiation Sciences Program are committed to the support of awards selected from previous solicitations. The Radiation Sciences Program expects to solicit proposals for an airborne campaign data analysis in ROSES-2019 or ROSES-2020. Interested researchers are encouraged to consult other program elements for potential funding opportunities.

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.

For further information on this program, contact:

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A.19 ATMOSPHERIC COMPOSITION: MODELING AND ANALYSIS

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. Atmospheric Composition Modeling and Analysis Program Activities

2.1 Research Areas of Interest

The modeling and analysis effort addresses the following research issues:

- Tropospheric air quality and oxidation efficiency,
- Pollution sourced aerosols where they impact cloud properties,
- Stratospheric chemistry, including 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.

Proposals may employ a combination of satellite (e.g., but not limited to MLS, TES, OMI, MODIS, MISR, CALIPSO, CloudSat, Suomi-NPP, and SAGE III/ISS), suborbital (e.g., but not limited to DISCOVER-AQ, ATTREX, CARVE, AToM, ACT-America, ORACLES, and KORUS-AQ), and ground-based measurements (e.g., but not limited to ozonesondes, NDACC, AGAGE, AERONET, MPLNET, and TOLNet) for modeling constraints and verification where applicable. While the emphasis of these studies is on the use of NASA-provided assets, the combination of these data with non-NASA products is also encouraged.

Modeling tools can range from primarily conceptual to process-level to regional to fully global, three-dimensional atmospheric composition models. The Atmospheric Composition Modeling and Analysis Program (ACMAP) is focused primarily on data analysis, model utilization, and model evaluation, rather than model development. Proposals with a primary focus on model development and only a secondary focus on utilization and data analysis are not encouraged.

Proposals are encouraged in the following areas:

Area A. Research topics in the area of tropospheric air quality and oxidizing capacity of interest to the program include the effects of climate change on tropospheric air quality and air quality on climate. Studies of the attribution of changes in air quality and oxidizing capacity over the past 20 years are encouraged.

Additional topics of interest include upper tropospheric composition, the interaction between the regional and global scale atmosphere, boundary layer processes, convection and long-range transport, and exchange between the stratosphere and troposphere. Studies of the changes in chemically and radiatively active trace gases in the upper troposphere on climate will also be considered.

Area B. Studies of aerosol characteristics with respect to their impacts on tropospheric chemical processes are encouraged. In addition, studies that deal with the effects of

clouds on atmospheric chemical processes, either by changing the radiative properties of the atmosphere or by providing a place for aqueous chemical reactions to occur, will be considered.

Area C. Stratospheric chemistry and ozone depletion studies of interest to the program include utilizing observations to understand the chemical, dynamical, and radiative processes controlling interaction between the stratosphere and troposphere.

To understand the stratospheric ozone and its response to changes in ozone-depleting substances (ODSs), it is necessary to recognize and attribute the observational signal of ozone response to ODS change in the context of a changing and variable climate. The program, therefore, seeks studies that will evaluate the potential impacts of both climate change and variability and changes in the concentrations of ODSs on future stratospheric ozone concentrations.

3. Summary of Key Information

Expected program budget for first year of new awards	~ $2.9M
Number of new awards pending adequate proposals of merit	~15-20
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*.
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.
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	NNH18ZDA001N-ACMAP
NASA 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.20 ATMOSPHERIC COMPOSITION: TROPOSPHERIC COMPOSITION PROGRAM

NOTICE: The Tropospheric Composition Program (TCP) will not be competed in ROSES-2018. The TCP program is not scheduled to next solicit proposals until after 2019. Proposers with interests that match the TCP programmatic objectives are encouraged to submit to A.19 Atmospheric Composition Modeling and Analysis Program which will be soliciting modeling and analysis proposals related to recent TCP missions.

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 the integration of satellite, suborbital and ground-based observations acquired during focused field deployments to enhance our understanding of processes impacting tropospheric composition and to improve our ability to simulate the atmospheric with chemical transport models. Along with the other Atmospheric Composition programs, TCP also sponsors interpretation of these comprehensive measurements to improve the continuous monitoring of tropospheric gases and aerosols from space. TCP also supports limited laboratory studies that are directly relevant to improved understanding of tropospheric chemistry.

For further information about the Tropospheric Composition Program, contact:

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.21 TERRESTRIAL HYDROLOGY

NOTICE: The Terrestrial Hydrology Program will not be competed in ROSES-2018. NASA anticipates that the Terrestrial Hydrology Program will be competed in ROSES-2019.

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 and Modeling Analysis and Prediction (see ROSES-2018 elements A.4 and A.15, respectively). 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) and Soil Moisture Active Passive (SMAP); or in planning and development, such as Gravity Recovery and Climate Experiment Follow-On (GRACE-FO) and 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/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), especially its annual priorities related to Water Cycle extremes.

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. Table of Information

NASA 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.22 NASA ENERGY AND WATER CYCLE STUDY

NOTICE: Amended September 13, 2018. The proposal due date for this program element has been delayed to October 11, 2018 to allow proposers affected by hurricane Florence to submit.

1. Scope of Program

The current state and evolution of the environment are critically intertwined with the water and energy cycles of the climate system. Progress towards comprehensive understanding of both cycles is enabling a better description of the current state of the climate, as well as the subtle shifts that may be going on. While global warming is often summarized as an index of mean temperatures, it is alterations of the water cycle that may be most relevant to life on Earth, especially human society. Water is fundamentally within the center of what all life needs to survive and thrive on the planet and it is no different for human society whose agriculture, energy production, recreation, etc., all require water.

Accomplishing any goals related to better understanding these two cycles requires, in part, an accurate accounting of the key reservoirs and associated fluxes, including their spatial and temporal variability. To accomplish this, integration of existing observations and research tools is a requirement. To achieve this, the NASA Energy and Water Cycle Study (NEWS) grand challenge can be summarized as documenting and enabling improved, observationally based, predictions of water and energy cycle consequences of Earth system variability and change. This challenge requires documenting and predicting trends in the rate of the Earth's water and energy cycling that corresponds to climate change and changes in the frequency and intensity of naturally occurring related meteorological and hydrologic events, which may vary as climate may vary in the future. The cycling of water and energy has obvious and significant implications for the health and prosperity of our society. The importance of documenting and predicting water and energy cycle variations and extremes is necessary to accomplish this benefit to society.

A coordinated team effort is required that will integrate NASA's global water and energy cycle resources to directly address the NEWS challenge. More information on NEWS is available at http://nasa-news.org. Interested collaborators with NEWS are specifically recommended to review progress and plans of current NEWS activities that are available at this web location.

Through national and international relationships, NEWS will ultimately facilitate NASA providing added value to the Earth observations resulting from NASA research and development, assist in bringing in added satellite calibration/evaluation data sources, and deliver independent observationally-based data sets for evaluating 4-dimensional data assimilation (4DDA) and prediction capabilities on a regional and global basis.

The overarching goal of NEWS investigations is to integrate Earth Science Research Program components to make decisive progress toward the NEWS challenge. To

achieve this objective, the NEWS investigations will integrate and interpret past, current, and future space based and *in situ* observations into assimilation and prediction products and models that are global in scope. These activities will serve efforts to improve understanding, modeling, and information for global prediction systems. To achieve these goals, the NEWS investigations must recognize that accurate prediction of not only trends in the mean, but also extremes and abrupt changes, is a key step toward useful applications. The critical feedbacks within the overall NEWS strategy are the lessons that scientific analysis, modeling, prediction, and consequences can guide and identify the technological and observational requirements of future NASA missions.

2. Description of Solicited Research

To answer a long standing motivational question to the NEWS community, "Is the Water Cycle Accelerating?" we must be able to elaborate on and respond to the related questions of "How and Why is the Water Cycle changing?" Already NEWS teams have leveraged the efforts of many NASA investigations and satellite mission teams to make advances refining our estimates of global water and energy budgets, as well as their individual variable components, and pushing these evaluations to finer spatial and temporal resolutions. These, and other studies, have revealed that in order to truly understand and describe the climatology of the water and energy cycle, one must simultaneously take into account, along with annual means, not only extreme events but infrequent but meaningful occurrences. For example, it's important to know if a region's annual rainfall comes primarily during a few thunderstorms or accumulates from frequent drizzle. Likewise:

- The variability of a river's annual sediment flux to the ocean may be largely accounted for by the sediment transferred during a single flood event;
- The daily ocean latent heat flux is largely controlled by the presence or absence of clouds overhead.
- Over longer temporal scales the annual ocean latent heat flux gains significant contribution from the transfers that happen during synoptic storms;
- The climatology of extreme events, such as floods in parts of the Western US, may require consideration of other infrequent events, i.e. Atmospheric Rivers.

To address this, NASA seeks to initiate two NEWS Process Teams to investigate simultaneously water and energy cycle dynamics over ranges of temporal and spatial scales.

2.1 Requirements

Proposals to form NEWS Process Teams should seek to understand a significant portion of the global water and energy cycle, with special attention on at least one major source of exchange of water and/or energy between the major components of the earth system (i.e. land, atmosphere, and ocean).

This implies that studies must meet the following requirements:

a. Study of and multiscale characterization of at least one major exchange of water and/or energy between land, atmosphere, and ocean.
b. Investigation of physical processes of at least two subdomains of the earth system

(i.e. two of land, atmosphere, and ocean) that are connected to the exchange process of requirement "a", above.

c. Significant use of multiple, i.e. at least 3, satellite based observational data sets. Each observation data set should provide independent information, with respect to the other two data sets, on the dynamics of the water and energy cycle.
d. Proposals should result in targeted, cutting-edge diagnostics that could be given to global climate modeling and weather forecasts centers to evaluate their models' capability to accurately re-create important, multi-scale components of the water and/or energy cycles.

2.2 Proposal Contents and Construction

Proposals for NEWS Process Teams need not overly elaborate on the overall importance of the water and energy cycles in the climate system, nor water availability for human society. Proposals should instead focus on:

a. The strengths and weaknesses of the data sets, those derived from satellite observations, models, or *in situ* observations, to be employed. Special attention should be given to how the weaknesses of a data set will be addressed.
b. Details of the methodology should be adequately presented. Given the multiscale approach needed by the NEWS process teams, it is likely that proposals will draw analysis techniques from multiple communities, such as synoptic analysis used in daily meteorological studies versus long term trend detection used by climatologists. As this is the case, proposals should include sufficient descriptions of any proposed analysis techniques and not rely on reviewers to access referenced papers for pertinent details.
c. How and why the combination of the data sets and analyses tools should give NASA confidence that the NEWS Process team will achieve significant improvements in our understanding and depiction of the water and energy cycles, across scales.
d. A description of how the proposed NEWS process team supports and is supported by ongoing efforts and priorities of Global Energy and Water Exchanges (GEWEX) activities and goals (http://gewex.org).

To help satisfy the above requirements, proposers are allotted 18 pages for the main body of their proposals (as opposed to the typical 15 pages). Also NEWS teams are expected to operate in conjunction with the wide efforts of NASA satellite, modeling, and data production teams. As such, proposers may consider any NASA effort that would be a data provider to the project to be a potential collaborator and need not include unfunded NASA center partners as typical proposal "collaborators".

3. Programmatic Information

Total funds available for work selected under this solicitation are approximately $1.3M per annum for three years.

The program anticipates making approximately two selections. It is anticipated that project start dates will be no earlier than March 1, 2019.

4. Table of Key Information

Expected annual program budget for new awards	~ $1.3M
Number of investigator awards pending adequate proposals of merit	~2
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	March 2019
Page limit for the central Science/Technical/Management section of proposal	18 pp; see also Table 1 of ROSES and 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*.
Detailed instructions for the preparation and submission of proposals	Please see Table 1 and Section I(g) Order of Precedence 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	NNH18ZDA001N-NEWS
NASA 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.23 WEATHER AND ATMOSPHERIC DYNAMICS

NOTICE: The Atmospheric Dynamics program will not be competed in ROSES-2018. It is tentatively scheduled to next solicit proposals in ROSES-2019.

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. Summary of Key Information

NASA point of contact concerning this program	Ramesh K. Kakar Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0240 Email: ramesh.k.kakar@nasa.gov

A.24 EARTH SURFACE AND INTERIOR

1. Scope of Program

NASA's Earth Surface and Interior focus area (ESI, 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 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 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 production 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 in 2018. 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).
2. Solid-Earth Observational Strategies: Proposals exploring observational strategies to meet priority ESI science objectives. Proposals that address ESI science objectives and associated remote sensing observations as identified in the National Academy of Sciences (NAS) Decadal Survey, *Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space* (2018), and the *CORE Report* will receive higher priority. Proposals that include instrument or technology development will be considered nonresponsive and returned without review.

Further details on this year's solicited topics 2.1 and 2.2 are described below, and 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 *Decadal Survey* and the *CORE Report* 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 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/2gfMlAQ)
- The NASA 2014 Science Plan (https://science.nasa.gov/about-us/science-strategy)
- The report *A Foundation for Innovation: Grand Challenges in Geodesy* (2012) (http://www.unavco.org/pubs_reports/geodesy_science_plan/GrandChallengesInGeodesy-Final-Singles-LR.pdf)
- 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)
- The Solid Earth Science Working Group (SESWG) report, *Living on a Restless Planet* (2002) (http://solidearth.jpl.nasa.gov/seswg.html)

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 solid-Earth systems, which can both benefit society and provide avenues for innovative research. Within this theme, proposals that develop new and innovative geodetic analysis techniques that result in data streams or products that may 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* 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 measureable 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 Observational Strategies

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. 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. Proposals to conduct Observing System Simulation Experiments (OSSE) 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 also encouraged. Such studies may address the development of future remote-sensing and geodetic observational systems, or the optimization of existing systems. 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 *Decadal Survey* and *CORE Report* will receive higher priority under this subsection. 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, ongoing satellite and airborne LIDAR, and spectral imaging such as ASTER and MODIS that provide structural and compositional models to inform tectonic and climatic influences on evolving terrains. Geodetic observations utilizing GNSS, SAR, and InSAR, including the airborne UAVSAR facility (L-band, P-band AirMOSS, and Ka-band GLISTIN-A), provide insights into dynamic processes. Ongoing and future missions such as ALOS-2, Sentinel-1, TerraSAR-X, COSMO-SkyMed, SAOCOM, and NISAR provide additional and upcoming opportunities in this realm. Magnetic and gravity missions, such as the historical SAC-C, Øersted, CHAMP, and GOCE, ongoing SWARM and GRACE, and future GRACE-FO, offer long-term 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 Requirement for 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 at https://airbornescience.nasa.gov/. 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 Requirement for Proposals Requesting NASA High-End Computing Resources

Interested proposers should consult ROSES-2018 Appendix A.1 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.

4. Summary of Key Information

Expected annual program budget for new awards	~$3M
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 (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, 2019
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of 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*.
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 also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of 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	NNH18ZDA001N-ESI
NASA 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.25 RAPID RESPONSE AND NOVEL RESEARCH IN EARTH SCIENCE

NOTICE: Before any work is begun on a proposal to this program, potential proposers should read the first section entitled Important Caveat to Potential Proposers.

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.

1. 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.

2. 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.

2.1 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).

2.2 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 include 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-2015–ROSES-2017, 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.

3. 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 the *Earth Science Overview* in Appendix A.1 of 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.

4. Programmatic Information and Additional Requirements

4.1 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/) 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.

4.1.1 *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.

4.1.2 *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 2.2 ("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.

4.2 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.

4.3. 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.

5. 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 4.1.1 and 4.1.2)
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, 2019.
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 and the *NASA Guidebook for Proposers*.
Relevance	See section 3. 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. 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	NNH18ZDA001N-RRNES

NASA 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.26 AIRBORNE INSTRUMENT TECHNOLOGY TRANSITION

NOTICE: The Airborne Instrument Technology Transition program will not be competed in ROSES-2018. The program may next solicit proposals in ROSES-2019.

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.[1] 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)[2], which 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

[1] http://airbornescience.nasa.gov/platforms/platforms.html
[2] http://esto.nasa.gov/

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.[3] Examples of previous field campaigns can be found at the Airborne Science Website.[4]

Proposers may find information on selections from previous calls for this element at NASA's NSPIRES web site.[5]

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

[3] http://appliedsciences.nasa.gov/
[4] http://airbornescience.nasa.gov/
[5] http://nspires.nasaprs.com/external/

A.27 EARTH SCIENCE U.S. PARTICIPATING INVESTIGATOR

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 2020 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 (Appendix A.2), Ocean Biology and Biogeochemistry (Appendix A.3), Terrestrial Ecology (Appendix A.4), Carbon Cycle science (Appendix A.5), Biodiversity (Appendix A.6), Physical Oceanography (Appendix A.9), Ocean Salinity (Appendix A.11), Cryospheric Science (Appendix A.16), Upper Atmospheric Research Program (Appendix A.17), or Atmospheric Composition: Modeling and Analysis Program (Appendix A.19).

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.

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.

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);
- 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 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	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*.
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.
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	NNH18ZDA001N-ESUSPI

NASA 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.28 INTERDISCIPLINARY RESEARCH IN EARTH SCIENCE

NOTICE: Interdisciplinary Research in Earth Science will not be competed in ROSES-2018. This program is tentatively scheduled to next solicit proposals no earlier than ROSES-2019.

1. Scope of the Program

This solicitation is issued periodically for new and successor interdisciplinary research investigations within NASA's Interdisciplinary Research in Earth Science (IDS) program. Proposed research investigations must 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 in the specific solicitation.

As an example, in ROSES-2016, the themes were:

- Understanding the Global Sources and Sinks of Methane
- Ecology at Land/Water Interfaces - Human and Environmental Pressures
- Understanding the Linkages Among Fluvial and Solid Earth Hazards
- Life in a Moving Ocean
- Partitioning of Carbon Between the Atmosphere and Biosphere

It is expected that the themes in any subsequent IDS solicitation will differ significantly from those from ROSES-2016 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
Telephone: 202-358-2559
Email: Jack.A.Kaye@nasa.gov

A.29 SCIENCE TEAM FOR THE NASA ISRO SYNTHETIC APERTURE RADAR (NISAR) MISSION

1. Scope of the Program

The NASA ISRO Synthetic Aperture Radar (NISAR) mission evolved from the radar part of the Deformation, Ecosystem Structure, and Dynamics of Ice (DESDynI) mission concept. DESDynI was one of four missions recommended for launch by NASA in the 2010-2013 timeframe by the U.S. National Research Council (NRC) *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond*. The 2012 Administration budget required NASA to reformulate the DESDynI mission as an L-Band SAR only design to meet budget constraints.

Since then, NASA has established a partnership with the Indian Space Research Organisation (ISRO) as the major international partner of the NISAR mission. NASA will provide the L-band radar instrument with associated reflector and boom assembly, several flight system elements (high rate telecom, GPS receiver, high capacity solid state recorder, and payload data subsystem), and ground data system. ISRO will provide the spacecraft, the launch vehicle, an S-band SAR instrument, and a science data system for the S-band data.

The NASA contribution to the NISAR mission is a directed mission within the NASA Earth Systematic Missions (ESM) Program, with project execution and management responsibility delegated to the Jet Propulsion Laboratory (JPL). The NISAR Mission is currently in implementation and transitioned into Phase C in September 2016. The current launch readiness date is late 2020 or early 2021. Further information on the NISAR mission can be found at http://nisar.jpl.nasa.gov/.

The NISAR mission will provide large scale data sets of Earth surface dynamics that are critical to three Earth Science disciplines: 1) Deformation (Solid Earth), 2) Ecosystems (Vegetation, Carbon Cycle) and 3) Cryosphere (Climate Change). To achieve the science objectives, the NISAR mission will be capable of performing repeat-pass interferometry and collecting polarimetric data. In addition, an applications objective of the NISAR mission relates to its potential role to inform the hazard/disaster management cycle (understanding, hazard/risk assessment, forecast/warning, situational awareness, response, recovery and mitigation).

The core of the payload is an L-band SAR to meet all of the NASA science/applications requirements. An S-band SAR will be contributed by ISRO to meet additional ISRO requirements. The payload includes a large, 12-m diameter deployable reflector and a dual-frequency antenna feed to implement the SweepSAR concept that scans the feed array on receive to simultaneously provide both wide swath and high resolution. The payload also includes a Global Positioning System (GPS) receiver for precision orbit determination. Due to the large amount of expected science data, a high rate data downlink subsystem and a solid-state recorder are included in the NISAR payload. The baseline mission plan calls for a sun-synchronous, near-polar orbit with dawn/dusk equatorial crossings and a 12-day exact repeat orbit.

The NISAR mission will be the first NASA radar mission to systematically and globally study the dynamics of solid Earth, the ice masses, and ecosystems, all of which are

sparsely sampled at present. The NISAR mission has three science foci (surface deformation, ecosystem dynamics, and cryosphere dynamics) and one application focus (hazard/disaster management). The associated objectives are:

- Improve knowledge of surface deformation required for understanding solid Earth dynamics and associated natural hazard risks and resource management
  - Observe secular and local surface deformation on active faults to constrain lithospheric and mantle rheology and model earthquakes and earthquake potential.
  - Catalog and model aseismic deformation in regions of high hazard risk.
  - Characterize magma migration through the lithosphere and observe volcanic deformation to model volcanic interiors and forecast eruptions.
  - Map pyroclastic and lahar flows on erupting volcanoes to estimate damage and model potential future risk.
  - Map fine-scale potential and extant landslides to assess and model hazard risk.
  - Characterize water resources, including aquifer physical and mechanical properties affecting groundwater flow, storage, and management.
  - Map and model subsurface reservoirs for efficient resource recovery (e.g., hydrocarbons, geothermal fluids, water) and disposal (e.g., wastewater, CO_2 sequestration).
- Enhance knowledge of ecosystem structural dynamics to determine environmental change and ecological impacts
  - Determine the changes in carbon storage and uptake resulting from disturbance and subsequent regrowth of woody vegetation.
  - Determine area of cropland and aboveground biomass of rapidly changing agricultural systems.
  - Determine the extent of wetlands and characterize the dynamics of inundated areas.
  - Characterize freeze/thaw state, surface deformation, and permafrost degradation.
  - Explore the effects of ecosystem structure and its dynamics on biodiversity and habitat.
- Advance knowledge of cryosphere dynamics to understand and describe changes of ice sheets, sea ice and glaciers over short and extended time scales
  - Understand the response of the ice sheets and glaciers to climate change.
  - Determine the displacements of ice sheets to better understand the contribution of ice sheets to sea-level change and coastal zone dynamics.
  - Understand the interaction among sea ice, oceans, and climate.
  - Characterize the short-term interactions between the changing polar atmosphere and changes in sea ice, snow extent, and surface melting.
- Strengthen the use of satellite-dependent information for hazard/disaster management to inform decision-making:
  - Detect, characterize, and model hazards and potential disasters, including those from floods, volcanoes, landslides, wildfires, earthquakes, tsunamis, and cyclones.

- Characterize secondary hazards associated with primary events.
- Demonstrate rapid damage assessment to support rescue and recovery activities, system integrity (water and energy utilities), lifelines and public health, levee stability, transportation and urban infrastructure, food security, and environment quality.

During formulation (Phase A), these objectives guided development of Level-1 and 2 science requirements that flow down to the NISAR engineering requirements. A competitively selected Science Definition Team (SDT), worked iteratively with the NISAR Program Scientist, Program Applications Lead, and the Project Scientist at JPL, to develop NASA's baseline and threshold mission requirements for the NISAR mission. The initial SDT was selected in 2012 for the DESDynI-Radar mission and re-competed in 2015 as the NISAR SDT with expansion from 16 to 20 members to explicitly include representation of science and applications objectives beyond the baseline/threshold science requirements. Given that NISAR is now in the later stages of development, this solicitation is for the NISAR Science Team (ST) for a three-year period that is expected to carry through launch and the commissioning phase.

The ST supports the NISAR project regarding the science requirements flow down, science algorithm definition, development of algorithms and associated error models, provision of algorithm theoretical basis documents (ATBD), the associated data acquisition plan to meet those requirements, along with the definition and implementation of relevant calibration and validation plans. The ST considers appropriate data latency and dissemination plans, presents and publishes results, and fosters public engagement including liaison with the broader science and applications communities. The ST also assists in the promotion of early engagement activities as further described in the NISAR Utilization Plan that may conduct prelaunch research and evaluation using data (simulated from airborne or space-borne data and field campaigns) to accelerate use of NISAR data after launch.

Given the global, systematic, and frequent repeat coverage expected for the NISAR mission that will be required in order to accomplish the science objectives, these same data would be available to serve a broad variety of other basic and applied science objectives. The NISAR project, in conjunction with NASA's Applied Sciences Program, holds periodic applications workshops in order for the NISAR project to be better informed of such potential applications, gain feedback on products and algorithms from early adopters, provide education, and ensure the larger community is better prepared for the future availability of the NISAR data and product streams and the prospective generation of value-added products, information, and decision-support services. Two broad community Applications Workshops been held to identify and evaluate potential scientific and applied uses of NISAR data. The first workshop**,** NASA-ISRO SAR Mission Applications Workshop: Linking Mission Goals to Societal Benefit, was held October 28-29, 2014 in Reston, VA**.** ISRO also held a Science Workshop November 17-18, 2014 in Ahmedabad, India. The second NISAR workshop, 2015 NASA-ISRO SAR Mission Applications Workshop: Linking the Applied Science Community to Mission Data was held at Ames Research Center, October 13-15, 2015. Subsequent to these broad workshops, NISAR has organized and participated in a number of more

focused workshops targeted towards specific communities and generation of potential higher-level data products from the NISAR data stream.

- Workshop on the Calibration and Validation of Upcoming Satellite Missions on Global Forest Structure and Biomass, held at the Smithsonian, Washington, D.C. May 31 to June 3, 2016.
- 2017 NISAR Applications Workshop: Critical Infrastructure, held at the Dept. of Homeland Security, Arlington, VA June 6-7, 2017.
- 2017 NISAR Applications Workshop: Sea Ice & Ocean Applications, held at the NOAA Center for Weather and Climate Prediction (NCWCP) in College Park, Maryland on June 23, 2017.
- Arming Forest Management with Information from NISAR Remote Sensing Data, Washington, DC on January 22-23, 2018.

Additional such workshops are in the planning phase for non-forested ecosystems and soil moisture, wetlands and flooding/inundation.

The NASA-ISRO SAR (NISAR) Science Users Handbook contains additional details on the science focus areas, mission measurement requirements and traceability, instrument and mission characteristics including the observing strategy, description of the data products and delivery, the theoretical basis of algorithms for the proposed products, and draft calibration and validation plans. Key appendices describe radar instrument modes, data product layers and provide brief descriptions of other applications. White papers for these and other application topics are available on the NISAR website.

NISAR will be the first free-flying dual-frequency SAR/InSAR mission. While the L-band SAR alone can meet all NASA mission requirements, the provision of S-band opens the opportunity to (1) supplant L-band coverage with S-band and (2) explore the use of dual-frequency data. The S-band SAR will have more limited acquisition time due to increased power and thermal requirements. Overall, the data acquisition plan is constrained by the downlink capabilities. The Science Team is expected to consider the science and applications opportunities afforded by the S-band capability relative to the mission requirements and provide guidance on options for an associated observation plan to the NISAR Project Scientist and Program Scientist. The NASA and ISRO science teams will coordinate and harmonize the joint NISAR science observation plan.

This solicitation seeks proposals for membership in the NASA NISAR Science Team (ST) to support further prelaunch planning and preparation for the NISAR mission during Phase D of development and Phase E operations including the commissioning phase. The ST will function for a three-year period and then be re-competed.

2. NASA Science Definition Team for the NISAR Mission

2.1 Structure of NASA's NISAR Science Team (ST)

The ST will consist of at least sixteen members with expertise in radar scientific data analysis, applications, and/or technology. The ST is planned to be led by four co-leads representing the three principal scientific disciplines (Solid Earth, Ecosystem Science, and Cryospheric Science) plus Applications. The ST membership will include balanced

representation from these three principal disciplines, along with the inclusion of other scientific disciplines that contribute to the utility of and/or benefit from the NISAR mission, such as Hydrology, Geodesy, and related Hazard/Disaster Science. While the main focus is on the science objectives given in Section 1, NASA also seeks to address key applied research and applications questions and to encourage and demonstrate significant applications of NISAR to societal-benefit needs, including governmental decision making, disaster risk reduction activities, and other matters of societal importance. Therefore, membership on the ST is open to members of the applied research and applications communities, including key partners from other Federal and state agencies. Proposers are encouraged to provide information on their NISAR relevant applied sciences expertise and how the NISAR mission can benefit that application area (e.g., subsurface reservoirs, forest and agricultural land use, soil moisture, natural disasters preparedness, response and recovery, hazard exposure and critical infrastructure, and ocean, coastal, and sea ice dynamics).

2.2 ST Responsibilities

The NASA ST will work closely with the NISAR Project Scientist to provide expert scientific guidance to the NISAR project in the areas of measurement requirements, product definition, algorithm development, calibration, validation, and early engagement activities with the broader science and applications user communities as defined in the NISAR Utilization Plan. The ST will support the NISAR Project Scientist in providing regular and frequent reports on findings and progress to the NISAR Program Scientist, Program Applications Lead, and NISAR Program Executive.

During NISAR Phases D and E, the members of the ST will be responsible for:

- Scientific input into any needed revisions of the NISAR Science Plan;
- Evaluating, as requested by the Project Scientist, the proposed NISAR mission designs in achieving the goals of the scientific requirements;
- Revisions, as may be needed, of Algorithm Theoretical Basis Documents (ATBD) for NISAR science requirements;
- Development or refinement of new ATBD for additional algorithms related to science or applications goals beyond the specified NISAR requirements;
- Supporting the development of calibration and validation plans and the implementation of associated activities;
- Promoting early engagement activities through participation in Applications Workshops and/or ad hoc Applications Working Groups as described in the NISAR Utilization Plan;
- Supporting the NISAR Project Scientist in the development of required analyses and documentation during the development of the NISAR mission including, but not limited to, scientific inputs for the reviews and key decision points leading to the launch of the NISAR mission and post-launch reporting on calibration and validation activities;
- Attending the ST meetings regularly; and
- Presentation and publication of scientific findings and results.

2.3 ST Team Member Proposals

The body of the ST member proposals for the Principal Investigator's (PI) membership on the ST must be limited to fifteen pages, and include the following information:

- The scientific research and/or societal application that the proposer wishes to represent as a member of the ST, with supporting documentation of expertise and potential role of NISAR;
- Only the Principal Investigator (PI) will be named to the ST. The specific role and contributions of any other team members must be clearly articulated; and
- A budget and budget justification that provides adequate support for the PI's strong contribution to the ST. This budget section is not included within the fifteen-page limit of the proposal's body.

2.3.1 *ST Proposal Content*

Proposals must clearly identify the particular NISAR scientific requirements and/or other science or applications goals that will be addressed. The proposal should elaborate on the specific role the PI will play with respect to the responsibilities of the NISAR ST outlined in Section 2.2. Note that while a proposal may offer to generate Level-3 products for purposes of calibration and validation of associated algorithms, this is not required; and generation of global products is beyond the scope of this announcement.

Proposals must address how the proposer will contribute to the development of NISAR's scientific and technical capabilities during the remainder of mission development including the commissioning phase (Phase D) and the early part of mission operations (Phase E) especially as related to calibration and validation activities. The proposal should also elaborate on expected contributions, if any, to the NISAR Utilization Plan related to early engagement with the broader scientific and applied science community.

Proposals must state the relevant expertise and experience of the team member relative to their proposed contributions. Proposals for continued membership on the science team should provide evidence of prior contributions and clearly describe the additional contributions to be undertaken through a follow-on effort.

The ST will conduct its business through regular meetings with more frequent teleconference calls and E-mail. The proposed budget should include funds for the Principal Investigator to participate in three ST face-to-face meetings per year and one Data Utilization workshop, lasting three days each. For planning purposes, proposers should budget for two meetings per year in Pasadena, CA, and two meetings per year in the Washington, DC, area. In addition, ST members should budget for one trip over the three-year period to attend a five-day meeting held jointly with ISRO, nominally in Ahmedabad, India.

For planning purposes, it is anticipated that ST membership budgets will average approximately $115K per year.

Proposals for participation in the ST from other U.S. Government agencies are encouraged to show significant cost sharing and/or in-kind support, though this is not required.

2.4 ST Co-Lead Proposals

Proposers who wish to be considered for the four potential Co-Lead positions should indicate their candidacy by answering the relevant cover sheet question and including a Team Co-Leader section within their proposal. NASA reserves the option to select no team Co-Leaders or to select team Co-Leaders from among the team membership proposals should proposals of adequate merit not be received for the four team Co-Lead positions.

The Co-Team Leader section can use up to five additional pages and should include:

- A clear articulation of the proposed Co-Team Leader's vision for the NISAR mission and its contribution to science and society;
- A statement of which Co-Lead position is sought (Solid Earth, Ecosystem Science, Cryospheric Science, or Applications) and the qualifications that make the proposer a prime candidate for ST co-leadership;
- A management plan that describes the approach to science team leadership including interactions with other ST members within that science or application area, interactions among the four Co-Leaders, and coordination with the NASA Project Scientist and Program Scientist;
- The scientific qualifications and leadership skills of the proposing Team Co-Leader along with relevant previous experience;
- The ability of the proposing Team Co-Leader to represent his/her scientific community's interests in the NISAR mission; and
- The ability of the proposing Team Co-Leader to represent the NISAR mission's overall goals and objectives to the broader scientific and applications communities.

In addition, in the Budget and Budget Justification sections of the Team Member proposal, Team Co-Leader proposals should include a budget and justification for that role that is separate from the budget for their team member activities. In addition to the travel expected for all ST members, the Team Co-Leaders should also include budget for two additional trips to India, nominally Ahmedabad for three days, one trip for each of the two years not included on a team member proposal. In other words, the Team Co-Leaders may be expected to attend one meeting each year with ISRO in India. Co-Leader budgets are expected to average approximately $155K per year.

3. Evaluation and Selection of the NASA NISAR Science Team

Proposals will be evaluated by a panel of scientific peers from the three principal scientific disciplines mandated by this call, Solid Earth, Ecosystem Science, and Cryospheric Science along with experts in other disciplines and the applied sciences, as needed.

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 factors given there, the evaluation of intrinsic merit for a proposal shall consider the ability and experience of the Principal Investigator in serving as a constructive, productive team member in related and relevant projects.

4. Summary of Key Information

Expected program budget for first year of new awards	$2.0M, see also Section 2.4
Number of new awards pending adequate proposals of merit	16-20
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	April 1, 2019
Page limit for the central Science-Technical-Management section of proposal	15 pp for ST member proposals and 20 pp for ST co-lead proposals; see also Chapter 2 of 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*.
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.
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	NNH18ZDA001N-NST
NASA point of contact concerning this program	Craig Dobson Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-2054 Email: Craig.Dobson@nasa.gov

A.30 CLOUDSAT AND CALIPSO SCIENCE TEAM RECOMPETE

1. Scope of the Program

1.1 Overview

Nearing twelve years of active service, the radar-carrying CloudSat and backscatter lidar-carrying Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) satellites have provided unprecedented information on the vertical profile of clouds, cloud liquid water, and aerosol particles over the globe. Taken individually, the CloudSat mission's primary science goal is to furnish data needed to evaluate and improve the way clouds are parameterized in global models, thereby contributing to better predictions of clouds and thus to the poorly understood cloud-climate feedback problem (http://cloudsat.atmos.colostate.edu/). For CALIPSO, the satellite was designed to help scientists answer significant questions and provide new information regarding atmospheric transport of airborne particles and air pollutants, as well as the effects of clouds and aerosol particles on Earth's changing climate (http://www-calipso.larc.nasa.gov/).

The greatest strength in CloudSat and CALIPSO, however, comes from their inclusion in the NASA A-Train. Combining the vertical cloud and aerosol information from these satellites together with aerosol, gas, and cloud data from other A-Train instruments allows for a more comprehensive perspective on how clouds and aerosol plumes form, evolve, and impact the atmosphere. From primary mechanistic studies to climatologies, this system of satellites has opened the observing world to three full dimensions.

This particular solicitation requests proposals for the CloudSat/CALIPSO science team.

1.2 Background

The CALIPSO and CloudSat spacecraft were launched aboard a Delta II rocket on April 28, 2006. The CALIPSO payload consists of the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP), the Imaging Infrared Radiometer (IIR), and the Wide Field Camera (WFC). CALIOP is a two-wavelength (532 and 1054 nm) polarization-sensitive lidar that provides vertical profiles of aerosols and clouds. Information about the spacecraft and its instruments can be found at: http://www.nasa.gov/mission_pages/calipso/main/index.html.

CloudSat carries the Cloud Profiling Radar (CPR), which is a nadir-looking radar measuring in the 94-GHz band. It is designed to measure vertical profiles of clouds and is the only current source for vertical profiles of global cloud liquid, ice water, and precipitation. More information about the instrument can be found at: http://www.nasa.gov/mission_pages/cloudsat/mission/index.html.

The spacecraft were launched on a joint mission to study the role of aerosols and clouds in the Earth's climate system. At this time both the spacecraft are confronting some challenges – After successfully confronting a battery anomaly in April 2011 which limited the instrument to daytime-only operations, CloudSat is now having reaction wheel difficulties. The CALIPSO lidar is now experiencing increasing numbers of low and no-energy shots as the canister pressure of the currently operating laser has dropped close to inoperable levels. (An attempt to switch back to the original laser is being planned for when the current laser is no longer operable.) While it is uncertain at

this time how much longer the satellites will remain in operation, NASA plans to maintain the science team for the foreseeable future, to utilize the current data sets and possible future data acquired by these sensors.

Since 2006, CloudSat data had been used in over 1300 peer-reviewed publications, and CALIPSO data had been used in over 2064 (numbers are not exclusive). Published research highlights for CloudSat include improved understanding of the surface energy balance, improved understanding of atmospheric convection, identification of flaws in the representation of precipitation in weather and climate models, and improved parameterizations of clouds and aerosols in global and process-scale models. Published research highlights for CALIPSO include the first detailed studies of aerosol radiative effects in desert regions, mechanisms of dust generation and lofting, investigations of emission and transport of biomass burning plumes, improved understanding of aerosol-cloud interactions, improved understanding of the surface and atmospheric radiation budget, and better understanding of cloud/radiation/climate feedbacks. This solicitation provides an opportunity to continue to make fundamental advances in our understanding of the role of clouds and aerosols in the climate system.

1.3 Research Themes

While team members may pay strict attention to one satellite or the other, NASA considers this one consolidated science team and encourages cross sensor studies. Specifically, proposals are requested that greatly enhance the state of atmospheric and climate science through the substantive utilization of CloudSat and CALIPSO data products. These can be taken alone, but preferably in conjunction with other satellite (e.g., A-Train), suborbital campaign, ground-based, and/or model data. The inventive combination of CloudSat and CALIPSO data with other sensors (such as other A-Train sensors or the CATS lidar on ISS) is encouraged. Note, however, that CALIPSO and/or CloudSat observations should be the primary basis of the proposed investigation and not relegated to a minor or supplementary role. Example topics include:

- Phenomenological studies of fundamental cloud, precipitation and aerosol processes and evolution, as well as aerosol indirect effects and vertical transport;
- Development and validation of aerosol and cloud parameterizations for regional, global, and climate models;
- Use of CALIPSO and CloudSat products in the development of three-dimensional aerosol and cloud climatologies, spatial correlations, or trends;
- Seasonal or interannual variability of cloud and aerosol properties on regional to global scales;
- Fundamental studies of the information content of CALIPSO and/or CloudSat data products and their use for data assimilation;
- Use of CALIPSO and/or CloudSat in understanding the atmosphere's three-dimensional radiative environment;
- Aerosol/cloud interactions and their impact on cloud microphysics, optics, and radiation;
- Aerosol direct and indirect radiative effects;
- Effects of aerosols on precipitation;
- Development of new or significantly improved level two cloud and aerosol products;
- Development of innovative uses of CALIPSO and/or CloudSat data, such as for

oceanography, meteorology, and land studies;
- Stratospheric aerosols and/or polar stratospheric clouds;
- Hydrologic processes in the context of weather and climate variability; and
- Assessment of cloud feedbacks in climate models.

Activities that are not included in this call are:

- Routine instrument algorithm maintenance, incremental improvement, or data visualization;
- Specific field missions or data collects for CloudSat and CALIPSO satellite calibration and validation; and
- Proposals for Science Team Leads.

2. Summary of Key Information

Expected program budget for first year of new awards	~ $4M
Number of new awards pending adequate proposals of merit	~ 20
Maximum duration of awards	3 years
Planning date for start of investigation	6 months after proposal due date.
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 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*.
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 also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of 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	NNH18ZDA001N-CCST

NASA point of contact concerning this program	David B. Considine Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-2277 Email: david.b.considine@nasa.gov

A.31 NEW (EARLY CAREER) INVESTIGATOR PROGRAM IN EARTH SCIENCE

NOTICE: The New Investigator Program (NIP) in Earth Science will not be competed in 2018. NIP is moving to a 3-year cycle and is scheduled to solicit proposals next in ROSES-2020. Eligibility will be extended to six years after award of PhD in order that potential proposers continue to have two opportunities to propose. The full text of the most recent call can be found in A.36 of ROSES-2017.

1. Scope of Program

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 aims to encourage innovative research initiatives and cultivate 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.

The NIP supports all aspects of scientific and technological research aimed to advance NASA's mission in Earth system science (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 efforts to discover and demonstrate practical uses of NASA Earth science data, knowledge, and technology (see http://appliedsciences.nasa.gov). In technological research, the ESD aims to foster the creation and infusion of new technologies into space missions in order to enable new scientific observations 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.

The proposed research project must be led by a single, eligible 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 Science PI and 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.

2. NASA point of contact concerning this program

Lin Chambers
Earth Science Division
Science Mission Directorate
NASA Headquarters
Washington, DC 20546-0001
Telephone: 202-358-1667
Email: lin.h.chambers@nasa.gov

A.32 THE SCIENCE OF TERRA, AQUA, AND SUOMI NPP

NOTICE: NASA will not solicit research proposals under The Science of Terra, Aqua, and Suomi NPP program element in ROSES 2018. The next estimated release of the program element is ROSES 2020.

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://jointmission.gsfc.nasa.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 will collect data for both weather and climate. 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.

2. Programmatic Information

Questions or comments may be directed to The Science of Terra, Aqua, and Suomi NPP Program Manager at the address given below:

Paula Bontempi
Earth Science Division
Science Mission Directorate
NASA Headquarters
Washington, DC 20546-0001
Telephone: (202) 358-1508
Email: Paula.Bontempi@nasa.gov

A.33 PRECIPITATION MEASUREMENT MISSIONS (PMM) SCIENCE TEAM

NOTICE: June 26, 2018. The point of contact (POC) for this program element has changed. The new POC is Gail Skofronick-Jackson.

1. Scope of Program

The Precipitation Measurement Missions (PMM) science team seeks investigations related to satellite observations of precipitation using measurements from, but not limited to, the Global Precipitation Measurement (GPM) Core Observatory (2014-present), GPM mission constellation partner spacecraft, and the Tropical Rainfall Measuring Mission (TRMM, 1997-2015). This program supports scientific investigations in three research categories: (1) The use of satellite and ground measurements for physical process studies to gain a better understanding of precipitation, the global water cycle, climate, weather, and concomitant improvements in numerical models from cloud resolving to climate scales; (2) development of methodologies for improved hydrological modeling and applications of these satellite measurements; and (3) continued enhancement and validation of GPM and TRMM retrieval algorithms. While the major focus of the expected research should be on GPM and TRMM satellite data products, observations from other satellite, aircraft, and ground sensors may be used for the proposed research.

Specific topics within each research category are identified below to help investigators focus on priority research needs. While research may span more than one topic, proposers should identify the primary category (only one) under which they are submitting the proposal. The appropriate box should be checked on the cover sheet.

When selecting your research category, please note that the NASA PMM program has conducted a series of field experiments designed to refine the assumptions and physical parameters in GPM precipitation algorithms and to study related physical processes. Proposals that consolidate microphysical information from GPM-related ground validation (GV) field experiments (http://pmm.nasa.gov/science/ground-validation) for the purpose of improving the GPM algorithms will be considered under the algorithm enhancement topic area and should describe how the validation effort addresses the algorithm enhancement topics below and the nature of the collaborations with the algorithm teams. Field campaign related research not specifically focused on algorithms, but instead focused primarily on understanding physical processes, should be submitted to category 2.2.

2. Research Categories

2.1. Algorithm/Data Product Enhancement and Validation

This research focus emphasizes specific topics that must be addressed to improve radar and radiometer algorithms and data products in the GPM era. Of high priority for algorithm proposals are activities that serve to advance and improve facility algorithms over all surface types for the GPM core and constellation and physically based retrieval algorithms over-land that make use of the full range of GPM data for retrievals of light to heavy precipitation and falling snow. During this funding cycle, the TRMM+GPM data

sets will be reprocessed as one record, thus these algorithm priorities span both datasets.

Important topics for algorithm enhancement include:

- Precipitation algorithm enhancement and validation for data products retrieved from the GPM Core Observatory and GPM constellation-member sensors (GMI, DPR, Combined DPR+GMI, merged multi-satellite products). Of interest are activities that extract information from the full range of radar and/or passive microwave frequencies, that improve retrievals of light rain and falling snow, that improve precipitation estimates over complex surfaces (e.g., snow covered surfaces, orographic terrain, ice sheets), and that develop innovative methods to improve the fusion of precipitation estimates from multi-instrument and/or multi-satellite platforms;
- Improvements to intercalibration of measurements from GPM radiometers, especially for the purposes of quality control and error characterization;
- Surface characterization methods and datasets, both static and dynamic, for use in GPM radiometer and combined radar-radiometer algorithms to improve the extraction of precipitation information from microwave signals over land;
- Error characterization of satellite rain and snow retrievals and/or ground-based measurements to facilitate the convergence between satellite and GV precipitation estimates;
- Development of methodologies for evaluating satellite precipitation products from non-GV sources, e.g., through assessment of parameters such as runoff, soil moisture, ocean salinity, etc.

2.2 Utilization of Satellite/GV Data Products for Process Studies and Model Development

This research focus area covers physical process studies utilizing satellite and GV data and the application of existing data sets to improve atmospheric and land-surface models ranging from cloud-resolving to climate scales. These investigations are intended to address PMM objectives of improving knowledge of precipitation systems; and improving weather, climate, and hydrological modeling and prediction.

The broad topics include:

- Use of satellite and field campaign data to study precipitation and microphysical processes, particularly for mixed-phase and frozen precipitation, and their improved representation in radiative transfer, cloud resolving, and climate models;
- Studies of precipitation to better understand storm structures, precipitation trends and extremes, water/energy budgets and variability, latent heating, freshwater resources, and interactions between precipitation and other climate parameters;
- Analysis of TRMM, GPM, and other satellite-based precipitation information for observational and modeling studies of climate (global and regional variability, ENSO, etc.) and weather (tropical convection, hurricanes, midlatitude convection and baroclinic weather systems, snow storms).

2.3 Methodology Development for Improved Application of Satellite Data Products

This research area focuses on the development of methodologies that combine

information from observations and models to produce improved analyses of precipitation, downscaling of satellite precipitation estimates to hydrometeorological relevant scales, improved hydrological modeling and prediction, improved application of satellite products in numerical weather prediction and data assimilation, and the use of satellite precipitation data in applications. These topics include:

- Use of satellite and field campaign data to evaluate and improve land surface and hydrological models and parameterizations;
- Development and implementation of data assimilation techniques for improved analyses and forecasts of significant weather (e.g., tropical cyclones and floods), 4-D assimilated climate data sets using satellite-based precipitation measurements, and downscaling of satellite precipitation information for hydrological modeling and prediction;
- Quantitative error characterizations of precipitation-affected radiances and instantaneous precipitation rates and their use in weather forecasting and data assimilation systems;
- Downscaling of high-resolution precipitation data and innovative hydrological modeling to advance predictions of high-impact natural hazard events (e.g., flood/drought, landslide, and hurricanes);
- Development of other precipitation-related applications that make use of GPM data for monitoring and decision support systems with targeted end-users across thematic areas including agriculture, modeling, ecological forecasting, disease tracking, precipitation-related disasters, and others listed at http://pmm.nasa.gov/applications.

3. Other Federal Agencies

Principal and Co-Investigators from other U.S. Federal agencies are eligible to respond to this program element. However, they must provide an explanation for why their own agencies are not supporting the proposed research and how the proposed work relates to the ongoing work at their agency.

3.1 GPM Algorithm Work Package Support

Principal investigators of the efforts associated with algorithm/data maintenance activities in the proposals selected for funding through Internal Scientist Funding Model (ISFM) at NASA Centers are barred from proposing to this program element. Related proposed activities by Co-Investigators working with the current ISFM work package PIs may be considered if the priorities and funding warrant the selection of such proposals. However, any such proposal must clearly state the relationship of the proposed work to that of the work package. Currently funded ISFM proposals and associated "abstracts" are provided at https://pmm.nasa.gov/.

4. Number of Review Panels

All submitted proposals are expected to be reviewed in one of three panels. It is expected that research categories 2.1, 2.2, and 2.3 will receive approximately 40%-30%-30% respectively of the available funding, but the proportions may be adjusted according to the needs of the PMM program at the time of the panels.

5. Summary of Key Information

Expected program budget for first year of new awards	~$6.0M/year
Number of new awards pending adequate proposals of merit	~40-50
Maximum duration of awards	3 years
Planning date for start of investigation	6 months after proposal due date.
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 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*.
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.
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	NNH18ZDA001N-PMMST

NASA point of contact concerning this program **[Changed June 26, 2018]**	**Gail Skofronick-Jackson** Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 **Email: gail.s.jackson@nasa.gov**

A.34 STUDIES WITH ICESAT-2

NOTICE: June 10, 2019. This program will not be solicited in ROSES-2018. Instead, it has been released in ROSES-2019 as program element A.36 Studies with ICESat-2..

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 the most advanced, highest-resolution altimetry instrument ever placed in Earth orbit. ATLAS is a photon-counting lidar with six beams and ICESat-2's near-polar orbit is optimized to enable it to characterize elevation changes in Earth's polar ice. The mission collects measurements globally – away from the poles – particularly to enable independent determination of vegetation height, but also to support research in hydrology, oceanography, atmospheric sciences, and other Earth and applied sciences.

Given the exciting scientific opportunities presented by the mission's unprecedented volume of high-resolution Earth observations, for proposers to this program element NASA requires *Open Science* approaches to accelerate the pace of scientific advancement (see section 5.2). NASA also encourages researchers to utilize emerging methods in scientific data analysis, including but not limited to: machine learning, cloud-based processing, and integration of ICESat-2 results with advanced Earth system models. Low-cost, highly experimental proposals are especially encouraged.

Principal Investigators (PI) of the proposals selected under this program have additional responsibilities as members of the ICESat-2 Science Team (I2ST).

2. Background: ICESat-2, ICESat, IceBridge, and CryoSat-2

ICESat-2 (https://icesat-2.gsfc.nasa.gov/) was developed based on recommendations from the National Academies of Science, Engineering and Medicine's report *Earth Science and Applications from Space National Imperatives for the Next Decade and Beyond (2007)* (https://www.nap.edu/catalog/11820/earth-science-and-applications-from-space-national-imperatives-for-the) to continue the satellite laser altimetry studies of Earth's polar ice begun by ICESat. The Academies' successor report, *Decadal Survey for Earth Science and Applications from Space (2017-2027)* (http://sites.nationalacademies.org/DEPS/esas2017/index.htm), requires an ongoing commitment to existing and planned instruments and satellites in the *Program of Record* that includes ICESat-2.

ICESat-2's single instrument, the Advanced Topographic Laser Altimeter System (ATLAS), is a six-beam, photon-counting lidar operating at 10 kHz. Each beam has a ground-footprint of ~17 meters in diameter, offset by 0.7 meters along-track. The six beams are organized into three pairs - consisting of strong and weak beams offset by 90 meters - that are separated from adjacent pairs by 3.3 kilometers. In addition to providing more observations than a single beam, the multibeam/pair configuration enables direct measurement of instantaneous surface slope over the land ice of

Greenland and Antarctica. With an orbital inclination of 92 degrees, ICESat-2 has a 91-day repeat orbit for observations over the polar regions. 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.

2.1 ICESat and IceBridge

ICESat-2's predecessor is the original Ice, Cloud, and land Elevation Satellite (ICESat) mission that launched in January 2003 and ceased operations in 2009 (http://icesat.gsfc.nasa.gov/). The ICESat instrument was the Geoscience Laser Altimeter System (GLAS), a single beam, full-waveform lidar operating at 40 Hz with ground-footprints of 70 meters diameter offset by 170 meters along-track. With an orbital inclination of 94 degrees, ICESat observations provided critical insight into the thinning of the Arctic sea ice cover, ice loss from the continental ice sheets of Greenland and Antarctica, and the global distribution of above-ground biomass. Limitations on ICESat laser lifetime led to a revised measurement-strategy. It was originally intended that GLAS would operate continuously with a 91-day repeat orbit—similar to the approach now used by ICESat-2 - but to extend GLAS's diminished laser life, this approach was altered to discrete campaigns with a 33-day near-repeat subcycle of the 91-day orbit surveyed at six-month intervals. ICESat data are available at http://nsidc.org/data/icesat/.

The gap between ICESat and ICESat-2 has been bridged by NASA's Operation IceBridge (http://www.nasa.gov/mission_pages/icebridge/index.html), a series of aircraft campaigns deploying lidar and other instruments over land and sea ice in both polar regions. The IceBridge instrument suite and flight plans are designed to specifically extend the record of ICESat to ICESat-2, and offer some calibration and validation of ICESat-2 and the European Space Agency's CryoSat-2, launched on April 8, 2010. IceBridge also deploys radars for mapping snow cover and the underlying bed, as well as gravimeters and other instruments. IceBridge data and instrument descriptions are available at http://nsidc.org/data/icebridge/.

2.2 CryoSat-2

A key, on-orbit satellite altimetry mission relevant to ICESat-2 is the European Space Agency's CryoSat-2. A radar altimetry mission, CryoSat-2 also measures sea ice freeboard, land ice elevation, and makes other geophysical measurements. Details about the Cryosat-2 mission are available at http://www.esa.int/esaMI/Operations/SEM36Z8L6VE_0.html.

3. ICESat-2 Data Products and Cloud-based Resources

ATLAS is a photon-counting lidar that determines surface elevations using the time-of-flight of a single photon. Data processing differs from that for traditional full-waveform lidar systems and results in very large volume products.

3.1 ICESat-2 Data Products

To facilitate research with ICESat-2, algorithms and data products (https://icesat-2.gsfc.nasa.gov/science/data-products) have been developed to support a range of users, from those requiring base telemetry through to modelers requiring gridded

geophysical data. Included among these are fifteen separate science-specific products - ATL06 to ATL21 - covering land and sea ice, vegetation and ecosystem structure, inland water height, sea surface topography, and various aspects of the atmosphere.

ICESat-2 data can be accessed 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 collects ~1 Terabyte (Tb) of data per day globally. While the processed data products are smaller (ATL03, for example, is ~0.5 Tb per day), moving, processing, and analyzing such volumes of data are challenging. Despite the barriers to entry, 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. To minimize data movement, ADAPT hosts all 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 may incorporate ADAPT into their work plans at the proposal stage.

4. Scope of Program

This program element solicits proposals to pursue any research topic using ICESat-2 observations and advancing the Earth Science goals articulated in the *NASA 2018 Strategic Plan* and *2014 Science Mission Directorate Science Plan* (both of which may be found at http://science.nasa.gov/about-us/science-strategy/).

NASA recognizes that ICESat-2's global, high-resolution data stream presents an exciting opportunity to utilize emerging methods in data analytics, including but not limited to artificial intelligence, machine learning, and data mining with applications to analysis, data fusion, and coupling-models-with-observations. The program welcomes proposals that team computer scientists and Earth system scientists. In addition, NASA recognizes that some of the initial applications of these approaches to Earth science may be exploratory, and a portion of the budget has been reserved for low-cost, highly experimental proposals of varying duration. The estimated budget in Section 9, *Summary of Key Information,* provides guidance for scoping proposal budgets.

Overall priority will be given to investigations focused on land and sea ice in the Earth's polar regions. Other areas of Earth science research will be considered at a lower priority, but NASA anticipates supporting several such investigations.

4.1 Polar Ice Research

For polar ice research, the program is open to the consideration of any type of Earth science research based on ICESat-2 observations. Data products (https://icesat-

2.gsfc.nasa.gov/science/data-products) developed by the ICESat-2 Project to support such work include:

- Ice elevation (ATL06 and 07);
- Sea ice freeboard and ice height (ATL10 and 11);
- Gridded geophysical data derived from these products (ATL14, 15, 20, and 21); and
- Polar cloud fraction, blowing snow frequency, ground detection frequency (ATL16/17).

Investigations that may particularly be enabled by ICESat-2 include but are not limited to:

- Using observations of elevation change to characterize physical processes controlling growth and retreat of polar ice, including connections to climate forcings;
- Gaining insight into ice surface mass balance, especially to improve representations of polar precipitation and surface melting/sublimation in Earth system models;
- Characterizing the dynamic processes controlling ice motion and elevation change, especially to improve land ice models for sea level rise projections or sea ice models to understand couplings to the Earth system; and
- Integrating ICESat-2 with other satellite and airborne altimetry observations to create multidecadal records that offer insight into the drivers of polar change.

Investigators are encouraged to use other geophysical data and integrate their results with Earth system models as appropriate, including:

- Altimetry observations from ICESat, IceBridge, and CryoSat-2;
- Other remote sensing observations that complement ICESat-2, such as those from GRACE-FO, InSAR, and other satellite missions; and
- Outputs and refinements to Earth system models, such as NASA's GEOS5 (https://gmao.gsfc.nasa.gov/GEOS/), ISSM (https://issm.jpl.nasa.gov/), ECCO (https://ecco.jpl.nasa.gov/), and other non-NASA models.

4.2 Research Foci Outside of Polar Ice

Beyond polar ice studies, this program element welcomes proposals based on ICESat-2 observations on any research topic that advance the Earth Science goals articulated in the *NASA 2018 Strategic Plan* and *2014 Science Mission Directorate Science Plan* (both of which may be found at http://science.nasa.gov/about-us/science-strategy/).

Potential topics include but are not limited to:

- Ecosystem structure and estimation of biomass;
- Change in the major glacial systems of Alaska, Canada, and High Mountain Asia;
- Atmospheric processes, especially precipitation and cloud properties relevant to interpretation of polar processes and affecting interpretation of ICESat-2 observations;
- Altimetry of the polar and global oceans;
- Bathymetry of oceans and inland-water;
- Inland-water hydrologic information, such as river and lake heights;

- Snow volume estimates;
- Aquatic retrievals related to ecology or biogeochemistry;
- Land surface studies; and
- Any area of *Applied Sciences* as defined in the *2014 Science Mission Directorate Science Plan*.

To facilitate such research with ICESat-2, algorithms and data products (https://icesat-2.gsfc.nasa.gov/science/data-products) have been developed to support a range of users, including:

- Land and water elevation, including forest canopy height and other surface properties:
  - Along each beam (ATL08)
  - Gridded (ATL18);
- Cloud characteristics (ATL09);
- Polar cloud fraction, blowing snow frequency, ground detection frequency (ATL16/17);
- Ocean elevation (ATL12);
- Mean Sea Surface (ATL19); and
- Inland water Height (ATL13).

5. Proposal Requirements

Proposers are encouraged to address each of the following four sections (5.1-5.4) separately in their proposals.

5.1 ICESat-2 Science Team: Membership, Meetings, and Team Leader

5.1.1 *Team Membership and Expectations*

In addition to their proposed research activities, Principal Investigators (PI) selected under this program have additional responsibilities as members of the *ICESat-2 Science Team* (I2ST). The team will:

- Accelerate ICESat-2 science by Open Science approaches (Section 5.2) ;
- Report to NASA Headquarters on mission operations;
- Provide guidance to the ICESat-2 Project Office for mission planning, as requested; and
- For proposals focused on research outside of polar ice, the PI/Team Member will serve as representative of the mission to their primary scientific community.

All proposers must describe anticipated I2ST contributions and their approach to *Open Science* (see Section 5.2). 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.

5.1.2 *Meetings*

There will be at least two in-person, 3-day meetings of I2ST each year in varying locations within the United States. It is expected 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.

5.1.3 *Team Leader*

The I2ST will be led by a Team Leader who will organize the team meetings, support the Project Science Office, report to NASA Headquarters, and be responsible for producing a yearly team report. Proposers wishing to serve as Team Leader must state so in their proposal, and are allowed up to two (2) additional pages to describe their qualifications, interests, and approaches to leadership, including facilitating Open Science approaches. These two addional pages should be set aside as a separate Appendix at the end of the proposal and appropriately titled. Team Leader activities should not be included in the proposal budget. The Team leader will receive an additional $80,000 per year to support his/her leader activities, and the successful proposer will revise the budget during final award negotiations.

5.2 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; and
- Depositing research output in FAIR archives.

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 OS in their work plans to achieve the following goals:

- 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.
- Workflows are documented to facilitate sharing of advances and validating results, by:
  - Utilizing open-source digital notebooks—such as Jupyter Notebook (http://jupyter.org/) - that document and demonstrate workflow;
  - Regular uploads to appropriate open code repositories—such as Github (https://github.com/) - of digital notebooks and other codes, either by using these repositories as continuous, open development environments or by making separate uploads to these repositories at intervals of no more than six months during conduct of the investigation; and

- Ensuring critical ancillary datasets are available in ready-to-use subsets and formats via open archives and/or the relevant NASA Distributed Active Archive Center (https://earthdata.nasa.gov/).
- Crediting individuals making similar pre-publication contributions wherever possible through co-authorship and other methods.

NASA requires proposals to specifically address each of these goals and will evaluate proposals with regards to their likelihood for success.

5.3 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).

In addition, all software developed under this program element is to be designated and distributed to the public as *open source software* using *Apache License 2.0* (https://www.apache.org/licenses/LICENSE-2.0) or a less restrictive license. Software developed under this program may be created to operate in conjunction with commercial or other restricted-use software (such as MATLAB, ENVI, and ArcGIS), but must be licensed separately from that software.

5.4 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).

6. Fieldwork and Aircraft

This program element will not support major field deployments. Small field programs to improve calibration and validation of ICESat-2 data products may be considered, but proposers should review and consider the estimated budget in Section 9, the 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.

Proposed investigations that would utilize logistics support provided by the National Science Foundation’s Office of Polar Programs must follow the instructions in their current Arctic and Antarctic research solicitations (https://www.nsf.gov/funding/programs.jsp?org=OPP) for planning fieldwork and estimating costs. For Arctic fieldwork, this includes obtaining and submitting a separate cost estimate document to be uploaded with the proposal budget.

Investigators proposing activities involving aircraft must contact Mr. Bruce Tagg (Bruce.Tagg@nasa.gov), SMD's Airborne Science Program Manager, during proposal preparation to discuss aircraft selection, budgeting, and airworthiness. NASA's airworthiness requirements and assessment processes apply to any aircraft activities supported by NASA, including those that use non-NASA aircraft. Proposals must include the costs to NASA of aircraft operations in the budget.

7. Additional Evaluation Criteria

The primary evaluation criteria are given in Section IV.(a) of the ROSES-2018 *Summary of Solicitation*. In addition to the definition of Merit given in Appendix D of the *NASA Guidebook for Proposers* , the evaluation criterion Intrinsic Merit specifically includes the following factors to apply to the requirements of Sections 5.1 through 5.4:

- Approach to *Team Membership and Expectations* (Section 5.1);
- Likelihood of achieving *Open Science* goals (Section 5.2);
- Compliance with *Open Source Software* requirements (Section 5.3); and
- Compliance with Data Policy for new data products (Section 5.4).

Proposers are encouraged to address each of these sections separately in the proposal.

8. Programmatic Information

Results from investigations supported under this ROSES element are expected to advance the Earth Science goals articulated in the *NASA 2018 Strategic Plan* and *2014 Science Mission Directorate Science Plan*, as well as associated Federal Research Objectives; especially those of:

- The *U.S. Global Change Research Program* (http://www.globalchange.gov/); and
- The *Interagency Arctic Research Policy Committee's* Arctic Science Research Plan (https://www.iarpccollaborations.org/plan/index.html).

9. Summary of Key Information

Point of contact concerning this program	Colene Haffke Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0065 Email: colene.m.haffke@nasa.gov

A.35 SERVIR APPLIED SCIENCES TEAM

NOTICE: Amended February 4, 2019. As a result of the partial government shutdown and concomitant delay in the review of Step-1 proposals, the date by which NASA plans to announce Step-1 selections is now April 19, 2019, and the Step-2 proposal due date is now July 19, 2019. New text is bold and deleted text is struck through.

This program element uses a binding two-step proposal process, in which the Notice of Intent is replaced by a required five-page Step-1 proposal that must be submitted by an Authorized Organizational Representative. Only those organizations that are invited to do so may submit a Step-2 proposal. See Section 4 for details.

Two Preproposal telecons will occur. Telecon A will be on March 14, 2018. For more information, visit https://www.servirglobal.net/AST-TeleconA. Telecon B will be on September 13, 2018. For more information visit https://www.servirglobal.net/AST-TeleconB.

1. Introduction and Background

1.1 Overview

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 program element 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 program element 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.

This program element will use a two-step selection process. A brief Step-1 proposal evaluation will identify proposers that NASA will invite to prepare an in-depth Step-2 proposal. The invited proposers are expected to collaborate with SERVIR regional hub representatives in developing their Step-2 proposals by defining the scope of their projects to ensure the proposals align with regional needs.

1.2 Applied Sciences Program Objectives

Within the Earth Science Division (ESD) of NASA's Science Mission Directorate (SMD), the Applied Sciences Program discovers and demonstrates innovative uses and practical benefits of NASA Earth science and data from Earth-observing satellites. The Program partners with organizations from the public and private sector to apply scientific findings and satellite data in their decision-making activities. The Program has three primary areas of operations: applications, capacity building, and mission planning.[1] 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. By working with partners and continuing to build new collaborations, the Applied Sciences Program is identifying ideas and priorities for new applications.

Within the Applied Sciences Program, the Capacity Building program sponsors projects that improve the capabilities of decision makers, community leaders, and resource managers in the United States and abroad to access and apply Earth observations data, products, and tools. A variety of methods and approaches are employed and experimented with to better build capabilities in individuals and institutions. These activities build capacity within the United States and the developing world to expand the Earth observations user base, and build the capacity of nontraditional audiences to be aware of and able to use Earth observations in decisions and actions. The SERVIR program element is within the Capacity Building program. More information is available through the Applied Sciences Program's website at http://appliedsciences.nasa.gov/.

1.3 SERVIR Objectives

SERVIR partners with regional, technical institutions around the globe, establishing SERVIR "hubs" within those institutions, to help them become stronger service providers to assist their member countries in improving the information used in development decision-making. Government policy makers and resource managers comprise the primary target audiences for SERVIR hubs. The goal of SERVIR is to improve environmental management and resilience by strengthening the capacity of governments to integrate Earth observation information and geospatial technologies into development decision-making. SERVIR has organized thematic priorities along four thematic service areas: Agriculture and Food Security, Water Resources and Hydroclimatic Disasters, Land Cover and Land Use Change and Ecosystems, Weather and Climate (see Section 2.4). Within each thematic service area, SERVIR provides services, which are comprised of any or all combinations of data, products, tools, applications, platforms, and training to meet the needs of users. SERVIR provides services to accomplish the following results in each region:

[1] The Program's applications themes align with the societal benefit areas of the international Group on Earth Observations: Biodiversity and Ecosystem Sustainability, Disaster Resilience, Energy and Mineral Resource Management, Food Security and Sustainable Agriculture, Infrastructure and Transportation Management, Public Health Surveillance, Sustainable Urban Development, and Water Resource Management. Applications refer to the use of remotely sensed observations and derivatives, modeling products, *in situ* data or any combination thereof, to generate outcomes of relevance and utility to the end user or decision maker.

1. Building the capacity of analysts and decision makers to use Earth observation information and geospatial information technologies;
2. Improving awareness of and access to available services; and
3. Providing user-tailored services to inform development decision-making.

An important related objective is to build the capacity of SERVIR hubs and their partners to provide high quality services, creating a stronger network at the regional level. NASA supports the SERVIR Science Coordination Office (SCO), which provides science coordination and opportunities for exchange among partners to create a global, interconnected network.

SERVIR hub host institutions have a unique set of characteristics, including political buy-in from member countries; technical capabilities in remote sensing, geographic information systems, and database management; and established relationships with users. SERVIR's network of hubs includes:

- Eastern and Southern Africa region. The regional hub is hosted by the Regional Center for Mapping of Resources for Development (RCMRD) in Nairobi, Kenya;
- Hindu-Kush-Himalayan region. The regional hub is hosted by the International Center for Integrated Mountain Development (ICIMOD) in Kathmandu, Nepal;
- Lower Mekong River region. The regional hub is hosted by the Asian Disaster Preparedness Center (ADPC) in Bangkok, Thailand; and
- West Africa region. The regional hub is hosted by AGRHYMET in Niger, and is supported by a consortium of regional technical partners, including CSE, CERSGIS, and ACMAD.
- Amazonia region. The acquisition of the regional hub in TBD country(ies) is underway at the time of this program element release.

Each regional hub works with a number of focus countries. NASA and USAID have selected subsets of countries as foci for this program element:

- SERVIR Eastern and Southern Africa: Foci are Ethiopia, Kenya, Malawi, Rwanda, Tanzania, and Uganda;
- SERVIR Hindu Kush Himalaya: Foci are Afghanistan, Bangladesh, Burma, Nepal, and Pakistan;
- SERVIR Mekong: Foci are Burma, Cambodia, Laos, and Vietnam; and Thailand and other countries as a part of the broader regional perspective;
- SERVIR West Africa: Foci will be Burkina Faso, Ghana, Niger, and Senegal; and
- SERVIR Amazonia: Foci will be Brazil, Columbia, Peru, Suriname, and Guyana.

A list of all countries supported by the respective hubs can be found on www.SERVIRGlobal.net.

SERVIR Global works with regional hubs and their national users to co-develop services to meet their specific requirements. SERVIR also makes these available to the public and other potential users via an online portal. The SERVIR Global website, including region-specific pages linking to regional geoportals, can be found at www.SERVIRGlobal.net, and the product catalog can be found at https://www.servirglobal.net/ - productcatalog.

Additional reference information about SERVIR is provided in Section 6.

2. Scope of Program Element

This section describes the scope of the SERVIR Applied Sciences Team, Team members, priority topics, and project timeline. This section also provides specific suggestions and considerations.

2.1 SERVIR Applied Sciences Team

The Applied Sciences Program invites proposals for membership on the third SERVIR Applied Sciences Team and Team member projects through this program element. The primary purpose of this Team is to improve, enrich, and expand the use of Earth observations in the countries associated with the SERVIR regions based on the needs of the region. The Team will be a resource and base of expertise in research, applications, information utilization and management, and innovation that the SERVIR SCO and regions can draw on, consult, and engage.

It is expected that the Team will collectively possess a range of experience, skills, and expertise related to user engagement, decision support, Earth science, monitoring and evaluation, applied science, and international development. Selected participants will likely include social scientists and economists, Earth science researchers, technical experts, modelers, geospatial experts, visualization specialists, applications specialists, international development specialists, and others.

A SERVIR SCO representative will serve as the Team Lead and will be supported by the AST Portfolio Manager. In addition to the Lead, the AST will have one "thematic service area lead" for each of the four topic areas (see Section 2.4) with an aim to synergize and integrate the AST projects in that thematic service area across SERVIR regions. Proposers are asked to identify their interest in serving as a Thematic Service Area Lead.

Key objectives of the Team are to:

- Advance innovative and practical uses of Earth observations serving regional and/or national needs for decision-making through co-development of solutions with SERVIR regional hubs.
- Strengthen the capacity of regional hubs and national users to use Earth observations in decision-making.
- Provide an expert knowledge base for the SERVIR regions and the SERVIR SCO.
- Provide feedback to NASA regarding usability and usefulness of satellite data and derived products for fulfilling the needs of decision makers in developing[2].
- Identify potential new data products of value to users.

Key responsibilities of the Team are to:

- Share information with each other and the SERVIR network.

[2] Feedback may be provided to the NASA SERVIR Science Coordination Office, the NASA data centers, science teams, the Applied Sciences Program, and/or missions in development including their early adopters programs.

- Share lessons learned to assist other AST members and the SERVIR network.
- Communicate across regions along each thematic service area to assist in inter-hub collaborations.
- Communicate regionally across each thematic service area to assist in holistic multidisciplinary perspectives and decision-making.

While each selected PI may have co-investigators or collaborators on their own project, only the PI will serve a member of the overall AST. Thus, proposers should not propose an entire Applied Sciences Team. This program element is expected to select the Team comprised of approximately 20 members.

The success of the Team depends on active collaboration with the hubs and with other team members. NASA ASP judges the success of the SERVIR AST through monitoring of a set of performance metrics that include two major attributes – collaboration with the hub and users in the region of study, and collaboration across the team.

2.2 Team Members

Each Team member will work primarily with one hub region. In collaboration with regional hub institutions, members will conduct activities, such as workshops and assessments, to identify gaps in hub and user capabilities, present approaches their project is taking to address the gaps to get feedback, and define measures of success. Each Team member will co-develop elements of services with SERVIR regional hubs to support identified needs in a thematic service area with their respective region's hub personnel and national users. Members will assist the SERVIR SCO and the respective regional hub in product transfer to the user through training and capacity building activities. The Team members will also support training and capacity building for the other SERVIR regions, as needed.

The PIs selected ("invited") to submit Step-2 proposals are expected to include SERVIR regional hub scientists as collaborators/co-Is on their project. These scientists will join in the co-development of the service and should be considered a part of the respective project team. SERVIR regional hub participation and co-development will be funded separately.

2.3 Thematic Service Area Projects

Each Team member's thematic service area project will contribute to hub services and may include data, products, tools, platforms, and training. The AST projects are not expected to deliver an entire service for the hub, instead the AST projects are expected to co-develop elements of the service identified by the hub. SERVIR's past experience shows that a clear and comprehensive articulation of assumptions, as well as identification of inputs, outputs, intended outcomes, and ultimate impact, is necessary to evaluate project effectiveness. This information (termed theory of change[3]) is used by the SERVIR hubs for each service the hubs develop. AST projects should ensure their projects are integrated into existing/evolving theories of change created by the hubs.

[3] A theory of change is a description of the logical causal relationships between multiple levels of conditions or interim results needed to achieve a long-term objective. It outlines pathways or steps to get from an initial set of conditions to a desired end result. A theory of change is analogous to a project hypothesis.

2.4 Priority Topics

Applicants for the Team should propose projects aligned with one or more of the thematic service areas and regions based on the needs described below. The following priority thematic service areas and topics are based on a) regional consultation and needs assessments conducted in the SERVIR regions and b) Applied Sciences applications areas (see Section 1.2). Investigators are encouraged to propose projects to address needs in all or part of a SERVIR region. In collaboration with the regional hubs, the awardees are expected to contribute to hub services and demonstrate them in the planned user environment. The user environment includes, but is not limited to, geospatial information systems (GIS), web map services and Internet bandwidth limitations. Available Internet bandwidth is an important consideration given connectivity challenges in some SERVIR regions. The awarded projects, as part of the application development, are expected to transfer the routine execution of the developed applications to the regional hubs and their users. In addition, it is expected that the project team will transfer the application, including source code and other relevant information, to the SERVIR hubs and SCO for archival purposes.

Priorities are organized by thematic service area and by region. Each AST project is expected to contribute to regional hub thematic services. All projects are expected to address short-term to seasonal forecasts to enable SERVIR's goal to improve environmental management and resilience. A general overview of regional and thematic services across the SERVIR network is provided below. Several of the services have a strong collaborative role by the current and previous SERVIR AST. The thematic service areas for this program element are Agriculture and Food Security, Water Resources and Hydroclimatic Disasters, Land Cover and Land Use Change and Ecosystems, Weather and Climate.

2.4.1 *Agriculture and Food security*

SERVIR is focusing on several services within this thematic service area, and a listing of ongoing regional services is given below. These services indicate the direction of services that will likely be undertaken by the SERVIR hubs in years to come. Across the network, this thematic service area focuses on drought management, improved accuracies in agricultural yield and area estimation, rangeland management, and pastoralism. Proposals are strongly encouraged to focus on supporting the services being developed in the region.

SERVIR-Eastern and Southern Africa. SERVIR E&SA has several ongoing services, including regional cropland and rangeland drought monitoring. Proposals are encouraged to address agricultural yield assessment uncertainties for key agricultural value chains across timescales from seasonal to annual. Proposals are also encouraged to improve drought assessment, methods for in-season cropland mapping for key agricultural value chains such as maize, and biomass assessments for rangelands. Data sets supporting the region's upcoming crop insurance partnerships are also encouraged.

SERVIR-Himalaya. SERVIR-HKH has several ongoing services, including regional drought monitoring and early warning system, Agro-met advisory service, food security vulnerability information system, and wheat sown area assessment

service. Proposals are encouraged to build on existing services that address agricultural drought and crop productivity assessments, examining seasonal and longer-term climate scenarios and agricultural drought characterizations and forecasts. Creation and characterization of data sets supporting crop insurance markets would be valuable.

SERVIR-Mekong. SERVIR Mekong is focusing on regional drought forecasting, supporting national and provincial government entities for improved agricultural planning, and on crop type mapping. Proposals are encouraged to address agricultural area mapping, and improving crop yield estimation and forecasting accuracies. Proposal ideas adding value to the ongoing services are encouraged.

SERVIR-West Africa. SERVIR-West Africa's ongoing services include locust monitoring and rangeland degradation. Proposals that offer an innovative expansion of this service are welcome. Proposals that address Earth observations-based estimation of crop planted areas and agricultural productivity assessments are welcome, especially examining the impacts of seasonal forecasts on agricultural drought characterizations, and rangeland management.

SERVIR-Amazonia. SERVIR-Amazonia is expected to start in 2018. The hub is expected to focus on ways to improve the drought forecasting tools and their impacts on reducing food insecurity in the region. Proposers are encouraged to use of satellite-derived products in a holistic drought assessment.

2.4.2 *Water Resources and Hydroclimatic Disasters*

SERVIR is focusing on several services within this thematic service area, and a listing of ongoing regional services is given below. These services indicate the direction of services that will likely be undertaken by the SERVIR hubs in years to come. Across the network, this thematic service area focuses on streamflow and flood modeling and early warning systems, Proposals are strongly encouraged to focus on supporting the services being developed in the region.

SERVIR-Eastern and Southern Africa. SERVIR E&SA is focused on regional streamflow monitoring and forecasting, as well in satellite-based water quality monitoring services. Proposals are encouraged to support the ongoing services by improving the holistic assessments of agriculture and water, focusing on seasonal and annual forecasts; and drought characterizations and forecasts with an aim to create and support a robust framework for decision makers in integrated water resource management. Proposals are also requested to focus on co-developing an impact-based flood early warning system with users, that links hydrologic forecasts with vulnerability assessment and risk analysis.

SERVIR-Himalaya. SERVIR-HKH is focusing on river/floodplain information management system and flood early warning system. Proposals are encouraged to build on the work already done in hydrologic modeling and short-term to seasonal forecasting of floods by adding quantifiable uncertainty estimation, flash flood estimation and forecasting, landslide probability estimation, holistic assessments of agriculture and water, and focusing on seasonal forecasts. Proposals are encouraged that link the latest relevant science from the High Mountain Asia Team (HiMAT) to SERVIR-HKH services.

SERVIR-Mekong. SERVIR-Mekong is focusing on services that are improving flood modeling and forecasting. Proposals are encouraged to support ongoing services by improving the forecasting accuracies, as well as on salt-water intrusion, sediment transport and holistic assessments of agriculture and water, focusing on seasonal forecasts. Proposals are welcome to address landslide risk assessment and monitoring of land subsidence.

SERVIR-West Africa. SERVIR West Africa is focusing on ephemeral water body mapping in Senegal and on groundwater status assessments. Proposals are encouraged to support the ongoing services, either in geographical scope or accuracy and spatial extent improvements. Proposals that address groundwater replenishment are encouraged. Flood modeling and forecasting, especially using short-term and seasonal forecasts will add value to ongoing work at the hub.

SERVIR-Amazonia. SERVIR-Amazonia is expected to start in 2018. The hub is expected to focus on ways to improve regional flood forecasting, especially in accurate timing and magnitude of floods. Proposals are encouraged to focus on improved hydrologic modeling products that can effectively use available ground observations for improved characterization of floods.

2.4.3 *Land Cover and Land Use Change and Ecosystems*

SERVIR is focusing on several services within this thematic service area, and a listing of ongoing regional services is given below. These services indicate the direction of services that will likely be undertaken by the SERVIR hubs in years to come. Across the network, this thematic service area focuses on regional landcover monitoring, forest vulnerability management system streamflow and flood modeling and early warning systems. Proposals are strongly encouraged to focus on supporting the services being developed in the region.

SERVIR-Eastern and Southern Africa. SERVIR E&SA services target land cover change mapping as well as invasive species mapping. Proposals are encouraged that can support the regional hub improve and connect land cover mapping efforts with sustainable landscapes and ecosystem services. Proposals are also encouraged in ecosystem valuation that will enable the hub and users to determine the impact of human activities on environmental systems by assigning an economic value.

SERVIR-Himalaya. SERVIR-HKH is focusing on regional land cover monitoring system, through development of primitive layers of biophysical quantities that can be deduced using Earth observations. Proposals are encouraged that can bring innovative primitives to the region with an aim of supporting the regional goals of sustainable landscapes and ecosystem services. Proposals are encouraged that link the latest relevant science from the South/Southeast Asia Research Initiative (SARI) to SERVIR-Himalaya services.

SERVIR-Mekong. SERVIR-Mekong is improving the regional landcover monitoring system with additional datasets, as well as supporting integrated land cover management toolbox for Cambodia's protected areas. Proposals are encouraged that can support enhancement of ongoing services at the regional hub to connect land cover maps with sustainable landscapes and ecosystem services. Proposals

that address crop type mapping are welcome. Proposals are encouraged that link the latest relevant science from the South/Southeast Asia Research Initiative (SARI) to SERVIR-Mekong services.

SERVIR-West Africa. SERVIR West Africa is working on deforestation precursor assessments. Proposals are encouraged to support this service, in addition to assessing potential areas of urban and agricultural expansions in next several years.

SERVIR-Amazonia. SERVIR-Amazonia is expected to start in 2018. The hub is expected to focus on the decision makers' need for an integrated development planning that prioritizes biodiversity conservation and ecosystem services. Proposals are encouraged to address the ecosystem services through a holistic perspective.

2.4.4 *Weather and Climate*

SERVIR is focusing on several services within this thematic service area, and a listing of ongoing regional services is given below. These services indicate the direction of services that will likely be undertaken by the SERVIR hubs in years to come. Across the network, this thematic service area focuses on monitoring extreme weather and integrated vulnerability assessments. Proposals are strongly encouraged to focus on supporting the services being developed in the region.

SERVIR-Eastern and Southern Africa. SERVIR E&SA services are expanding on their work in integrated disaster vulnerability and impact assessments. Proposals are encouraged to seek innovative ways to build on existing services to improve the vulnerability assessment methodologies. SERVIR E&SA is working closely with existing regional climate experts, such as the IGAD Climate Prediction and Applications Center (ICPAC) in Nairobi, Kenya. Proposals are encouraged that enhance work being done at ICPAC and SERVIR E&SA to quantify the uncertainties in sub-seasonal to seasonal forecasts.

SERVIR-Himalaya. SERVIR-HKH is focusing on monitoring extreme weather, and connecting the forecasts to hydrologic models. Proposals are encouraged to seek innovative ways to examine impacts of weather variability on sub-seasonal to seasonal, annual timescales to help users in the region with improved forecasting capability in hydrology, agriculture and beyond.

SERVIR-Mekong. In this thematic service area, proposals are encouraged to seek innovative ways to examine impacts of variability on sub-seasonal to seasonal to help users in the region, such as Mekong Regional Commission, with a comprehensive forecasting capability in water resources and agriculture.

SERVIR-West Africa. In this thematic service area, proposals are encouraged to seek innovative ways to link in sub-seasonal to seasonal forecasts for improved water and agricultural productivity. Proposals that link remotely sensed datasets and products to augment the capabilities of African Center of Meteorological Application for Development (ACMAD) for regional weather scale and longer forecasts are welcome.

SERVIR-Amazonia. SERVIR-Amazonia is expected to start in 2018. The hub is expected to focus on the decision makers' need to measure the impact of weather

and climate on the Amazonian ecosystem, especially in the context of length of dry season. Proposals that seek innovative ways to link seasonal forecasts to provide quantifiable estimate of uncertainties in dry season length and onset of rains are welcome.

2.5 Timeline of Projects

2.5.1 *Year 1 of Project*

During the first year of the project, the Team is expected to:

- Align the project activities (defined during the Step-2 proposal development process; see Section 4) with the identified needs of the user. During the first year, the regional hub institution will liaise with the users as part of the hub's consultation and needs assessment process and will make the connection between the project and the user activities.
- Contribute to the hub's service concept, as well as service design documents[4] and begin work along the project plan.
- Provide bi-monthly updates and develop an annual report and presentation at the end of Year 1 based on the interaction with the regional hub regarding the user needs.
- Actively participate in technical interchange teleconferences and meetings with the SERVIR SCO, USAID-Washington and regional mission, SERVIR Support Team, regional hub personnel, and other Team members.
- Provide an obligation and costing phase plan within two months after award and designate a point of contact in the PI's financial accounting department. In support of the NASA Headquarters Program Officer, the SCO will maintain a regular communication with that point of contact for costing and budget phasing adjustments throughout the award period.
- Adjust project ideas within the scope of the overall project to become cohesive with the other selected AST projects in the same region or theme to avoid duplication of efforts to ensure better coordinated Team.

Project continuation beyond Year 1 will be determined by the Applied Sciences Program based upon the following performance assessment factors. It is the intention of Applied Sciences Program to support all projects meeting these performance assessment factors.

- Quarterly progress updates.
- Demonstration of active participation in the service planning process.
- Alignment and inclusion of AST projects in a regional hub's work plan with demonstrated feasibility to impact users.

[4] SERVIR uses Service Planning approach comprised of consultation and needs assessments, development of service concept documents that provide the vision and approach for the service, and service design documents, which can include Product Definition Documents, Training Definition Documents, Data Management Definition Documents among others. Monitoring and Evaluation and Learning is conducted throughout the service planning and captures the Theory of Change for the service and establishes a clear mechanism for ensuring the service achieves a lasting impact. These are living documents and are meant to ensure awareness of all ongoing activities. When changes are necessary, they are communicated to all parties prior to implementation. More information on SERVIR's Service Planning Toolkit is at this link.

- Submission of an annual report that demonstrates the expected outputs from models, applications, and/or decision support tools that will support the user needs; ARL progression, commitment to AST team communications and activities; plans to build regional hub user capacity to sustainably transfer the project outputs for lasting impact; and rationale for project success and continuation beyond Year 1.
- Contribution to the SERVIR AST performance metrics.

2.5.2 *Years 2 and 3 of Project*

During the remaining two years of the project, the Team is expected to:

- Continue and complete the work outlined in the project plan to develop the application or tool in support of hub-identified service.
- Actively collaborate with the regional hub and their users consistent with the service design documents developed during the first year. Strengthen capacity of users to use the products.
- Support transfer of products and source code to the hubs and their users, consistent with the NASA Earth Science Data System's open source policy. Provide archival copies to the SERVIR SCO.
- Monitor the key indicators of success for the project. A list of AST performance metrics will be provided to the Team at the time of selection.
- Support the SERVIR SCO to articulate and communicate the results, benefits and successes of the applications produced by the Team.
- Actively participate in technical interchange teleconferences and meetings with the NASA Headquarters, SERVIR SCO, USAID-Washington and regional missions, SERVIR Science Coordination team, regional hub personnel, and other Team members.
- Continue to provide quarterly updates and annual reports.

Years 2 and 3 will be continued based upon satisfactory reporting and continued progress towards achieving project plan objectives.

2.6 Specific Suggestions and Considerations

The Applied Sciences Program strongly encourages projects to use an array of Earth observations and science research results, including multiple spacecraft observations, geophysical parameters, Earth system models, and predictive capabilities. At least one NASA Earth observation product or model output must be used. The Program encourages project teams to consider and leverage products from NASA missions, as well as simulated products from upcoming, planned missions (e.g., GRACE-FO, SWOT, NISAR), and NASA-sponsored activities (e.g., NASA Food Security and Agriculture Consortium, SPoRT, Western Water Applications Office (WWAO), NASA Earth Exchange - NEX). In addition, the Program encourages projects that integrate multiple sources of Earth observations and information. Examples include commercial[5] and international satellite Earth observations, airborne observations, *in situ* (i.e., ground-based) sensor measurements, surface observation networks (e.g., SCAN, SNOTEL,

[5] Proposals that plan to use commercial data should include the costs in their proposal. SERVIR can facilitate access to limited high-resolution electro-optical multispectral imagery.

NEON), socioeconomic data (SEDAC, U.S. Census/equivalent), and operational and scientific models. Proposers may propose new *in situ* and airborne data collection as a small part of the overall proposal.

The Program strongly encourages the use of visualizations and visualization techniques to illustrate alternative scenarios and support decision-making activities. The Program strongly encourages multi-organizational, multidisciplinary, and multi-sectoral project teams. The PI or the designated project team members are strongly encouraged to have colleagues familiar with resource management, business, or policy-making activities and users' needs. The Program encourages early interaction with personnel knowledgeable about NASA Earth science, models, and sensors (e.g., science teams and instrument scientists) to understand capabilities and limitations.

Applicants should be aware of existing SERVIR products and capabilities to avoid duplication; information about these and others are available on the SERVIR website in the Product Catalogue. These products can be leveraged. Applicants should also be aware of non-SERVIR projects in the region to avoid duplication. More information on existing SERVIR efforts can be found in the SERVIR Product Catalog (https://www.servirglobal.net/ - productcatalog).

3. Programmatic Information

3.1 Period of Performance

Awards will be for a three-year period of performance with annual funding contingent upon criteria above (Sections 2.5.1 and 2.5.2 above) and available funding.

3.2 Budget

The expected annual program budget for awards is approximately $4.4 million, and proposers are strongly encouraged to keep the total average cost per investigation to approximately $220,000 per year per award, depending on the complexity of the proposed effort. When developing annual budget requirements, please account for time needed to get the project team up and running in year one and adjust the year to year phasing accordingly. This budget total includes NASA civil servant salaries and indirect costs, despite the fact that these costs may not be included in the budget section of a submitted proposal. (For more information on this, see Section IV(b)iii of the *ROSES Summary of Solicitation* and the SARA website at http://science.nasa.gov/researchers/sara/how-to-guide/nspires-CSlabor/). Thus, any NASA civil servant Co-Investigators on proposals submitted by other organizations must share their total costs, including salaries and indirect costs, with the submitting organization so that the proposing organization knows when they are exceeding $220,000 per year.

The budget for each project should include at least one domestic and one international trip per year for programmatic meetings (annual program review and SERVIR Annual Global Exchange). In addition to the programmatic travel, each project is expected to include at least six international trips (at least two per project year, on average) during the project's three-year life for engagement with regional hub personnel and regional/national users.

Cost sharing is not part of the evaluation criteria. However, cost sharing may become a factor at the time of selection when deciding between proposals of otherwise equal overall merit.

4. The Two-Step Proposal Process

The Program is using a binding two-step proposal submission process, introduced in Section IV(b)vii of the ROSES-2018 *Summary of Solicitation*, and described below. A Step-1 proposal is required, limited to five pages, and can only be submitted by an Authorized Organizational Representative (AOR). The five-page Step-1 proposal must present the proposed concept based on thematic service areas identified in Section 2.4. The Step-1 proposers shall not contact hub scientists for the purposes of their Step-1 proposal development.

After review of submitted Step-1 proposals and decisions by the selecting official, a subset of the proposers will be invited to submit Step-2 proposals. Only those who are invited to submit a Step-2 proposal will be able to do so. During development of Step-2 proposals, the investigators are expected to collaborate with SERVIR regional hubs to ensure alignment of proposed Step-2 work with the regional hub needs, priorities, and work plans.

4.1 Step-1 Proposals

A five-page Step-1 proposal is required and must be submitted electronically by the AOR by the Step-1 due date given in Tables 2 and 3 of this NRA. No budget is required for Step-1 proposals. Submission of a Step-1 proposal is required in order to submit a Step-2 Proposal. Proposers should refer to the "Instructions for Submitting a Step-1 Proposal" under "Other Documents" on the NSPIRES page for this program element. Please note that the Proposal Summary, Business Data, Program Specific Data, and Proposal Team are required Cover Page Elements for a Step-1 proposal. Submission of the Step-1 proposal does not obligate the proposer to submit a Step-2 proposal.

4.1.1 *Step-1 Proposal Content*

Step-1 proposals must be uploaded as a PDF file not to exceed five pages, including any references or citations. The five-page, Step-1 proposal should:

a. Emphasize responsiveness, clearly indicating how the proposal addresses the program element.
b. Specify the SERVIR hub region, sub-region, and country(s) for the proposed activity, and how the proposed work aligns with the regional and thematic service area needs outlined in this program element.
c. Include a brief description of the proposed applied research, illustrating experience of the team in connecting their work with users in the subject area.
d. Include a brief description of previous research carried out by the international scientific community in the subject area.
e. Briefly identify existing decision methods being used and new approaches/aspects being proposed.
f. List the remote sensing assets, models, or tools the proposed work can potentially use.

g. Identify potential societal impacts of the proposed effort.
h. Outline potential expected outputs and outcomes of the work.
i. Identify proposed deliverables.
j. Provide a tentative schedule.
k. Identify Co-Is and other personnel deemed critical to the success of the proposed activities (see 4.2 below, the identified critical personnel cannot be changed between Steps 1 and 2).

4.1.2 *Step-1 Evaluation Criteria*

Step-1 proposals will be evaluated for relevance and intrinsic merit. Relevance of the proposed efforts will be assessed based on alignment with the regional needs, USAID and hub regional priorities, and utility and potential alignment of proposed effort with the SERVIR regional hub work plan. Intrinsic merit will be evaluated on the novelty of the proposal ideas, past experience of the PI and the proposing group, and the perceived impact of the proposed work, e.g., the ability to meet the needs of the region as expressed by SERVIR regional hubs. Cost reasonability will not be an evaluation criterion for Step-1 proposals.

A peer-review panel will evaluate the Step-1 proposals. NASA expects to have separate Step-1 peer review panels for each region. Proposals will be assigned to a panel based on a) the proposer's identification of the appropriate region, and b) NASA's assessment of proposal content. While NASA expects to select proposals in each of the regions, NASA reserves the right to select proposals in none, some, or all of these depending on the nature and distribution of proposals received and the outcome of the peer review process. All proposers will be notified of the outcome of the evaluation process.

4.2 Step-2 Proposals

The investigators invited to submit the Step-2 proposals will be required to interact and work with SERVIR regional hubs for their Step-2 proposal development. The Step-2 proposals are intended to closely complement the work plans at the SERVIR regional hubs (regional hub work plans are funded separately through USAID mechanisms). The synergy between Step-2 proposal and hub work plan is expected to result in seamless, innovative science efforts needed by the regional hubs and their users in SERVIR regions.

Because NASA will be deciding which projects are invited to continue to Step-2 based on peer review of the Step-1 proposal, NASA must limit the changes that occur between Step-1 and Step-2. Step-2 proposals must contain the same application goals (thematic service area) proposed in Step-1. The PI may not be changed, nor may Co-Investigators or other critical professional personnel who were proposed to support the Step-1 proposal be removed. Proposers who want to add funded investigators to the Step-2 proposals must inform the points 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. Collaborators, students, and other personnel who are not critical to the success of the project may be changed between Step-1 and Step-2.

The content of Step-2 proposals should adhere to the *ROSES-2018 Summary of Solicitation* (*SoS*) see Table 1, and Section 3.7 of *Guidebook for Proposers*. Where they

disagree the *ROSES SoS* takes precedence. Step-2 proposals must include a paragraph that details their commitment to being part of the Team. The commitment can include a) what it means to be a team and b) why the proposing PI thinks they are a good team contributor. In addition to being on the Team, if the PI is interested in serving as the thematic service area lead for SERVIR AST, the leadership commitment and experience should be included in this section.

4.2.1 Step-2 Proposal Format and Regional Hub Alignment

Proposers should refer to the PDF entitled "Instructions for Submitting a Step-2 Proposal" that will appear under "Other Documents" on the NSPIRES page for the program of interest. All proposals submitted to ROSES must strictly conform to the formatting rules in Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*. Those that violate the rules may be rejected without review.

Following the 15-page Scientific/Technical/Management section of the proposal, the respondents must include an additional two-page section titled "SERVIR Regional Hub Alignment" which will be used to clearly identify how the proposed work will complement the regional hub work plans. The societal impact of the proposed work and planned approaches to qualify or quantify the work's impacts on decision-making should be clearly illustrated.

4.2.2 Step-2 Proposal Review and Evaluation Criteria

Step-2 proposals will be evaluated based on the criteria given in Section VI of the *ROSES Summary of Solicitation.* The evaluation will be based on the proposal's relevance, intrinsic merit, and cost. The evaluation of relevance will be based on the proposal's alignment with needs in the region and with the regional hub work plan. The evaluation of intrinsic merit will include the quality of proposed tool or application and methods proposed, demonstrated ability to work with users, the time table for the application development, and the credentials of the proposing team.

NASA may use multiple Step-2 peer review panels for each region, and proposals will be assigned to a panel based on a) the proposer's identification of the appropriate region and b) NASA's assessment of proposal content, including thematic emphasis. While NASA expects to select proposals in each of the regions, NASA reserves the right to select proposals in none, some, or all of these depending on the nature and distribution of proposals received and the outcome of the peer review process.

5. Award Reporting Requirements

Each awarded project will be responsible for quarterly maintenance of project information, status updates, highlights, and milestone achievements. NASA will coordinate with each PI at award to provide the necessary information for the online system.

The following reports will be required of awardees. In cases where teams of organizations or subcontractors 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.

5.1 Quarterly Reports

A one-page project "quad-chart" (format provided at award) with Purpose and Objectives, Approach, a Figure, and Key Milestones and Application Readiness Levels (ARLs, see Section 6.2 below) is required to be updated quarterly, and provided with additional charts to summarize progress. Progress is also verbally reported at quarterly SERVIR AST teleconferences.

5.2 Annual Reports

The Year 1 Report summarizes the first year of project development, regional hub engagement, user engagement, and progress to date. Part 1 of this report should articulate the thematic and regional challenge and decision-making activity, application of Earth observations, product definition, and starting and ending ARLs (with justifications). The report should explain any variations in the anticipated results, a discussion of major problems (technical or other), and lessons learned and recommendations.

For consideration to continue through the remaining two years of the project, Part 2 of the report should provide a plan for remaining activities. Part 2 should articulate the approach to implement the application, the baseline users' approach to the decision to be affected, updated assessments of the potential impact of the application, any changes to the composition of the team, preliminary transition approach, key milestones and final expected ARL, and key challenges to address.

Year 2 and 3 reports summarize progress, results, transition, and illustrations of regional hub and user engagements.

5.3 Financial Updates

Quarterly financial updates will be provided from the PI institution to the SERVIR SCO financial analyst and will reflect the latest costing information. In addition to tracking performance, this information may be used by the Headquarters Program Officer and SERVIR SCO to adjust the budget phasing plan, in agreement with the PI and her/his financial point of contact.

6. Reference Information

6.1 SERVIR Global Network

6.1.1 *NASA's Role*

NASA funds the Applied Sciences Team of U.S.-based researchers to provide opportunities for collaborative research with regional hubs, partners, and local experts to solve regional and local development challenges. The SERVIR Science Coordination Office (SCO), based at the NASA Marshall Space Flight Center in Huntsville, Alabama, provides technical support to SERVIR regional hubs/consortia related to data access, science, technology, and geospatial information technology management and policy, in line with NASA's assets and capabilities in these areas.

6.1.2 *USAID's Role*

USAID funds and manages agreements with regional hubs/consortia to implement SERVIR activities through its regional field offices. USAID facilitates connections to USAID-funded programs and partners that may be interested in connecting with SERVIR regional hub/consortia institutions and partners to benefit from their data, tools, trainings, or other services. USAID manages the SERVIR Support Team to assist regional hubs (see below).

6.1.3 *The SERVIR Support Team's Role*

A SERVIR Support Team, led by a contractor, provides technical support for SERVIR regional hubs/consortia related to service planning, communications and outreach, sustainability planning, knowledge management, and program planning and management. This helps to ensure consistent quality and recognition of SERVIR's efforts, as well as sustainability of SERVIR within regional organizations.

6.1.4 *What is a SERVIR Regional Hub or Consortium?*

USAID and NASA have identified seven capabilities of a successful SERVIR regional hub or consortium:

- Political – mandate to convene and advise member states;
- Technical – ability to work with remote sensing information, models, and GIS, and provide training on these tools and models;
- Engagement/Outreach – ability to reach out to and communicate effectively with users;
- Organizational/Financial – ability to manage and finance operations;
- Infrastructure – availability of hardware, software, and reliable internet;
- Network – ability to connect with partners doing related work;
- Thematic expertise – subject matter knowledge in the priority service areas.

SERVIR has operated through two different models in other regions to access these capabilities: as a single regional institution or "regional hub" (e.g., Hindu-Kush Himalaya), and as a consortium of institutions (e.g., Mekong and West Africa). In the Mekong region, Spatial Informatics Group (SIG), Deltares, and the Stockholm Environment Institute (SEI) join ADPC in a consortium. In West Africa, CSE, CERSGIS, and ACMAD join AGRHYMET to form the regional consortium.

6.1.5 *What are SERVIR Computational Capabilities?*

SERVIR has an internal pilot computational capability that includes a computer cluster, called SOCRATES, of 500+ virtual CPUs, 4TB memory, and 200+ TB of disk space. The hubs have access to the cluster, and can spawn machine images of standard operating systems (Linux, Windows, etc.) where pilot application development is expected to take place. The cluster is expected to grow in size as more users and tools are developed over time. Additionally, hubs have their own hardware infrastructures, often a mix of Linux and Windows servers. SERVIR also heavily leverages commercial solutions such as Amazon AWS, Microsoft Azure, and Google Cloud, in addition to use of Google Earth Engine.

6.2 Application Readiness Levels (ARLs)

The Applied Sciences Program developed a nine-step Application Readiness Level (ARL) index to track the development of applications and integration of Earth observations into partner 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 with the technology-based TRL, the operational decision-making activity of the practitioner organization is the applications analog to space.)

The ARL reflects three main tiers in application 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' system and transition.

The nine ARLs defined as follows:

1. Basic Research – Basic principles and phenomenology 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 laboratory 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 to 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.

7. Summary of Key Information

Expected program budget for first year of new awards	~ $4.4M, see Section 3.2
Number of new awards pending adequate proposals of merit	20; notionally 4 for each SERVIR region
Award duration	3 years
Proposers' Telecon	Telecon A: March 14, 2018 - more information at https://www.servirglobal.net/AST-TeleconA; Telecon B: September 13, 2018 - more information at https://www.servirglobal.net/AST-TeleconB
Due date for mandatory Step-1 proposals	See Tables 2 and 3 of this ROSES NRA.
Notifications of Step-1 selections	~~February 1~~ **April 19**, 2019
Due date for invited Step-2 Proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	October 1, 2019
Page limit for the central Science-Technical-Management section of proposal	Step-1 proposals: 5 pp; Step-2 proposals: 15 pp; and an additional 2 pp for Regional Hub Alignment, see Section 4.
Relevance to NASA	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*.
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 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	NNH18ZDA001N-SERVIR

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A.36 EARTH SCIENCE APPLICATIONS: WATER RESOURCES

NOTICE: March 15, 2018. In the second paragraph of Section 4.2 an incorrect reference "Step-1" has been changed to "Step-2". New text is in bold and deleted text is struck through.

Proposals to this program will be taken by a "binding" two-step process in which the Notice of Intent is replaced by a required five-page Step-1 proposal submitted by an organization Authorized Organizational Representative. Only proposers who submit a Step-1 proposal and are invited to proceed may submit a Step-2 (full) proposal. See Section 4.

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 specific goal of this solicitation is to advance the use of satellite observations and hydrologic modeling to monitor and assess local and regional water quality and quantity for improving water resource risk assessment, economic planning, investment planning, and policy making. Innovative solutions are sought that support an integrated approach by synergistically combining Earth observations, modeling, and existing *in situ*/partner data sets to address specific, well-defined information needs for water resources management. Examples include satellite-based improvements to water decision support systems, novel approaches for increasing the utility of satellite data in water planning data and models, and solutions for assessing and/or mitigating water-related risks for near- to long-term planning. This solicitation seeks to support the water community's significant strides towards implementation of an integrated approach to water resources planning to address vulnerabilities in long-term water supply reliability, infrastructure, and balancing environmental, social, and economic considerations.

1.1 Applied Sciences Program Objectives

The 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 uses of Earth observations, formulate new applications, integrate Earth observations and related products in practitioners' decision-making, and transition the applications to capable end-users. The projects are carried out in partnership with public and private organizations to achieve sustained uses

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 use of an array of Earth observations and related products in decision-making. The Program considers Earth observations to include a broad range of products and capabilities, including Earth-observing space-based measurements (i.e., NASA in-orbit and near-launch satellites, the International Space Station, as well as foreign, commercial and other U.S. Government satellites), airborne measurements, 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 program also recognizes the essential role of ground based measurements in development of satellite / airborne algorithms, model development, calibration/validation and uncertainty quantification, and as a part of an overall process for complementing existing water resources monitoring efforts.

The Applied Sciences Program has three primary lines of business: Applications, Capacity Building, and Satellite Mission Planning. The Applications themes include five of the nine societal benefit areas (SBA) of the international Group on Earth Observations (GEO): Health (including Air Quality), Disasters, Ecological Forecasting, Food Security and Agriculture, and Water Resources.[2] In addition, there is a cross-cutting Wildfires theme and several regional to global scale initiatives including the Food Security and Agriculture Office (http://www.eofsac.org), the Western Water Applications Office, VALUABLES (http://www.rff.org/research/collection/consortium-valuation-applications-benefits-linked-earth-science-valuables). Satellite Mission Planning currently includes applications programs for satellite and other space-based missions; examples include the SMAP Early Adopters, IceSat-2, ECOSTRESS and others.

The Capacity Building program improves the ability of individuals and institutions in the U.S. and abroad, including those in developing countries, to access and apply Earth observations for environmental and resource management. The program includes three elements: ARSET training sessions via webinars and on-site; DEVELOP for workforce development and short-term applications projects; and SERVIR for applications in developing countries (joint with the U.S. Agency for International Development).

1.2 Water Resources Applications Area

The Water Resources applications area is managing this solicitation. This applications area primarily focuses on water issues related to drought, streamflow, flood forecasting, water demand and supply, and water quality. The Water Resources applications area

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[1] Examples include, companies, regional associations, international organizations, multinational financial institutions, philanthropic institutions, Government agencies, tribal organizations, and not-for-profit organizations.

[2] The nine GEO SBAs are: Agriculture, Biodiversity, Climate, Disasters, Ecosystems, Energy, Health, Water, and Weather.

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.

The Water Resources applications area continues to identify water resource management challenges that face water management professionals, policy makers and society. Challenges to water access, water supply, water use, and water quality are identified by end users and scientists and through community engagements, such as the workshop on Transboundary Water Security, Group on Earth Observations Global Water Sustainability (GEOGLOWS) [https://www.earthobservations.org/activity.php?id=118], the Annual NASA Water Resource Team Meeting [https://earthzine.org/2017/10/25/nasa-water-resources-team-supports-water-resources-management/], Western States Water Council meetings [http://www.westernstateswater.org/], among others.

2. Scope of Solicitation

The specific goal of this solicitation is to advance the use of satellite observations and hydrologic modeling to monitor and assess local and regional water quality and quantity for improving water resource risk assessment, economic planning, investment planning, and policy making. Innovative solutions are sought that support an integrated approach by synergistically combining Earth observations, modeling, and existing *in situ*/partner data sets to address specific, well-defined information needs for water resources management. Examples include satellite-based improvements to water decision support systems, novel approaches for increasing the utility of water planning data and models, and solutions for assessing and/or mitigating water-related risks for near- to long-term planning, including water infrastructure planning, maintenance, and monitoring.

In order to characterize water information, one must fully understand the water-related conditions that impact the decision-making process. Proposals are encouraged to seek innovative, open and sustainable data processing and delivery solutions for stakeholders. Relevant stakeholders may include water management agencies, insurance/reinsurance companies, water sensitive corporations, water engineering firms, national security interests, humanitarian aid agencies, commodity exporters, and importers, and data and information providers, among others.

The proposed solutions must include a plan for integration into an existing water information and/or water-related risk assessment process. Application innovation, satellite sensor integration or redundancy, and the long-term sustainability of the overall solution should be stressed. The proposed solutions, including the scientific basis for the proposed solution, should be fully described and referenced. This solicitation expects project teams to include, if not be led or co-led by, water management/policy personnel who will facilitate the transition to sustained operational use by the water management partner or stakeholder.

In general, the proposed project should: a) advance the ability of organizations (public and private) to use Earth observations and apply computational and modeling capabilities that utilize Earth observations, and b) enhance decision-makers' abilities to respond effectively to the challenges presented by threats to the security and

sustainability of water resources that are difficult to address with current water management tools. Proposed projects should develop or advance the usability of data products available to water managers that are derived from Earth observations and models, as well as address and facilitate their use in operational decision making through innovative data processing and delivery systems, such as high-performance computing and rapid prototyping using cloud computing. Overall, the proposed work should clearly demonstrate how it will enhance current decision-making processes employed by water managers and their stakeholders.

The proposed solutions must include pathways to sustainable solutions**.** These pathways must address challenges of new and changing data sets, data latency, new data volumes, and/or new data algorithms/models through innovative technology solutions, as well as sound cost–benefit justifications.

Proposed projects may be performed with partners at any level. However, sub-U.S. State level (such as a county or its international equivalent) proposals must include multiple sites and demonstrate broader, regional impacts or potential. Proposals that target international applications are encouraged to team with U.S. business/management and policy organizations, or U.S. agencies with a foreign service mandate, (e.g., Department of State, U.S. Agency for International Development, Department of Defense, U.S. Department of Agriculture, etc.) and/or U.S. Non-Government Organizations (NGO).

This solicitation is open to applied science projects at or above Application Readiness Level[3] 2 (ARL 2); that is, an Application Concept and scientific basis for the Concept should already be discovered and well established. While it is expected that each applied research project will have a different timeline for development and transition depending on the maturity of the applied research, proposals that aim to conduct fundamental Earth science research (i.e., ARL 1) will be considered noncompliant.

2.1 Solicitation Recommendations

The Program strongly encourages projects to use an array of Earth observations and science research results, including multiple spacecraft observations, geophysical parameters, Earth system models, and predictive capabilities. At least one NASA Earth observation product or model output must be used. The Program encourages project teams to consider and use products from water-focused NASA satellite missions (e.g. SMAP, GPM,), as well as simulated products from upcoming, planned missions (e.g. GRACE-FO, SWOT, ECOSTRESS), and NASA-sponsored activities (e.g. SPoRT, NASA Earth Exchange - NEX, SERVIR).

[3] Application Readiness Level (ARL) is a nine-stage metric used in applications of Earth science to decision-making activities. The ARL assesses the maturity of Earth science applications projects and allows NASA to track integration of Earth science into decision-making by articulating expected advancement along a continuum from fundamental research to application and sustained operations. More information at: http://www.nasa.gov/sites/default/files/files/ExpandedARLDefinitions4813.pdf

Proposals that request resources on NEX computing resources should specify within the body of the proposal the data sets, anticipated data volumes, and annual estimated computing requirements (in SBU's,http://www.nas.nasa.gov/hecc/support/kb/Common-Standard-Billing-Unit-(SBU)-Rates_271.pdf) for each year of the project, and any additional requirements or computational needs specific to the proposed project. The proposal should also describe the relevant high-end computing and modeling expertise of the proposing team. For a listing of current NEX data resources, please see https://nex.nasa.gov/nex/resources/127/.

Proposals that request resources on other NASA high end computing resources must be explicitly justified by completing a request form in the HEC eBooks system (https://hec.reisys.com/hec/computing/index.do). A PDF version of the request should be uploaded as a separate attachment to the proposal. Please see the guidance provided in Section 1(d) of the *Summary of Solicitation* for more details.

The Program encourages projects that synergistically integrate multiple sources of Earth observations and information. Examples include commercial and international satellite Earth observations, aerial-based observations, *in situ* (i.e., ground-based) sensor measurements, surface observation networks (e.g. SCAN, SNOTEL, NEON), socioeconomic data (SEDAC, U.S. Census/equivalent), and operational and scientific models.

Proposals to this solicitation should describe sustainable solutions that incorporate solid business/organization models that strive to incorporate fiscal realism of sustained operations and the vision to meet the water resource challenges of both today and the future. Proposals that are able to articulate quantitatively the envisaged economic impact of the proposed solution are highly encouraged.

The program strongly encourages multiorganizational, multisectoral, and multidisciplinary teams to implement the proposed project in order to meet the requested actions in the Scope of the Solicitation. For instance, project teams should consider including experts in the areas of management, planning, statistics, economics, financial risk assessment, and/or policy analysis to support assessments of the performance and decision-making improvements resulting from the project. The Program encourages teams to consider having Principal Investigators (PIs) or Co-Principal Investigators that are from or are very familiar with the needs of the end-users and decision-making organization(s). The Program encourages early interaction with personnel knowledgeable of NASA science, model, and sensors (e.g., science teams and instrument scientists) to understand capabilities and limitations. All types of organizations are eligible to apply, including academia, private, military, Government, and nonprofit sectors.

3. Program Information

Total Amount of Funding (FY19-FY22)	$9 M total
Anticipated Number of Awards	5 - 10 projects
Expected Range of Award per project, per year	$275K - $550K

Period of Performance	3 years
Expected Project Start Date	December 1, 2018
Contributions from Partner Organizations	Transition plan with resource commitments from partner organizations is expected

4. The Two-Step Proposal Process

The Program is using a mandatory two-step proposal submission process. The overall description of a two-step process can be found in Section IV. (b) vii of the ROSES-2018 *Summary of Solicitation*. A Step-1 proposal is required and must be submitted electronically by the Authorized Organizational Representative (AOR). The five-page Step-1 proposal must present the proposed concept based on the Scope of Solicitation from Section 2.

After review of submitted Step-1 proposals and decisions by the selecting official, a subset of the proposers will be invited to submit Step-2 proposals. Only those who are invited to submit a Step-2 proposal will be able to do so.

4.1 Step-1 Proposals

A Step-1 proposal is required and must be submitted electronically by the AOR by the Step-1 due date (see Section 5, Summary of Key Information). No budget is required for Step-1 proposals. Submission of a Step-1 proposal is required in order to submit a Step-2 Proposal. Please note that the Proposal Summary, Business Data, Program Specific Data, and Proposal Team are required Cover Page Elements for a Step-1 proposal. The NSPIRES system will guide proposers through submission of required cover pate information. Submission of the Step-1 proposal does not obligate the proposer to submit a Step-2 proposal.

4.1.1 Step-1 Proposal Content

Proposers should refer to the "Instructions for Submitting a Step-1 Proposal" under "Other Documents" on the NSPIRES for this program element. Step-1 proposals must be uploaded as a PDF file with a technical management section (not including any references or citations) not to exceed five pages. The five-page technical management section of the Step-1 proposal must:

a. Specify how the proposed work aligns with the Scope of Solicitation.
b. Include a brief description of the proposed application and applied research (including geographic scope), illustrating the experience of the team and the connection of their work with potential users in the subject area.
c. Include a brief description of the starting ARL for the project (including justification/references for ARL level) and relevant previous research carried out by the project team and/or scientific community in the subject area.
d. Describe, specifically, the current information flow from data, through decision process, to the result of the decision.
e. Describe, specifically, how this proposed effort will impact the information flow (see item d.) including the anticipated enhancements.

e. List the NASA and other remote sensing assets, models, or tools the proposed work can potentially use.
f. Describe how the capabilities described by the project will be transitioned and sustained beyond the end of the project.
g. Identify potential societal impacts and outcomes, including the proposed deliverables
h. Provide a tentative schedule.
i. Identify Co-Investigators (Co-Is), project partners, and other personnel deemed critical to the success of the proposed activities (see 4.2 below, the identified critical personnel cannot be changed between Steps 1 and 2).

4.1.2 Step-1 Evaluation Criteria

Step-1 proposals will be evaluated for relevance and intrinsic merit. Relevance of the proposed efforts will be assessed based on alignment with the Scope of Solicitation in Section 2. Intrinsic merit will be assessed based upon a clearly articulated potential for specific impacts of the remote sensing and/or modeling capability on a well-defined decision-making process, the scale and scope of the potential impacts, evidence that the proposed capability is at ARL 2 or higher and likely to succeed, evidence of strong engagement and participation by the water management entity partnering on the project, and a concise, well-defined transition plan for sustained operation of the proposed solution. Project cost will not be an evaluation criterion for Step-1 proposals. A peer-review panel will evaluate the Step-1 proposals. All proposers will be notified of the outcome of the evaluation process.

4.2 Step-2 Proposals

Step-2 proposals must contain the same application goals proposed in the Step-1 proposal. The PI may not be changed, nor may Co-Is or other critical professional personnel who were proposed to support the Step-1 proposal be removed. Proposers who want to add funded investigators to the Step-2 proposals must inform the points of contact identified in the summary table of key information at least two weeks in advance of the Step-2 due date. Collaborators, students, and other personnel who are not critical to the success of the project may be changed between Step-1 and Step-2 proposals.

Proposers should refer to the "Instructions for Submitting a Step-**2** ~~1~~ Proposal" **[Corrected March 15, 2018]** under "Other Documents" on the NSPIRES page for this program element once the Step-2 proposals have been invited. The content and formatting of Step-2 proposals should adhere to Section 4.2.1 below, Table 1 of the ROSES *Summary of Solicitation* and Section 2.3 of *Guidebook for Proposers*, in that order of precedence. See Section I.(g) of the ROSES *Summary of Solicitation*.

This section describes proposal contents, in some cases enumerating the ways in which this particular call clarifies, adds to, or differs from the ROSES *Summary of Solicitation* and the Guidebook for Proposers.

4.2.1 *Constituent Parts of the Proposal and Page Limits*

Proposals should adhere to the following page guidelines and order. Content descriptions, if specified below, supersede direction in the *Summary of Solicitation* or *Guidebook*.

Proposal Cover Page ..... As found on NSPIRES site or Grants.gov
..... .(includes budget summary)

Proposal Summary..... ..... 4000 characters
Table of Contents..... ..... 1 page
Project Content .... 15 pages

- Decision-Making Activity – Description and role or authority of water resources partner(s)
- NASA Earth Observations and/or models
- Project Elements (please see description below; page limit includes, charts/figures/tables, as appropriate; integrated into text if possible)
- Anticipated Results
- Project Management
- Schedule with Milestones

Performance Measures..... ..... 1 page
Statements of Commitment – Co-Is .... as needed
Letters from End-User Organizations..... up to four, one-page letters
Budget Justification: Narrative and Details..... as needed
Facilities and Equipment (if applicable).. ..... 1 page
Resume/Curriculum Vitae: Principal Investigator(s)..... 2 pages
Resume/Curriculum Vitae: Each Co-Investigator……1 page
Current/Pending Support..... ..... as needed
References and Citations..... ..... as needed

Total Budget (with salaries; separate PDF file)…….as needed

These constituent parts of the Step-2 proposal are described in further detail below.

Proposal Summary

This section should state how the project responds and relates to the priority topics identified in Section 2 of this appendix.

Project Content

As the main body of the proposal, this section should cover the following material:

Decision-Making Activity - Description

This section must explicitly identify and describe the decision-making activity to be enhanced (or created) in the project, including the baseline performance of the decision-making activity. This section must identify and describe the end-user organization(s) and their responsibility and/or mandate to address the topic/issue.

Earth Observations

This section must identify and describe the NASA Earth observations (per Section 1.2) that the proposal seeks to integrate to improve the decision-making activity. This section should also include any non-NASA data sets that are expected to play an important role in the applications (e.g., commercial satellite data, ground (*in situ*) sensors, specific geospatial datasets, etc.).

Project Elements

- Description of the water management challenge;

- Methodology and Earth observations to be employed for the application to address the challenge, including discussion of the innovative aspects of the approach, evidence that the approach is likely to succeed, rationale for Earth observations to be used;
- Discussion of the overall accuracy / uncertainty associated with the proposed solution, past work to quantify the accuracy of the proposed solution or its components, and evidence that the proposed solution is suitable to address the water resource management challenge addressed;
- Organizational/Management approach to discover solutions and plan the integration of Earth science results into the decision-making activity (existing or new);
- Identification and description of the ARL of the application, including any expected ARL advancements from beginning to end of the proposed project[4];
- Transition plan and evidence of partner commitment to sustaining the solution over the long-term.
- Challenges and risks affecting project success (technical, policy, operations, management, etc.) and the approach to address the challenges and risks;
- Issues affecting the adoption, transition, and sustainable use of the Earth science products by the water managers and organizations; and
- Relevant tables/figures that demonstrate key points of the proposal.

Anticipated Results
This section must describe the expected results from the project. This section must state the team's hypothesis for the expected improvements. This section should articulate the expected improvement(s) over the "baseline" performance of the water managers' decision making and should clearly describe the anticipate project impacts.

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.

Schedule and Milestones
This section should map the expected project schedule and milestones. Milestones should be notable thresholds leading toward the success of the project (e.g., software implementation, application testing and validation, etc.) Note: Meetings (number of, frequency of, etc.) do not qualify as project management milestones.

Performance Measures
This one-page section must articulate the metrics and measures (both quantitative and qualitative) the team will use to assess the results from the project. The metrics/measures should, at a minimum, include those that the water managers employ to assess their decision making and services.

Statements of Commitment/Letters of affirmation from End-User Organizations

[4] Please follow the ARL definitions in http://www.nasa.gov/sites/default/files/files/ExpandedARLDefinitions4813.pdf

In addition to the team member confirmation of participation online via NSPIRES, this section may include Statements of Commitment from the Co-Investigators and up to four, one-page letters of affirmation from the end-user organizations that will benefit from the proposed project. The letters may include input from the community and beneficiaries served by the end-user organizations. All statements or letters must be addressed to the PI and included in the proposal.

Budget Justification: Narrative and Details
Budget information should conform to the standards of the *Guidebook* and the *ROSES Summary of Solicitation*. The NASA Science Mission Directorate has adopted commercial data purchases as a mainstream way of acquiring research-quality data, as these commercial capabilities become available. Per NASA policy, NASA encourages the use of commercially-available data sets[5] by PIs, as long as it meets the scientific requirements and is cost effective.

4.2.2 *Step-2 Evaluation Criteria*

The evaluation criterion "Relevance" specifically includes:

- Overall intent to apply Earth observations to make potentially valuable, substantive improvements to risk assessment, economic planning, investment planning, and policy making challenges and
- Breadth and potential impact of the project.

In addition to the factors given in the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*, the evaluation criterion "Intrinsic Merit" specifically includes the following factors:

- Overall ability to develop and test the value of the proposed concept and application;
- Overall plan and ability to use Earth science products and results (NASA Earth Science and other), model outputs, simulated products from planned missions, etc.;
- Overall ability to characterize the decision-making activities;
- Quality and extent of teaming across appropriate sectors and areas of expertise and the involvement of end-user organization(s) in the project; and,
- Overall ability to enable a transition of project results to sustained operations (e.g., cost realistic solution, well-integrated solution, etc.), including evidence of innovative and sustainable data processing and delivery solutions for stakeholders.

In addition to the factors given in the *NASA Guidebook for Proposers*, the evaluation criterion "Cost Realism" specifically includes the following factors:

- Overall approach and ability to manage the project and achieve stated objectives;
- Overall ability of the proposed work to cost-effectively meet identified requirements.

[5] Commercial remote sensing data that have been validated by the Joint Agency Commercial Imagery Evaluation (JACIE, http://calval.cr.usgs.gov/jacie.php) are encouraged.

Cost sharing from the end user is strongly encouraged, but not required for proposals to this solicitation. Evidence of cost sharing will not be considered as part of the peer review evaluation. When deciding between proposals of otherwise equal merit, the NASA selecting official may consider the extent to which the proposed project includes matching funds or in-kind contributions from non-Federal sources and Federal agencies.

4.2.3 *Award Reporting Requirements*

The following reports will be required of awarded proposals. 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. Annual site visits and annual Program Team meetings are also part of the reporting process. The proposed budget should provide for these reporting requirements. Throughout the project, project reviews and site visits will be scheduled in order to review progress toward goals and determination on an option year. These reviews will also assess plans and prospect of a successful transition of the applied research to the stakeholder/end-user during the course of the project.

Each project will be responsible for timely maintenance on-line (e-Books) 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. This reporting/communication tool is critical to ensuring each project gets the recognition it deserves, as well as improving communication about milestones, deadlines, and project specific events.

Reports will be required at the end of each quarter of the project and summarized annually. A Final Report is required prior to the end of the final option year. Quarterly Report and Annual Report templates are provided upon award. The Final Report should describe how the project met the solicitation requirements and demonstrated an impact on decision-making activities using relevant and sustainable science/technology. The report should also explain any variations in the anticipated results and a discussion of major problems (technical or other). The report should also include lessons learned and recommendations. The Program may request a presentation of the project report, results, and findings.

4.2.4 *Cooperative Agreement Special Requirement*

For proposals that request a cooperative agreement, the proposal must describe the support envisioned from NASA. NASA will work with the awardees regarding Earth science results, observations, models, data management issues, interoperability standards, and other relevant activities. Commercial organizations, especially those that might produce commercially marketable products, are strongly encouraged to read NASA guidelines on cooperative agreements, see for example references in Section III(d) of the *ROSES Summary of Solicitation*.

5. Summary of Key Information

Expected total program budget	$9M total, see Section 3
Number of new awards pending adequate proposals of merit	~ 5-10

Maximum duration of awards	3 years
Due date for mandatory Step-1 proposals	See Tables 2 and 3 of this NRA
Due date for invited Step-2 proposals	See Tables 2 and 3 of this NRA
Planning date for start of investigation	December 1, 2018
Page limit for the central Science/Technical/Management section of proposal	Step-1 proposals: 5 pp; Step-2 proposals: 15 pp; see also Section 4.2.2
Relevance to NASA	This program is relevant to the Earth science strategic questions and goals 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*.
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.
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	NNH18ZDA001N-WATER
NASA point of contact concerning this program	Bradley D. Doorn Applied Sciences Program Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-2187 Email: Bradley.Doorn@nasa.gov

A.37 EARTH SCIENCE APPLICATIONS: DISASTER RISK REDUCTION AND RESPONSE

NOTICE: Amended June 1, 2018. Two changes have been made in Section 4.5: First, the previously separate 1-page "Project Management Approach and Tools" and "Schedule" sections of proposals have been combined as a single 2-page "Project Management Approach, Tools and Schedule" section. Second, it is noted that Gantt/dependency and organization charts may be appended to this section and do not count against the 2-page limit. New text is in bold and deleted text is struck through. Moreover, the due date for proposals has been delayed to June 29, 2018.

April 10, 2018. In Section 5, two items on the list had erroneous references to other Sections of the text. Those have been corrected. New text is in bold.

This program element is for mature applications projects (ARL ≥ 4) and applied research to improve specific decision-making activities. Proposals that aim to conduct fundamental Earth science discovery or Feasibility Studies (projects at ARL 1-3) will be considered noncompliant.

This program element includes required cost sharing. See Sections 3.5 and 4.2 of this program element and Section III(d) of the *ROSES Summary of Solicitation.*

Responses to questions submitted no less than 30 days before the proposal due date to HQ-DRRR@mail.nasa.gov will be posted in a Frequently Asked Question (FAQ) document on the NSPIRES page for this program element under "other documents".

1.0 Overview

The NASA Earth Science Division (ESD), Applied Sciences Program solicits proposals for user-centric applications research enabling risk-informed decisions and actions. Selected projects must use an earth system approach, where satellite and other Earth observations can provide a unique perspective. The expected result of this program element is that these projects will be used to constitute a portfolio of integrated disaster risk reduction and response tools comprising a decision-making toolbox that meets broad stakeholder needs. Successful projects and their work plans must be efficient, transparent, accountable and inherently collaborative. They must embrace and invest in coordination activities to deliver and accelerate results which strengthen disaster risk reduction and response to the next major disaster.

The ESD Disasters Application Program seeks multidisciplinary projects which harness the convergence[1] of expertise and collaborative partnerships. Trans-boundary projects which incorporate cultural, economic and political context are particularly encouraged. Hazards know no boarders, and many of the most intensive disaster risks[2] and response challenges are complicated by the science of exposure and vulnerability. Our overall strategic research objective is to enhance disaster risk reduction and resilience decision making for preparedness, mitigation, response, and recovery phases of disasters and to transition their use to a public or private organization for sustained decision-making services to end-users. This is achieved through a user perspective and the optimal integration of Earth observations from the current and planned constellation of satellites, airborne assets, and ground stations as well as near-real time data and crisis informatics tools. This also includes improving the performance of existing decision-making capabilities or developing new ones that address unique geographical or demographic needs.

2.0 Scope of Applied Science Program

2.1 Applied Science Program Objectives

The ESD Applied Sciences Program promotes efforts to discover and demonstrate innovative and practical uses of Earth observations by funding applied science research and applications projects to enable near-term uses of Earth observations, formulate new applications, integrate Earth observations in decision-making, and transition the applications to end-user operation. This program element stresses the importance of public-private partnerships and cooperation in the communication and promotion of earth observations to ensure productivity and inclusiveness. Projects are carried out with public-sector and private-sector investments to achieve sustained use, durability, and societal benefits from the Earth observations[3].

The Applied Science Program[4] supports projects to develop and demonstrate improvements in decision-making and actions using a wide array of Earth observing systems. These include satellite measurements (NASA and other U.S. Government,

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[1] Convergence … integrates knowledge, and tools to form a comprehensive synthetic framework for tackling scientific and societal challenges that exist at the interfaces of multiple fields…the convergence of expertise necessary to address a set of research problems, and the formation of the web of partnerships involved in supporting such scientific investigations and enabling the resulting advances to be translated into new forms of innovation and new products. (NAS 2014. *Convergence*. Washington DC. DOI: https://doi.org/10.17226/18722)

[2] Intensive disaster risk refers to the risk associated with high-severity, mid to low-frequency disasters, (UNISDR, 2017; UNISDR, 2015). ... Intensive risk is therefore not only characterized by intense hazards, but also by the underlying risk drivers or vulnerability factors such as poverty and inequality (UNISDR, 2009) http://www.preventionweb.net/risk/intensive-extensive-risk and http://www.preventionweb.net/risk/bibliography.

[3] Examples include companies, humanitarian organizations, regional associations, international organizations, government agencies, multinational financial institutions, philanthropic institutions, tribal organizations, and not-for-profit organizations.

[4] For more information visit the NASA Earth Science Division's Applied Sciences Program website, http://AppliedSciences.NASA.gov/.

foreign and commercial in-orbit and planned satellites), sub-orbital airborne systems, geodetic stations, related communication and data systems, as well as outputs and predictive capabilities from Earth science models, algorithms, visualizations, Earth system knowledge, and other geospatial products. Hereafter, these are collectively referred to as "Earth observations".

The Applied Sciences Program strongly encourages projects to consider the large source of open and available data and information including the comprehensive array of multi-sensor remote sensing capabilities (e.g. optical, microwave, and radar), networks and platforms (space, airborne, ocean, water and earth *in situ*) as well as socio-economic data. Projects should use these to provide validated tools (e.g. maps and models of disaster risk and resilience assessment, impact extent, damage, recovery and restoration analysis) and risk-based monitoring (e.g. supporting imagery and tracking of intensive risk for targeted early warning, enhanced crisis awareness or efficient recovery and restoration progress). This includes developing capabilities to incorporate analysis and data management approaches for data discovery, distribution, and use. Project proposals must demonstrate that they are informed by reports and frameworks such as those by the National Academy of Science, e.g., Decadal Survey on Earth Observations and Applications[5] or reports of the Disasters Roundtable,[6] Whitehouse Office of Science and Technology Policy (OSTP) Sub-committee on Disaster Reduction (SDR), e.g. Grand Challenges for Disaster Risk Reduction,[7] Sendai Framework for Disasters,[8] National Response Framework,[9] the Sustainable Development Goals[10], etc.

The Applied Sciences Program's Applications themes are currently focused on four of the nine Societal Benefit Areas (SBA) of the U.S. Group on Earth Observations (USGEO): Health (including Air Quality), Disasters, Ecological Forecasting, and Water Resources[11]. The Program also includes energy, weather, agriculture, and climate-related influences (e.g. drought and wildfire) within each of these themes as

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[5] Decadal Survey for Earth Science and Application. See http://sites.nationalacademies.org/ssb/currentprojects/ssb_166359

[6] The National Academies' Disasters Roundtable. See http://dels.nas.edu/dr/

[7] Subcommittee on Disaster Reduction Grand Challenges. See http://www.sdr.gov/grandchallenges.html

[8] The Sendai Framework. See http://www.unisdr.org/we/inform/publications/43291

[9] The FEMA National Response Framework. https://www.fema.gov/media-library/assets/documents/117791. The DISASTERS program places a priority on geospatial enablement including advancing Principal Investigator projects within a tool box consistent with the GeoPlatform, which provides shared and trusted geospatial data, services, and applications for use by the public and by government agencies and partners to meet their mission needs. For further reference see https://www.geoplatform.gov/ and for specific technical guidance on interoperability and the architecture please see https://www.fgdc.gov/what-we-do/develop-geospatial-shared-services/interoperability/gira

[10] The Sustainable Development Goals (SDGs) http://www.un.org/sustainabledevelopment/sustainable-development-goals/ and for disasters https://sustainabledevelopment.un.org/topics/disasterriskreduction

[11] The nine USGEO SBAs are: Agriculture, Climate, Disasters, Ecological Forecasting, Energy, Health, Oceans, Water Resources, and Weather.

appropriate. The Program has instituted a nine-stage Applications Readiness Level (ARL)[12] as an index to track the maturity of applications and applied research projects. This program element is for mature applications projects (ARL ≥ 4) and applied research to improve specific decision-making activities. Proposals that aim to conduct fundamental Earth science discovery or Feasibility Studies (projects at ARL 1-3) will be considered noncompliant.

2.2 Disasters Applications Area

The Applied Sciences Program's Disasters Response Application area promotes the integration of Earth science data and information for disaster risk reduction and resilience. Effective application decision tools for this purpose should address socio-economic challenges, sustainable development, environmental management, climate change adaptation, or humanitarian assistance, among others. The Disaster Program emphasizes information and tools for situational awareness and decision-making support for action, therefore integrated science that identifies linkages or leverages activities for risk reduction and resilience across the societal benefit areas are encouraged. These linkages may include, for example, the relationship to trans-boundary water stresses, extreme weather hazard impacts, energy-power outages, agriculture and food security, infrastructure impacts, disruptions to at-risk cities and municipalities, and other impacts of primary and secondary hazards across the themes discussed above.

Reducing disaster risk and promoting resilience requires an understanding of the earth as a system. Answering applied science and technology development questions requires rapid infusion of experimental information into disaster risk reduction plans and resilience assessments, and efficient open access to diverse information available from NASA and other public and private entities. The Disasters Response Application Area[13] applies modeling, mapping and analysis capabilities to improve the usage of this information.

The general themes of the Disasters Response Application area flow from the Office of Science and Technology Policy (OSTP) Subcommittee on Disaster Reduction (http://www.sdr.gov/), and the National Platform of the UN ISDR associated with the Sendai Framework. The Sendai targets on reducing disaster losses include mortality, numbers of affected people, economic losses, and damage to critical infrastructure. Accordingly, NASA's Disaster Application area recognizes the following types of hazards and their induced impacts that effect these target areas:

- Hydrological – floods and inundation (coastal, riverine, floodplain, glacial, etc.)
- Geological – earthquakes and tsunamis, landslides, volcanoes, etc.

[12] Application Readiness Level (ARL) is a nine-stage metric used in applications of Earth observations. The ARL assesses the maturity of applications projects and the advancement along a continuum from fundamental research to application and sustained operations. More information at: https://go.usa.gov/xNw9n

[13] The Disasters applications area website is available at https://appliedsciences.nasa.gov/programs/disasters-program.

- Atmospheric – tropical cyclones, severe weather, volcanic aerosols, etc.
- Ecological - wildfires, algal blooms, etc.
- Technological - oil spill, chemical release, marine debris, etc.

The Applied Sciences Program Disasters area has a dual mandate to conduct both Disaster Applications Research and Response activities.[14] Projects above ARL 4 are expected to be available to respond to real-world events by participating in NASA Disaster Response efforts where the project can add value. The Program is primarily seeking projects that have a realistic plan and commitment to achieve at least ARL 5 within the 12-18 months and ARL 6-9 within the remaining three-year timeframe of the project. The program will assist the PI to assess and advance project ARL via deployment and testing of the applications in a relevant environment, i.e., during activations of the program's disaster response component. This will also provide the opportunity for the project to test its ARL levels for incorporation into the program's Disaster Response Plan's Playbooks for various types of disasters. Principal Investigators and their end-user partners are required to be evaluated together for application readiness level (ARL) advancement quarterly and may also be asked to provide a status report for bimonthly and annual project reviews or during site meetings with the Program Manager and Associates.

3.0 Scope of this Disaster Risk Reduction and Response Program Element

Through this program element, the Applied Sciences Program supports projects that apply Earth observations in decision-making activities for disaster response and resilience and further NASA's strategic goals in earth system science applications for societal benefit. The program element is intended to support projects that will provide useful information to improve action, plans, and assessments of resilience in human and bio-geophysical systems in various disaster prone and high-risk regions of the globe on scales ranging from local to regional to global. Specific investigations to be supported under this program element include, but are not limited to, the following Earth Science areas:

- Satellite remote sensing studies aimed at better characterizing hurricane and tropical cyclones, severe weather, earthquake, volcano/volcanic ash, and cascading hazards throughout geographical areas or environments with intensive risk.
- Modeling of these processes to support earth system application science and the applied research results producing risk and resilience assessments, damage and recovery maps, and predictive decision tools.
- Obtaining and developing data sets and applications to validate and/or improve the skill, convergence, and integration.
- Advance testing, evaluation, and deployment of risk-informed modeling and mapping products to support and build towards risk-based monitoring, incident and emergency response, recovery, and planning systems.

[14] https://disasters.nasa.gov/

The primary hazard and disaster themes for this program element are floods, earthquakes, volcanoes, hurricanes/tropical cyclones, severe weather and the cascading impacts of these hazards. Other disaster themes and extension to multi-hazard approaches may be considered if the innovative convergence of the research can be justified, e.g., applications relating wildfires with increased flood impacts or earthquakes and rainfall with induced landslides. Projects focused on higher readiness levels are of particular merit if they can efficiently leverage previously independent research projects in ways that accelerate the infusion of innovative science and technology results into applications and decision support. Otherwise, disaster risk projects for these other hazard types may only be considered in subsequent ROSES program elements or through smaller and short-term support (typically delivering results in 6 to 12 months) such as Rapid Response and Novel Research in Earth Science (program element A.25) or Topical Workshops, Symposia, and Conferences (TWSC; program element E.2) proposals.

The program element seeks multinational, national, regional, tribal, U.S. states, and sub-state (e.g., a U.S. county, municipality, or international equivalent) projects. Proposals at state and sub-state levels must include elements to enable and deliver national impact and are extensible beyond the specific limited location so the project results apply broadly. The Program ultimately seeks proposals that are applicable globally. Proposal teams working internationally must include one or more established public or private organizations with an international mandate.[15]

Projects should engage and involve existing business, agency, state, and intergovernmental structures that address disaster risk, assistance and resilience issues, policies, cultures, and other socio-economic activities to identify high priority and tractable topics. Disasters communities have developed networks and websites to share information. Proposal teams are encouraged to utilize these resources to gather information, make contacts to community representatives, understand key needs and issues, evaluate existing decision support tools, etc.

3.1 Project Scope and Purpose

The objectives of a proposed project must be to a) develop and prove the potential enhancements of an application of specific Earth observations to one or more decision-making activities and b) transfer and enable the adoption of this application by one or more specific end-user organizations in a sustainable manner (i.e., without continued NASA financial support post-project). Application readiness must be advanced with information brokers able to deliver value-added products to end-users including Government agencies, non-governmental organizations, private sector and civil society groups, as well as communities and individuals. The projects should target geographical areas by geophysical or hydrometeorological system with significant impact to lives, economies, and infrastructure, rather than simply hazard type. This means that the

[15] For example, US Government organizations with a foreign-service mandate and appropriation (e.g., USAID, USDA), nongovernmental organizations (e.g., United Nations, Conservation International), international financial institutions (e.g., The World Bank), humanitarian organizations (e.g., International Red Cross), and philanthropic foundations (e.g., Moore Foundation).

science-area questions must focus on hazard-prone and at-risk areas, which address disaster challenges identified by users locally and regionally, but they must also be extensible globally.[16]

The program element expects dedicated involvement and partnership with the organization(s) that will ultimately adopt the application in their decision-making activities and/or in their products and services to end-users. The explicit, eventual goal is to transition feasible, beneficial applications to a sustained, operational status by the partner organization(s) and/or end-users. Projects should include a variety of data, information, processing, visualization and communication systems that leverage key partners including, but not limited to, the Committee on Earth Observation Satellites (CEOS) missions,[17] and the Group on Earth Observation (GEO)[18] coordinated assets. Principal Investigators are encouraged to identify and explain applicable contributions to risk reduction that underpin The Sustainable Development Goals[19] and the explicit science and technology objectives documented in The Sendai Framework for Disaster Risk Reduction.[20] Applicable proposals should address these and other disaster-themed agendas by justifying their relevant use case with broad operational, regional, and global initiatives. Investigators are required to incorporate existing NASA remote sensing assets (satellite missions, airborne assets, and the International Space Station) as well as data centers and emerging capabilities for earth observations and applications science (e.g. flight missions or ISS sensor systems[21]). Non-NASA remote sensing satellite and sensor data may be used to augment or as proxy data sets for application development relevant to upcoming missions and technologies. It may also be proposed to study the complementarity of data sets such as airborne LIDAR data and space-borne SAR imagery and analysis. Satellite data may be used to update models while available aerial imagery and *in situ* measurements may be used for validation.

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[16] NASA Strategic Plan 2014. Strategic Goal 2 Advance understanding of Earth and develop technologies to improve the quality of life on our home planet.

[17] CEOS is the Community of Earth Observing Satellites. For further information see ceos.org. NASA is a member of CEOS and the U.S. promotes the CEOS Working Group on Disasters including pilot projects on flood, earthquake, volcano, and landslide as well as an emerging Recovery Observatory.

[18] GEO is the Group on Earth Observations and includes national, regional and global remote Earth observing systems and sensors, information and processing systems. For further information, see earthobservations.org NASA promotes multiple tasks and initiatives of societal benefit including disaster risk reduction for global flooding

[19] Sustainable Development Goals include cross-cutting objectives that rely on disaster risk reduction and resilience building. The Sendai Framework was the first agreement of the 2030 Sustainable Development Agenda to be adopted and indicators developed. For further information See http://www.un.org/sustainabledevelopment/sustainable-development-goals/

[20] Sendai Framework for Disaster Risk Reduction is a global effort under the UN International Strategy for Disaster Risk Reduction. The United States is a party to this agreement and contributes to the work plan and coordination. The 2015 plan formally recognized Earth Observation application as a contribution to disaster risk reduction and resilience. See http://www.unisdr.org/we/coordinate/sendai-framework

[21] ISS is the International Space Station. For further information on the complement of sensors and capabilities see:
https://www.nasa.gov/mission_pages/station

The Program encourages project teams to consider and use data and products from recently launched NASA missions as well as data relevant to planned products from upcoming, near-term missions. Proposals can include data products from non-NASA satellites, including foreign and commercial satellites,[22] if used in conjunction with actual or proxy NASA Earth observations or models. This could include data from passive imagers and radiometers, active SAR and LIDAR, GNSS, and other sensors as well as other information such as demographic or socioeconomic data sets.[23] The Program also strongly encourages the use of standard platforms and existing visualization, geospatial information, and web services to accelerate readiness and utility. The NASA Science Mission Directorate has also adopted commercial data purchases as a mainstream way of acquiring research-quality data as these commercial capabilities have become available. The inclusion and use of commercially available data sets is an allowable expense, as long as the data meets the technical requirements. Proposals should identify any commercial data sources intended for use and provide details on the associated cost.

Projects must innovate scientifically and technologically. They must demonstrate merit in application science, and commit to a timeline for transitioning proven research results toward relevant, sustained and durable utility. Applicants may also propose concepts that establish or strengthen capabilities provided that the need and activity can be clearly defined and that end-users are explicitly involved. This entails:

- Developing mature capabilities for decision-making tools;
- Enhancing the performance and interoperability of existing decision-making tools;
- Extending the use of an existing application;

Investigators are requested to leverage mature research understanding and to ensure freely open and timely access to easily discoverable and analysis-ready data, including metadata, to improve the value and benefit to society. Data products and their use must also be readily available and accessible, consistent with standard government and commercial practices and policies, with due consideration to urgent disaster-related and humanitarian use. In particular, modeling and mapping should improve situational awareness and the capability to plan, mitigate, and respond to events and to restore communities, nations, and regions. The indicators of project impact should include

[22] Including satellites from agencies involved in CEOS Disaster Working Group Pilot Projects and Recovery Observatory. Use of data accessible through the International Disaster Charter or partner services such as the European Union's Copernicus Emergency Management Service are encouraged.

[23] NASA DAACs https://earthdata.nasa.gov/about/daacs

proactive end-user engagement and application transfer, integration, and utility measures along with the building of demonstrable resilience.[24,25]

Proposals must address the capacity and commitment plans to provide applications data and digital product overlays to the Program during NASA response activities, in coordination with key federal agencies, intergovernmental bodies, and international organizations. Proposals should also consider how these engagements can identify breakthrough opportunities to test and evaluate robustness of experimental application science, and demonstrate readiness, utility, and extensibility in the field. In particular, Principal Investigators and teams are expected to use a best-effort approach when relevant flood, earthquake, hurricane, or tropical cyclone events or other official activations[26] trigger NASA's disaster response process.

3.2 Disaster Application Response and Recovery Teams

The Program intends to aggregate projects to form Disaster Application Response and Recovery Teams (DARRTs), which will address one or more specific themes. Successful investigators will be invited to lead and/or join a (DARRT) for testing, validation, and integration of experimental products through repeated and routine use when the NASA Disaster Program is mobilized around "real world" responses with operational organizations and end-users. DARRT development, coordination, and utilization activities to improve integrated application science results, predictive tools, and assessments will be enabled by collaboration. Investigators funded under this program will be required to be active partners and DARRT participants. Following the awards, the Program will evaluate DARRTs and groups of linked projects for

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[24] Disaster Risk Reduction is the concept and practice of reducing disaster risks through systematic efforts to analyze and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.
Risk is the combination of the probability of an event and its negative consequences. The Disasters Program is focused on Intensive Disaster Risk, the risk associated with high-severity, mid to low-frequency disasters, Resilience is the ability of a system, community, or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions. Definitions are from United Nations Office for Disaster Risk Reduction, UNISDR Terminology and Disaster Risk Reduction (Geneva, 2009). Available at: http://www.unisdr.org/we/inform/publications/7817

[25] Presidential Policy Directive 8 (PPD -8: National Preparedness) and the National Preparedness Goal establish the overarching principles for national preparedness policy, which aims to achieve "a secure and resilient nation with the capabilities required across the whole community to prevent, protect against, mitigate, respond to, and recover from the threats and hazards that pose the greatest risk." The complete document may be found here: https://www.dhs.gov/presidential-policy-directive-8-national-preparedness

[26] NASA's Disaster Response Program supports the International Charter "Space and Major Disasters," while not an official signatory to the non-binding charter. NASA supports the charitable and humanitarian retasked acquisition of and transmission of space satellite data to relief organizations in the event of major disasters, including capacity building, consultation and creation and delivery of event-specific applications.

supplemental funding to conduct an impact analysis as part of their overall project. Proposal teams are invited to include their interest, experience, and/or a plan to quantify the potential or expected impacts of the proposed Earth observations application on the identified decision-making activity/challenge in their proposal. Note: DAARTs are not required to submit this as part of their initial proposal or budget.

In all cases, projects must contribute toward an integrated suite of experimental applications or "toolbox" as an aid to adoption for preparedness, early warning and situational awareness. Specifically, the toolbox is a transdisciplinary concept that proposers must acknowledge and use to justify enhancement to collaborative decision making for durable and sustainable disaster risk reduction. Since the program element aims for an integrated suite of experimental applications or "toolbox" for situational awareness, proposers must identify which phase or phases of the disaster cycle will be addressed (preparedness, mitigation, response, and/or recovery).

Investigations will utilize satellite remote sensing observations, but should — as appropriate — integrate these with airborne, ISS, and *in situ* observations, measurements and models. They must also frame their efforts to develop decision support tools to foster transdisciplinary applied research, improve model skill, and enable integrated solutions of the predictable changes throughout the locations of interest. The integrated suite of experimental applications or "toolbox" for situational awareness and decision making, enabling disaster risk reduction for resilience, will be developed with intent to be interoperable and linked to by the DARRTs.

It is expected that all projects will participate in response activities within their DARRT on a best effort basis and to a reasonable extent, which will be determined in pre-award negotiations concerning the project grant and schedule. This will also provide invaluable feedback to the PI, the program, and the end-user for the ultimate improvement of the disaster management process. The end-users will consistently and routinely make critical use of experimental decision tools and provide feedback to the project. They are expected to be more than advocates and should be inherently involved in the project from the start and throughout ARL advancement, and be earnestly committed to supporting transition toward durable and sustained application. Specific levels of effort for major disaster responses are assessed on an event-by-event basis. Contributions will be tracked and reviewed on an annual basis for determination of resource effectiveness and efficiency, and may be used to support the ARL assessment process.

Proposals must include a DARRT team participation plan that documents latencies, geospatial and temporal scales, and an assessment of the critical socio-economic and cultural factors that may apply. Thresholds for accuracy and reliability of the application’s products and tools must be scientifically valid, but also balanced against practice with sufficient confidence identified to prove value in end-user outcomes (e.g. lower latency is often preferable to increased precision for disaster response).

Investigators are encouraged to identify and support Co-Investigators, engage Collaborators, and foster global and regional and local partner networks having complementary and gap-filling capacities, knowledge, skills, and expertise. The program reserves the right to constitute teams. In order to improve and streamline contribution to

disaster response, DARRT members may also be invited to support scenario-based exercises, application workshops, pilot projects, and short-term studies. DARRT members and teams will also be provided training on NASA's Disaster Response Program playbooks for flood, earthquake, and severe storm.

The Program encourages multi-organizational, multidisciplinary, and multi-sectoral DARRTs. These teams must show efficiencies toward development, testing, converging and evaluation of integrated solutions that close gaps for one disaster or enable multi-hazard and induced multi-hazard disaster response. To accomplish this, projects are strongly encouraged to have team members familiar with disasters management, business, or policy-making activities and end-user needs. The Program also encourages early interaction with personnel knowledgeable of NASA Earth science missions, data, models, and sensors (e.g., NASA science teams and instrument scientists) to understand capabilities and limitations. Teams should consider including experts in the areas of statistics, economics, risk, emergency and resource planning, stress and resilience assessment, emergency management, policy analysis, and project management to support assessments of the performance and decision-making improvements resulting from the project.

Project DARRTs might consider having the Principal Investigator (PI) be someone who is very familiar with the needs of the practitioners and decision-making organization(s). Projects teams might also consider having co-Principal Investigators – for example, one to lead technical aspects of the project and one to lead the decision-making and application aspects of the project. In this case, the proposal needs to specify a PI and a Co-PI. For administrative purposes, the proposal must specify only one PI, yet the proposal can describe the project leadership arrangements for multiple Co-PIs.

NASA encourages proposals that can promote low-budget, but high-impact. This typically requires the involvement of stakeholder communities, institutions, and the national and regional authorities, so that the applications are relevant to areas of potential risk. Projects should also embrace opportunities to complement ESD's existing capacity building priorities and programs. If a DARRT contributions to events, exercises, or activations result in project outputs that have substantial value to users, then the Investigators may be invited to apply to further develop or refine these capabilities. In these cases, the vehicle for moving this forward may be a ROSES A.25 Rapid Response and Novel Research in Earth Science (RRNES)[27] proposal to supplement planned or proposed disaster response application work related this program element. RRNES proposals must meet science and merit criteria such as timely access to unique event-specific data streams, opportunistic disaster response testing, or user support for requested product integration that enables efficient transition to operational application.

[27] The status of NASA's 'Rapid Response and Novel Research in Earth Science' (RRNES) program elements are typically associated with NASA ROSES proposal opportunities, and managed as rolling submissions within NASA ESD.

3.3 Proposal Review Emphasis and Evaluation Criteria

Evaluation criteria from Section VI(a) of the ROSES-2017 *Summary of Solicitation* and Appendix D of the *NASA Guidebook for Proposers* apply. We are using the standard three criteria with the following clarifications:

Relevance: This criterion is guided by Section 3.4 below. In addition to the factors given in the *NASA Guidebook for Proposers*, the evaluation criterion for relevance specifically includes the following factors:

- Intent and ability to demonstrate the applicability of Earth observations to address a topic of importance to this program element (See Sections 3.0, 3.1 and especially Section 3.4);
- Intent and ability to determine the utility of Earth observations for potentially substantive improvements to Disasters challenges and decision-making activities;

To assist in evaluation for relevance, proposals should ensure that the following five following questions are specifically addressed:

1. What is the application science question being addressed?
2. What is at risk e.g. people, ecosystems or infrastructure and why is this project important?
3. What is the worst-case disaster scenario that the project aims to avoid and why is this scenario urgent?
4. What is the purpose or overall goal of the proposed resilience efforts and why will the results be durable?
5. Who are vested stakeholders and why are they committed to partnership?

Intrinsic Merit: The underlying value, impact, and utility of the project as well as the long-term continuity of the proposed applied research solution during and/or after project completion. The continuity of the solution must address the following: End-user/partner financial sustainability (budget to implement the solution); End-user/partner organizational sustainability (technical staff to implement the solution); End-user/partner technological sustainability (infrastructure/information technology to implement the solution); and, finally, transition from research towards end-user/partner operation (plan and timeline to accomplish the transition).

In addition to the factors given in the *NASA Guidebook for Proposer*s, the evaluation criterion "Intrinsic Merit" specifically includes the following factors:

- Ability to develop, test, demonstrate, achieve, and transition the proposed application;
- Approach, methodology, and ability to apply Earth observations and related products;
- Ability to characterize the decision-making activities and needs for improvement; and,
- Quality of teaming across appropriate sectors and areas of expertise and the involvement of end-user organization(s) in the project.
- Ability to enable a transition of project results to a sustained (e.g. cost realistic solution, well-integrated solution, etc.).

Cost Reasonableness: Overall approach to manage the project and to achieve stated objectives. Appropriate level of effort to meet the objectives cost-effectively. Extent to which the proposed project includes funds or in-kind contributions from non-Federal sources and Federal agencies, consistent with Sections 3.5 and 4.2 of this opportunity and the *ROSES Summary of Solicitation*.

In addition to the factors given in the *NASA Guidebook for Proposers*, the evaluation of Cost Reasonableness specifically includes the following factors:

- Overall approach, ability, and level of effort to manage the project and achieve stated objectives;
- Quality of performance measures and overall plan and ability to use them;
- Overall feasibility of the proposed work to cost-effectively meet identified needs and enable sustained results following completion of the project.

3.4 Priority Topics

This program element encourages but is not limited to proposals that use NASA Earth science products and information to improve disaster management and policy decisions for one or more functional, phenomenological, or environmental topic areas:

Functional Topic Areas:

- Risk Assessment, Risk-based prediction, Monitoring and Preparedness
- Incident and Emergency Response
- Damage Assessment and Recovery
- Resiliency (Mitigation and Adaptation)

Phenomenological Topic Areas:

Proposals are solicited addressing natural and technological disasters among categories including geophysical (earthquake, volcano, ground movement), meteorological (aerosols, volcanic ash, weather), hydrological (flood, mass movement), ecological (wildfire, toxic releases) and climatological (wildfire, drought) and their cascading hazards including landslides, tsunami, volcanic eruption, tropical storm, river and flash flood, forest fires. The time scales of project questions must also be relevant to multi-hazard and cascading events with applications and tools contributing value to disaster management.

Environmental topical classifications should also be considered as follows:

1) Specific geographical and environmental areas at risk that are affected by or prone to particular hazards or cascading events. Although the application is developed for a particular geographical area, it must be globally extensible. Scenario examples may include, but are not limited to:

a. Coastal
b. River basin
c. Seismic hazard zones
d. Rural
e. High mountain

f. Urban

2) Specific cultural and socio-economic demographics or environments with cascading concomitant impacts, mitigating measures and insurable risks. Scenario examples may include, but are not limited to disasters impacting:

a. Lives and safety
b. Infrastructure
c. Economies

Proposals must identify and advance at least one Primary Hazard Scenario among flood, earthquake, hurricane/tropical cyclone, severe weather, or volcano, preferably within a multi-hazard approach. In addition, each proposal must select and address one or more examples of commonly-associated Secondary Hazard Scenarios of cascading risk within identified cultural and socio-economic context. Cascading risks may be physical or security related such as food, energy, water resource, and transport supply and infrastructure failures while cultural and socio-economic factors for resilience may include urban versus rural, coastal versus inland, demographic, economic or similar considerations. They must also document:

a. Disaster life-cycle (preparedness, response, recovery, and mitigation) challenge or challenges.
b. Existing methodologies used to respond to that challenge, i.e., decision-making process, tools, science-basis, information, and resources knowing that the choices made influence the relative costs).
c. Importance (extent/impact both geographically and economically (there are accelerating costs of events)).

Projects may focus on one disaster in greater depth within the multi-hazard or attempt to provide a broader reach. Application development that optimizes multi-sensor data utilization and integration (especially aspects of data fusion and big data, and the full spectrum of Earth Orbiting satellite observations) is strongly encouraged. Projects may also take a multi-hazard approach including cascading events (e.g. Short term: Earthquake/volcano/flood with infrastructure damage and induced landslide, volcano and atmospheric/water plumes and contamination, flood inundation and infrastructure damage, hurricane wind and storm surge infrastructure/power outages). Project should also build in or demonstrate geographical extensibility from local to regional to global scope, for various regimes, e.g., high altitude, rough terrain; coastal, marine, etc. The proposal must explicitly address durability for transition of mature research to sustainable applications and pre-operational testing and validation.

The Program strongly encourages the development of applications ideas and proposals establishing baseline conditions before and during events, identifying robust data sets to ensure reliability, and integrating tools for assessment of situational awareness and response needs. While not a priority, the program will accept proposals that substantially expand upon or advance the integration and interoperability of previously funded applied research to create new or different decision-making systems or tools for reducing risk, strengthening response, and/or enhancing recovery. For example, the

program will accept proposals expanding work matured toward full transition, integration, and sustainability with previous end-users awarded through the *ROSES-2011 Earth Science Applications Feasibility Studies: Disasters* solicitation, as well as through Rapid Responses or in partnership with other offices and divisions in ESD.

3.5 Partner Organization Involvement and Cost Sharing

Proposals are required to include stakeholders and partnerships in disaster risk reduction who make consistent, routine and reliable contributions to preparedness, mitigation, response, and/or recovery. They are expected to become experienced users of the projects outputs and to promote the use of the projects outcomes. If the disaster scenario or event of the proposed application is most relevant to a specific trans-boundary geography, environment, or sector the proposal team must have commitment in, and active involvement from collaborators representing these stakeholder communities. Investigators must also indicate how projects will create and strengthen a network of partnerships comprising both traditional and nontraditional users of NASA's Earth observations, science, products, technologies and expertise. PIs are expected to work directly with stakeholders and partners to advance the best applications and ensure effective utility. This includes creating and leveraging capacity building program partnerships, supporting trainings and exercises with hands-on instruction to our stakeholders, and helping them to develop skills, techniques, and tools and to stay up-to-date on innovations. Investigators must, therefore, include in their proposals a partner engagement and outreach plan to establish collaborators across the science, technology, and disaster risk reduction enterprise, (i.e., emergency and resource managers; energy, transportation, insurance or economic risk sector experts; nongovernmental organization representatives; relief and humanitarian organizations, or development bodies). These partnerships are essential, not just because it's the right thing to do, but also because it results in applications of the highest quality.

Commitment from end-users and practitioners is paramount for the transition and adoption of products for sustained use. This is critical to the eventual success of all applications projects. Projects need to involve end-users and practitioners at the onset of the project and to the fullest extent possible, particularly to describe the disaster management challenges and decision-making improvements necessary. The project team must show a clear path for further developing the partnerships and opportunities for transfer throughout the course of the project. The 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 the project. As the application matures and the likelihood of success increases, the commitment of the partner 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 graduated cost sharing requirement to accomplish this transition.

The Program allows and strongly encourages nontraditional partners including private sector companies (and teams of companies; e.g. insurance/re-insurance risk and assessment, infrastructure planning and protection, risk and disaster management

technologies and services) and non-governmental organizations (e.g. those focused on assessments and intervention based on disaster risk and resilience, response, recovery and relief) to submit proposals and/or be involved in project teams. In all instances, this program element requires strong partner cost sharing commitments, including both a base funding schedule and a supplemental incentive funding scheme (see Tables I and II below).

Table I Base Funding Cost-Sharing Requirement

Project	Activity	NASA Share	Partner Share
Year 1	Prove out application Potential ARL >4 And Advance 1 ARL Level	100%	0%
Year 2	ARL > 5	80%	20%
Year 3	Continue	60%	40%
Year 4	Complete Application and Transition ARL 8, 9	40%	60%

Table II Incentive Funding Above Base Levels - Caps

Project	Activity	NASA Incentive Up to 50% matching	Partner Contribution Above Requirement
Year 1	Prove out application Potential ARL >4 And Advance 1 ARL Level	$5-$50K	$10K-$100K
Year 2	ARL > 5 Workshop and Report	$5K-$100K	$10K-$200K
Year 3	Regional Test and Evaluation Exercise and Report	$5-$150K	$10K-$300K
Year 4	Complete Application and Transition Geographical Extension, Workshop and Exercise	$5K-$100K	$10K-$200K

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. Proposers are required to include cost share in the budget, in the amounts listed in the chart above. 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 original budget or later negotiated with the program at funding. Proposal budgets that fail to include the required cost share at these minimum percentages will be considered non-complaint and maybe returned without review.

Applications 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 I 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 timeframe.

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. Additionally, should partner contributions exceed requirements, NASA reserves the right to provide matching funds at its discretion up to 50% of the amount exceeding the required contribution subject to the caps in Table II above.

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.

As part of the annual and final reports, awardees will verify cost share requirements. A compliance evaluation by the program will be part of the yearly review to determine if NASA will continue funding, and may result in enforcement actions, including termination, for failure to comply with the terms and conditions of the award.

Upon completion of the Project, end-user organizations are responsible for the operational costs required to run the decision support system.[28] If additional activities are needed to assist in the sustained use of the Earth observations, NASA may support other 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 organizations, as possible. The final project year should include transition activities and an end-of-project event to announce results.

4.0 Amendments and Clarifications to the *Summary of Solicitation*

The following information provides clarifications or amendments to the *ROSES Summary of Solicitation*. The information below supersedes direction provided in the respective sections of the *ROSES Summary of Solicitation*.

4.1 Request for Notices of Intent

[28] The ongoing costs to incorporate and maintain the application of the Earth observations in the decision-making activities are typically much less than the costs to develop, test, and transition the application.

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 in order to submit a proposal.

4.2 Eligibility of Applicants: Section III(a) of the *Summary of Solicitation*

Consistent with Section III(a) of the *ROSES Summary of Solicitation*, all organizational sectors are eligible to apply, including academia, private, government, military, intelligence community, the nonprofit sector, and companies supporting them. Multi-organizational and multi-disciplinary teams are strongly encouraged.

4.3 Cost Sharing or Matching: Changes to Section III(d) of the *Summary of Solicitation*

Cost-sharing and partner resource commitments for Applications Projects are required in years two through four of the project. Commercial organizations, especially those that might produce commercially marketable products, are strongly encouraged to read the rules on cost sharing and cooperative agreements, see for example references in Section III(d) of the *Summary of Solicitation*.

While this program element accepts in-kind contributions during the course of the project as cost sharing, financial contributions are preferred. The monetary value of in-kind contributions should be provided and certified as part of the annual and final reports. Relevant past work, prior results, or previous support and accomplishments can be described, but the Program does not consider these as cost sharing or in-kind contributions.

4.4 Costing and Phasing

Projects selected under this program element will have a first Feasibility phase with funding and deliverables over 16-18-months. Resources will be allocated upon award to be obligated and costed by the Principal Investigator by the end of the Fiscal Year. For example, resources in this first phase may be sufficient for 6 months and a second phase of 12 months. Before the end of this Feasibility phase the project will undergo a Project Review. Projects making satisfactory progress will continue on their original plans, or be re-aligned to integrate with or complement other members of the DARRT. Tasks may also be augmented or reduced at the recommendation of the reviewers and direction of the Program Manager. Projects continuing to the subsequent steps for achieving higher ARLs will submit an obligation and cost plan that matches the government's Fiscal Year calendar. Projects unable to meet costing schedules will be rephrased if possible. If found chronically delinquent in costing, incompatible with program objectives, or otherwise non-compliant, projects may be terminated following appropriate NASA and Federal Government approved grant procedures, guidelines and practices.

4.5 Proposal Format and Contents: Changes to Section 3.7 of the *NASA Guidebook for Proposers* **[Corrected, June 1, 2018]**

All proposals must provide sufficient detail to allow reviewers to assess viability and potential for success. Proposals should adhere to the following maximum page guidelines and order. Content descriptions, if specified below, modify the *NASA Guidebook for Proposers*.

Proposal Cover Page via NSPIRES site or Grants.gov (includes budget summary)
Proposal Summary ..... 4000 characters (included in cover page)
Table of Contents. ..... 1 page
Decision-making Activity Description ..... 2 pages
Earth Observations ..... 2 pages
Technical/Scientific/Management ..... 12 pages
Figures and Tables ..... (as appropriate; integrated into text if possible)
Performance Indicators and Measures ..... 1 page
Anticipated Results/Improvements ..... 2 pages
Project Management Approach, Tools**, and Schedule** ..... ~~1~~ **2** page**s**
~~Project Schedule ..... 1 page~~
Partner Engagement and Outreach Plan ..... 1 page
DARRT Team Participation Plan ..... 1-2 pages
Transition and Sustainability Plan ..... 1 page
Impact Analysis (Optional) ..... 1 page
Partner, Broker, and End-user Statements/Commitment Plans .... up to 4 one page letters
Budget Justification: Narrative and Details ..... as needed
Facilities and Equipment (if applicable) ..... 1 page
Curriculum Vitae for Principal Investigator ..... 2 pages
Curriculum Vitae for Each Co-I and Critical Team Member ..... 1 page
Current/Pending Support ..... as needed
References and Citations ..... as needed
Total Budget (separate PDF file) ..... as needed

Proposal Summary

As a summary, this section should briefly describe the concept for the proposed activity. This section should state why the project should be done and how the project relates to the topics identified in Section 1.2 and 2.3 of this opportunity. The section must include and briefly state the application proposition to be tested and developed in the project.

Decision-making Activity Description
(Baseline Assessment and Indicators for Decision-Making and Resilience-Building)

This section explicitly identifies and describes the decision-making and resilience-building capability to be addressed and demonstrated in the project. This section must describe the management, business, policy topic, or other issue that it serves, including any quantitative information regarding its use. This section must also identify and describe the partner, broker and end-user organizations and their responsibility and/or mandate to address the topic or issue. This section must contain statements from the practitioners describing related challenges, needs, and opportunities to improve the decision-making activity or process. It must also quantify the pre-project baseline performance of the decision-making activity by identifying and using the metrics and indicators recognized by partner/end-user organizations. These indicators will also be used to evaluate the success criteria of this project.

Earth Observations

This section identifies and describes the specific Earth observations, derived products and/or models that the proposal seeks to apply to improve the decision-making activity. The Program encourages multi-sensor and multi-platform approaches as well as using non-traditional information including crowd-sourced, census, and economic data as appropriate. Proposers should describe relevance to the GEO focus areas, the International Charter for Disasters, and the CEOS Working Group on Disasters Pilot Projects. This section should include any non-NASA data sets and models that are expected to play an important role in the application.

Technical/Scientific/Management

As the main body of the proposal, this section should cover the following material:

- How the project responds and relates to the priority topics identified in Sections 1.2 and 2.3;
- Application of the Earth observations (satellite, airborne, space station, *in situ* from NASA and partner organizations, including crowd sourcing and non-traditional data streams as appropriate) to the decision-making activity, including rationale;
- Methodology to be employed in the application, including discussion of productive and inclusive innovation aspects;
- Systematic approach to integrate Earth observations into the decision-making activity (existing or new) and to develop and test the integrated system and address integration problems (technical, computational, geospatial information systems and web services, other organizational, etc.);
- Documentation and justification of the ARL of the application, including the expected improvements throughout the project;
- Challenges and risks affecting project success (technical, policy, operations, management, etc.) and the approach to address the challenges and risks; and
- Relevant tables/figures that demonstrate key points of the proposal.

Performance Indicators and Measures

This section must define the metrics and measures (both quantitative and qualitative) the team will use to determine the outcomes, results, and value of the project. The measures should, at a minimum, include those that the partner/end-user/decision-making organization(s) employ to assess their decision making and services as well as those used to establish the baseline performance. Please link to NASA strategies, CEOS, GEO, Sendai, and SDG objectives and disaster assistance/recovery outputs and outcomes as relevant. Additional metrics may be needed to evaluate disaster transition activities and related metrics for usability and extensibility.

Anticipated Results/Improvements

This section describes the expected results and improvements to the decision-making activity from the application and integration of Earth observations. This section should articulate the expected improvement(s) over the “baseline” performance of the decision-making activity.

Project Management Approach, Tools, and Schedule

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. Proposals using Co-PIs should describe the project leadership arrangements. A project schedule Gantt chart with milestones and dependencies is required. Project schedule and project milestones must be included. Projects are strongly encouraged to use ARL advancements as part of their project milestones. Note: Project team meetings (number of, frequency of, etc.) do not qualify as project milestones. **Also, Gantt/dependency and organization charts may be appended to this section and do not count towards the 2 pages. [Clarified, June 1, 2018]**

Project management practices are to be articulated, including the use of standard quantitative evaluation methodologies and tools to track and report cost, schedule, and performance. To ensure progress toward integration, adaptation, and multi-sector adoption of relevant applications, a resource commitment plan is also requested which specifies ability to meet cost sharing requirements with users. Principal investigators with contributing users or partners who meet eligibility criteria and make substantial ARL advancement may apply for incentive funding. Opportunity exists for public and private-sector partnering in disaster risk reduction and resilience building.

Partner Engagement and Outreach Plan

In their engagement plan, projects must include the tasks and dependencies for advancing, assessing, and reporting substantive and measureable user outcomes at high ARLs.

DARRT Team Participation Plan

This section must discuss how the PI will work with and on DARRTs. If the PI is interested in leading a DARRT, articulate the approach to team leadership and portfolio management.

Transition and Sustainability Plan

This section should identify major issues (e.g., management, organization, technical) affecting the adoption and sustained use of the application. Accounting for these items, this section should articulate the proposed transition plan, including specific activities within the timeframe of the project to enable the end-user organization(s) to adopt the enhancements in their decision support activity (or new decision support activity). The section should describe activities (e.g., training, workshops, webinars, etc.) to support and enable the sustained use of the Earth observations and enhanced decision making. Include relevance to CEOS, GEO tasks or pilots, interagency, or partnership plans as relevant, outreach and education plans as appropriate, media and press release, web services and websites, or other new media, as appropriate.

Impact Analysis (Optional)

This optional section can articulate the proposed approach to assess the quantitative value and impacts of the application (see final paragraphs of Section 2.5). If provided, this section should describe the interest, experience, and rigorous method for quantifying the benefits of the project's outcomes to the disaster management challenge addressed by the project. The section can suggest key people, such as statisticians and economists, whom the project team would enlist if the project were selected for supplemental funding (budgeting to occur following award).

Letters of Commitment and Support from End-User Organizations

This section must include one-page letters (up to four) from end-user organizations and partners who will be strongly committed in the proposal. The set of letters can also include other end-user organizations who will tangentially benefit from the proposed project, however, at least one of those support letters must be from a *bona fide* data broker who will serve as a conduit for NASA data, applications, tools, and information for disaster response to a major disaster preparedness and/or response entity and will agree to serve as a NASA ASP Disasters point-of-contact (POC) in the applicable ASP Disaster Response Plan playbook. The letters may include input from the community and beneficiaries served by the end-user organizations. All letters must be addressed to the PI and included in the proposal (i.e., not sent to NASA).

Budget Justification: Narrative and Details

Budgets should include sufficient travel funds for one annual meeting of the Disasters Applications area, as well as for appropriate end-user site visits and project team meetings. Budgets should include sufficient annual travel funds for at least one technical conference/workshop (including NASA Science Team meetings) and at least one disaster response user/management-oriented conference/workshop to disseminate and demonstrate results. Those interested in team management and leadership may add additional content.

4.6 Award Reporting Requirements: Changes to Section VII(c) of the *Summary of Solicitation*

Each awarded project will be responsible for timely maintenance (via an on-line system and with the NASA Shared Services Center) of project information, status updates, highlights, quarterly ARL level, and milestone achievements. NASA will coordinate with each PI at award to provide the necessary information for the on-line system. Throughout the project, reviews and site visits (often at partner/end-user location) will be scheduled to review progress toward goals. These reviews will also assess plans and prospects for a successful transition of the application to the partner/end-user. In addition, the project will attend the annual Disaster team meeting and will also report progress and disseminate results at one or more technical conference/workshop and one or more disasters user/management-oriented conference/workshop.

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. Awarded projects will produce a one-page project "quad chart" summary at start of the project, with updates as needed. Reports will be required at the end of each quarter and summarized annually. Quarterly Reports are a brief written summary of progress with key milestones met/upcoming, and major changes/issues. Feedback from partner/user organizations is especially encouraged. Annual reports should thoroughly discuss milestones and achievements met in the past year and the project plans and milestones for the coming year. Annuals should also address any risks to schedule and milestones and include information on financial status. Written documentation of collaboration and feedback from information brokers who distribute timely and reliable guidance to actors during event response and exercises is also required to be part of the project's annual reports. Templates for quad chart, quarterly reports, annual reports and final reports are provided upon award.

The Final Project Report, required prior to the conclusion of the project, must clearly describe how the project met requirements and demonstrated an impact on decision-making activities using Earth observations. The report should substantiate improvements from the baseline performance, including quantitative and qualitative enhancements to the decision-making activities and societal benefits (actual or estimated) from the improved decisions. The report should also explain any variations in the anticipated results and a discussion of major problems (technical or other). The report should also include lessons learned and recommendations. The Program may request a presentation of the project report, results, and findings. The proposed budget for the project should provide for all reporting requirements.

NASA, ESD, and the Applied Sciences Program will periodically and routinely request information to support outreach and engagement efforts (including press releases, fact sheets, webinars, use of new media (e.g., twitter), conference, website content, etc.). PIs and project teams are expected to publish results from their work in peer-reviewed/refereed, trade, and popular literature. PIs will also be requested to provide input several times a year to ASP-wide program reviews. Principal Investigators will also be invited to contribute to Monthly Science Reports (MSRs) and After Action Reports (AARs) shared with NASA ESD and MSD leadership. These are associated with highlights of progress or results addressing a significant disaster event. Investigators and their team will also be invited to participate and contribute to disaster Mission Application workshops and studies.[29] They are also required to provide input to the program's Disaster Application and Response websites and/or portals.

4.7 Quantitative Benefits and Impacts

Following the awards, the Program will evaluate and may select groups of linked projects for supplemental funding of an impact analysis as part of their overall project. Proposal teams are invited to include information on their interest, experience, and/or a

[29] The status of NASA's 'Topical Workshops, Symposia, and Conferences' (TWSC) solicitations are typically associated with elements of ROSES annual announcements and managed as rolling submissions within NASA ESD.

plan to quantify the potential or expected impacts of the proposed activity on the identified disaster challenge, particularly the impact of integrating Earth observations and science within the proposed activity. The Program may then select a sub-set of projects for supplemental funding to conduct an analysis and quantification of the socioeconomic impacts and benefits. Following awards, the Program will also specify the process as well as the information required for consideration and evaluation.

This optional Impact Analysis represents the quantitative assessment of the potential or expected economic costs or societal impacts of the proposed activity on the identified disaster life-cycle challenge and on the end-user, particularly its relationship to the Sendai Framework and its impact (to livelihoods and productive assets, science, education, cultural heritage, housing, critical infrastructure, agricultural loss or related costs) of integrating Earth observations and science within the proposed activity. This element will be evaluated "post-award" for supplemental funding to DAART awardees who have proposed a clear path to a convincing impact analysis (e.g. inclusion of impact assessment, decisions/policy analysis experts). Proposals may include a separate budget for this Option or one may be requested by the program after careful evaluation of the potential impact of the project. The Program is pursuing efforts to characterize the benefits from Earth science applications when they are considered, used, or integrated in resource management decisions so a request for this optional analysis may occur immediately after project award or at any time during the project.

5.0 Compliance Checklist

In order to be considered compliant, all proposals must adhere to the following checklist: **[Corrected April 10, 2018]**

- ☐ Read entire solicitation carefully
- ☐ Application must start at ARL ≥ 4
- ☐ Select geographical area with ability to extend globally
- ☐ Specify cultural and socio-economic context
- ☐ Identify and address at least one primary hazard and one secondary cascading risk
- ☐ Use multiple NASA Earth science mission data sets, products, and tools
- ☐ Contribute to a disaster community toolbox for DRR
- ☐ Applications must have an identified and involved partner
- ☐ Identify which phase or phases of the disaster cycle will be addressed
- ☐ Address the five relevance questions (see Section 3.**3**)
- ☐ Include a Partner Engagement and Outreach Plan
- ☐ Include a DARRT Team Participation Plan
- ☐ Include a Transition and Sustainability Plan
- ☐ Identify a single PI and all others as Co-I's in NSPIRES.
- ☐ Co-PIs and their roles can still be identified in the text
- ☐ Verify that Cost-Sharing requirements are met in the budget
- ☐ Gantt Chart with project milestones included
- ☐ Include letters of commitment from required end-users
- ☐ Include CVs for PI, Co-Is, and critical project team members

☐ Ensure all required sections and pages listed in Section 4.**5** are included

6. Summary of Key Information

Expected program budget for first year of new awards	~ $4.0M per year total
Anticipated number of awards pending adequate proposals of merit	~3-4 multi-organization, team projects ~3-6 applications development projects
Expected Range of Annual Award per project	~$400-600K for teams, and ~$150-300K for single applications
Period of Performance	4 years with phasing
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
Expected Project Start Date	6 months after proposal due date
Page limit for the central Science-Technical-Management section of proposal	12-15 pp; see Section 4.4
Contributions/cost sharing from Partner Organizations	See Sections 3.5 and 4.2 above.
Relevance to NASA	This Program is relevant to the Earth Science Strategic Goals and objectives 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 Solicitations*
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 also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guideline for Proposers*.
Website 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	NNH18ZDA001N-DISASTERS

NASA points of contact concerning this program. General questions about the Program should be directed to this point of contact, while questions about specific application areas should be directed to the Associates below.	David S. Green Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0032 Email: david.s.green@nasa.gov
Atmospheric and Hydro-meteorological Disasters Associate	John Murray NASA Langley Research Center MS-401B 21 Langley Blvd., Hampton, VA 23681 Telephone: (757) 864-5883 Email: John.J.Murray@nasa.gov
Geophysical Disasters Associate	Tim Stough NASA Jet Propulsion Laboratory 4800 Oak Grove Dr. Pasadena, CA 91109 Telephone: (818) 393-5347 Email: Timothy.M.Stough@nasa.gov

A.38 ADVANCING COLLABORATIVE CONNECTIONS FOR EARTH SYSTEM SCIENCE

NOTICE: The Advancing Collaborative Connections for Earth System Science (ACCESS) program will not be competed in ROSES-2018. NASA expects to continue to solicit improvements to NASA's Earth science data systems through future ACCESS solicitations. However, currently all funds available for these activities are committed to the support of awards selected through prior year solicitations.

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

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A.39 MAKING EARTH SYSTEM DATA RECORDS FOR USE IN RESEARCH ENVIRONMENTS

The Making Earth System data records for Use in Research Environments (MEaSUREs) program will not be competed in ROSES-2018. NASA expects to continue to solicit Earth science data products and system capabilities through future MEaSUREs solicitations. However, currently all funds available for these activities are committed to the support of awards selected through prior year solicitations. The next competition is expected in ROSES-2022.

1. Scope of Program

The overall objective of MEaSUREs solicitations is to select projects providing Earth science data products and services driven by NASA's Earth science goals. MEaSUREs may include infusion or deployment of applicable science tools that contribute to data product quality improvement, consistency, merging or fusion, or understanding.

MEaSUREs does not solicit proposals for systems and information technology. Proposers wishing to support the deployment of data and information systems and services; and tools that enhance NASA's data and information systems infrastructure, increase the interconnection of services for research, and enable freer movement of data and information within the distributed system of users and providers, are invited to apply to the Advancing Collaborative Connections for Earth System Science (ACCESS) Program.

MEaSUREs does not solicit proposals for science data product algorithm development or refinement, or for calibration/validation activities. These research activities are solicited through other Earth Science Research Program opportunities (see Appendix A.1).

2. NASA Point of Contact concerning this Program

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A.40 CITIZEN SCIENCE FOR EARTH SYSTEMS PROGRAM

NOTICE: NASA does not intend to offer this program element in ROSES-2018.

1. Scope of the Program

The primary goal of the Citizen Science for Earth Systems Program is 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 complements NASA's capability of observing the Earth globally from space, air, land, and water by engaging the public in NASA's mission to "drive advances in science, technology, aeronautics, space exploration, economic vitality, and stewardship of the Earth" and Strategic Goal 2.2 to "advance knowledge of Earth as a system to meet the challenges of environmental change and to improve life on our planet" (http://science.nasa.gov/about-us/science-strategy/). 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.

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A.41 ADVANCED INFORMATION SYSTEMS TECHNOLOGY

NOTICE: Amended January 31, 2019. The proposal due dates for this program element were previously temporarily changed to "TBD" as a result of the partial government shutdown. This amendment sets April 16, 2019, as the new proposal due date for this program element. No new NOIs are requested. Questions may be asked online throughout the month of February, see Section 2.3.2, and responses will be posted by March 4, 2019. New text is in bold, deleted text is struck through.

1. Advanced Information Systems Technology Program Background

NASA's Advanced Information Systems Technology (AIST) Program identifies, develops, and supports adoption of information technology expected to be needed by the Earth Science Division in the 5-20-year timeframe, as described in ROSES-18 Appendix A.1. Currently, the AIST Program is organized around two primary thrusts, the Analytic Center Framework (ACF) and the New Observing Strategy (NOS).

The ACF harmonizes tools, data, and computing environments to meet the needs of Earth science investigations of physical processes and natural phenomena. The aim of these investigations is to improve human understanding and prediction of Earth processes and natural phenomena. The ACF integrates new or previously unlinked datasets, tools, models, and a variety of computing resources together into a common platform to address previously intractable scientific questions. Additionally, this activity seeks to generalize custom or unique tools that are used by a limited community, in order to make them accessible and useful to a broader community. The ACF concept is intended to be instantiated for a specific investigation quickly and to be configured to help answer the specific science questions being investigated. Some ACF instantiations might become permanent, based on the needs of the user community. An ACF instantiation may support a scientific investigation using data from both NASA and non-NASA sources. The ACF is described in more detail at the AIST website (https://esto.nasa.gov/info_technologies_aist.html).

AIST's NOS thrust provides a framework for identifying technology advances needed to exploit newly available observational capabilities. The NOS thrust enables development of the information technologies needed to support planning, evaluating, implementing, and operating a dynamic set of observing assets consisting of various instruments located at different vantage points (e.g., *in situ*, airborne, and in orbit) to create a more complete picture of a natural phenomenon or physical process. The emergence of new sources of observational data, including high-quality instruments on Smallsats, CubeSats, and commercial space platforms, allows measurement of phenomena that could not be studied using previously available observational techniques. Because of their relatively low cost and easy access to space these research instruments, hosted on small spacecraft and commercial satellites, enable observing strategies using multiple or even large numbers of similar platforms, yielding high revisit rates or multi-angle observations of the same phenomenon. In addition, the ability to point instruments, coupled with new high-performance onboard processing capabilities,

enables high density observations for specific phenomena of interest instead of operating in a fixed pattern. Comprehensive revolutionary data collection strategies often involve the integration of data from non-NASA sources, as described in the National Academy of Sciences (NAS) Decadal Survey (https://www.nap.edu/catalog/24938/). The NOS concept is described in more detail on the AIST website at https://esto.nasa.gov/info_technologies_aist.html, which also includes the results of workshops on related topics.

2. Proposal Information

2.1 Proposal Research Topics

Proposals are solicited that fall into either of the two AIST Program thrusts.

2.1.1 *Analytic Center Framework Development*

AIST seeks to develop and mature cutting-edge tools and models to support the ACF concept. The types of technologies needed, but not limited to, support the following activities and products:

- Discovery of data that are useful to the investigation, regardless of source, which provides an investigation-unique catalog of data sources
- Characterization of instruments, science data processing techniques, data and data products, and related uncertainty to be captured in more precise and comprehensive metadata
- Ingesting data from various sources into a temporary storage system and development of a publishable description of the data
- Analytic tools to characterize the natural phenomena or physical processes from data
- Data-driven modeling tools enabling the forecast of future behavior of the phenomena
- Collaboration tools enabling scientific discussion of the analysis/modeling results
- Innovative visualization, including virtual and augmented reality, to enable scientific understanding
- Work-tracking tools to aid and accelerate publication of research and the relevant artifacts required by the publication
- Work flow management tools that help the investigation proceed in an efficient and repeatable manner

2.1.2 *New Observing Strategy Development*

AIST seeks to develop technologies and tools for use in planning, evaluating, and operating multi-element spaceborne observing systems. The types of technologies needed, but not limited to, support the following phases of observing strategy development:

- Mission analysis and concept design
- Estimation of science value to enable comparison of alternative strategies
- Evaluation/comparison of alternative observing strategies
- Integrated operations of different types of instruments or at different vantage points,

- Intercalibration of heterogeneous instruments, and
- Integration of the products from multiple instruments into a single, unified picture of the phenomena being studied.

2.2. Special Matters Related to Proposals

2.2.1 *Technology Infusion*

Proposals must demonstrate technology development that has potential to eventually be infused into a NASA Earth Science domain, either the Science Research and Analysis element's Thematic Focus Areas or in the Applied Sciences Program, described respectively in the ROSES-18 Earth Science Research Overview, sections 2 and 3. Successful proposals will address technologies that are useful to at least one science or application community and have a realistic potential for acceptance by the community in the future. The degree to which that potential is clear is directly related to the TRL of the project. Achievement of full infusion and broad community acceptance are not required during the proposal period of performance. The proposal must identify both the technology being developed and a collaborator or co-investigator from the domain into which the technology might be eventually infused. Letters of Endorsement, described below, provide strong evidence of claims of potential for infusion into external communities.

2.2.2 *Open Source Software License*

The software developed under this program element must be designated, developed, and distributed to the public as Open Source Software (OSS), as described in the ROSES-18 Earth Science Research Overview. Software developed may be created to operate in conjunction with commercial or other restricted-use software (such as MATLAB, Envi, arc-GIS) and environments, but must be licensed separately. The proposal shall include a plan for open source contribution of the software and, if applicable, a reuse license. Further licensing guidance can be found on the EarthData website.

2.2.3 *Agency Computing Resources*

NASA's major computing environments available for use are summarized in Table 1.

Table 1 NASA Computing Environments

Resource	Additional Technical Information	Cost for Use by Proposers
High End Computing	https://www.hec.nasa.gov/request/request.html	No cost to appropriate users.
NASA Ames D-Wave	https://www.nas.nasa.gov/projects/quantum.html	No cost to appropriate users.
AIST Managed Cloud Environment	http://amce.nasa.gov/	Funded by awarded project. Include cost in proposal

2.2.4 *Independent Testing*

The AIST Program uses the Earth Science Information Partners (ESIP) to perform independent assessments of Technology Readiness Level (TRL) (https://esto.nasa.gov/files/trl_definitions.pdf) and adoptability of AIST projects. This practice has the additional benefit of improving the chances for adoption of projects or infusion of technologies by giving additional target audiences opportunities to evaluate the product and to influence final enhancements that might make the product more usable. Awarded AIST projects may participate in this assessment by coordinating with the AIST Program Manager during the final year of project development.

2.2.5 *Geographic Information Systems (GIS)*

The AIST Program encourages technology development that can be deployed into frameworks commonly used by the NASA Earth science community, other government agencies, and commercial and educational organizations. The use of commercial or open-source Geographic Information Systems (GIS) for research and applied science has been demonstrated in an environment using an analytic center framework that enhances assembly, manipulation and analysis of large data sets from a variety of sources, including NASA Distributed Active Archive Centers (DAACs) and field campaigns. Investigations involving substantial development of visualization or analysis frameworks duplicating existing capabilities are discouraged.

2.2.6 *ESTO Reporting Requirements*

There are a number of ESTO-specific reporting requirements that must be incorporated in the work plan of AIST proposals, including semi-annual, annual, and final review presentations and the ESTO Quad Chart. These reviews are required in addition to the Agency reports for grants and are detailed on the ESTO reporting requirements website https://esto.nasa.gov/files/solicitations/AIST_18/ESTO_Rpt_Reqmts_AIST2018.pdf. Proposals must demonstrate an understanding of these reporting requirements and these requirements must be included in the work plan in the AIST proposal.

2.3. Proposal Submission

Proposers are advised to periodically check the following basic references:

- Solicitation website (https://solicitation.nasaprs.com/ROSES2018) for amendments to the ROSES-2018 NASA Research Announcement (NRA).
- *ROSES-2018 Summary of Solicitation* (https://nspires.nasaprs.com/external/solicitations/summary!init.do?solId=%7bE2CB9318-72CB-C51A-6962-013E762AE713%7d&path=open) (hereinafter referred to as the *ROSES-2018 Summary*).
- March 2018 version of the *NASA Guidebook for Proposers Responding to a NASA Funding Announcement* (https://www.hq.nasa.gov/office/procurement/nraguidebook/) (hereinafter referred to as the *NASA Guidebook*).

Proposals shall conform to the guidance included in the *ROSES-2018 Summary*, with the following additional guidelines:

a. The Project Description is limited to 15 nonreduced, single-spaced, typewritten pages, formatted in accordance with the *NASA Guidebook* and should contain the information described in *Guidebook* section 3.13. Proposals which exceed the 15-page limit may be returned without review. All other required sections are not subject to the 15-page restriction.
b. The Project Description should include the items specified in the *ROSES-2018 Summary*, plus a discussion of the following topics:
   1) What is the information technology involved?
   2) Results of any comparative technology analysis.
   3) How would this project contribute to missions or scientific investigations?
c. The work plan shall include clear, measurable, milestones throughout the project.
d. Immediately following the Project Description, the proposal shall contain an ESTO Quad Chart, as described in the reporting guidance in 2.2.8 above and on the ESTO reporting requirements website at https://esto.nasa.gov/files/solicitations/AIST_18/ESTO_Rpt_Reqmts_AIST2018.pdf The Quad Chart should contain no more than four key milestones.
e. Immediately following the Quad Chart, the Proposal shall include a TRL Entry and Exit Table that lists the subsystems or components to be developed, their TRLs and a brief, relevant justification for each.
f. Since AIST Projects do not produce large quantities of data products, but rather demonstration or sample versions, an extensive Data Management Plan (DMP) is not generally necessary. This requirement may be met by responding to the relevant NSPIRES Proposal Cover Sheet question.

2.3.1 *Proposal Content Checklist*

Proposal content is specified by Section IV of the *ROSES-2018 Summary*, Additional, AIST-specific requirements for proposal content are presented in Table 2. Proposals that do not adhere to these requirements may not receive a response from NASA.

Table 2 Proposal Checklist

Applicable A.41 Section	Requirement	Comments
2	Select between ACF or NOS thrust	NSPIRES cover sheet field
2.2.1	Domain from Appendix A.1 (sect. 2 or 3) for infusion and named on team	Domain and Representative NSPIRES cover sheet fields
2.2.2	Open Source License	NSPIRES cover sheet field
2.2.6	Inclusion of ESTO reporting	NSPIRES cover sheet field
2.3d	ESTO Quad Chart	ESTO Reporting Site
2.3e	Entry and exit TRLs	Include rationale
2.3f	Data Management Plan	NSPIRES cover sheet field
2.3	Work plan, schedule & clear milestones	*Guidebook* 3.1.3
3.0 Relevance	Letter of Endorsement from target science/mission community	Potential for infusion into target community

3.0 Merit (g)	Letter of Endorsement from target community	Potential for and type of impact on community
3.0 Merit (h)	Letter of Endorsement from target community	Potential for infusion and how it would help
3.0 Merit (i)	Letter of Endorsement from commercial firm	Potential for commercial use

2.3.2 Virtual Q&A

An online question form is available at the AIST2018_VBC site (https://esto.nasa.gov/AIST2018_VBC/) from the release date for 30 days **from the post-shutdown amendment**. Proposers may submit questions regarding this program element at any point during that time using the online form. Responses will be posted to that website and on the NSPIRES page for this program element (https://nspires.nasaprs.com/external/solicitations/summary!init.do?solId=%7bC0D379E0-B4A8-6B97-7B0C-7F5409CD2442%7d&path=open) under "other documents" **by March 4, 2019**. Proposers should check these websites periodically in case there are additional questions and answers posted.

2.3.3 Notice of Intent

No new Notices of Intent **are requested.** ~~(NOI), as described in the *NASA Guidebook*, are strongly encouraged, but not required.~~

3. Proposal Evaluation Criteria

The primary evaluation criteria are described in Section VI.(a) of the *ROSES-2018 Summary*.

The evaluation of the Relevance criterion is defined as the applicability of the proposed investigation to Earth Science Division missions and technology needs, and specifically includes the relevance to NASA's Earth Science Division scientific and technical areas of emphasis, as described in the ROSES-18 Earth Science Research Overview. A Letter of Endorsement by a representative, not on the proposed project team, from the target audience will be considered as strong evidence for the relevance factor.

In addition to the definition of Merit given in Appendix D of the *NASA Guidebook*, the evaluation criterion Intrinsic Merit specifically includes the following factors to apply to the requirements of Section 2 above:

a) Feasibility and merit of the proposed technical approach to achieve the technology development objectives.
b) Degree of innovation of the proposed study or technology development concepts and approach; preference is shown to new technologies which have potential for impact.
c) Past performance and related experience in the proposed area of technology.
d) Qualifications of key personnel (including membership of a relevant domain scientist on the proposed team) and adequacy of facilities, staff, and equipment to support the proposed activity as it contributes to cost realism.
e) Substantiated justification and appropriateness of the entry and exit TRL.

f) The feasibility of making a demonstrable TRL increase of at least one level during the performance period.
g) The potential for the technology development to reduce the risk, cost, size, and development time of Earth science systems. The target mission or research area should be identified and potential cost reductions should be clearly stated and substantiated to the extent possible, with supporting analysis that indicates scalability. A Letter of Endorsement from a mission or research area potential adopter describing the envisioned impact is strong support for this claim.
h) The potential of the technology and tools to be integrated, once matured, into an Earth science mission, research activity, or a product for use by NASA's Applied Sciences Program. A Letter of Endorsement from the target community which describes the potential for infusion is strong support for this claim.
i) The potential for the technology to have commercial benefits. A Letter of Endorsement from a potential commercial adopter is strong support.
j) The inclusion of a clear and comprehensive plan for releasing code into the open source.

In addition to the evaluation of cost reasonableness described in the *ROSES-2018 Summary*, AIST evaluation is further refined to include the following proposal characteristics:

a) Adequacy and achievability of proposed milestones and associated success criteria.
b) Reasonableness of the level of effort (person-time) estimated to successfully achieve the proposed task.
c) Adherence to sound and consistent management practices appropriate to the TRL of the proposed task.
d) Commitment of the organization's management to the proposed technology development (evidenced by prior teaming arrangements, etc.). Proposers should identify any previous investment by the organization/program and provide supporting documentation.
e) The cost of goods and services needed to conduct the proposed project.

4. Award Information

Information regarding Awards is provided in Section II of the *ROSES-2018 Summary*.

Proposals awarded as a result of this competition may be considered for a follow-on option to permit expanded scope, provided they have successfully accomplished the proposed work, demonstrated satisfactory financial management, and have identified additional capabilities or additional technology infusion opportunities that were not apparent at the time of proposal submission. The specifics of the optional follow-on will be negotiated after the annual review.

4.1 Period of Performance

The expected period of performance is 12-24 months.

5. Summary of Key Information

Expected program budget for first year of new awards	~ $11.4 million
Number of new awards pending adequate proposals of merit	~ 16-20
Maximum duration of awards	2 years
Virtual Q&A Site	https://esto.nasa.gov/AIST2018_VBC Open from release date for 30 days
Due Date for Notice of Intent to Propose (NOI)	**No new NOIs requested** ~~See Tables 2 and 3 of ROSES~~
Due date for delivery of proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	Within 9 months after proposal due date.
Page length for the central Science- Technical-Management section of proposal	15 pages; see also Chapter 2 of the NASA *Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/ and Section 2.3 of this program element.
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*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
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 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	NNH18ZDA001N-AIST
NASA point of contact concerning this program	Michael Little Earth Science Technology Office Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Email: Michael.M.Little@NASA.gov

A.42 INSTRUMENT INCUBATOR PROGRAM

NOTICE: The Instrument Incubator Program will not be competed in ROSES-2018. NASA expects to continue to solicit Earth science instrument technology through future IIP solicitations. The next opportunity is currently anticipated to be included in ROSES-2019.

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. 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 or greatly enhance Earth observation measurements and
- Reduce the risk, cost, size, volume, mass, and development time of Earth observing instruments.

2. Point of contact concerning this program

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A.43 ADVANCED COMPONENT TECHNOLOGY

NOTICE: The Advanced Component Technology (ACT) program will not be competed in ROSES-2018. NASA expects to continue to solicit Earth science instrument technologies through future ACT solicitations. The next opportunity is currently anticipated to be included in ROSES-2020.

1. Objectives

The ACT program seeks proposals for technology development activities leading to new component- and subsystem-level space-based and airborne measurement techniques to be developed in support of the Science Mission Directorate's Earth Science Division.

The objectives of the ACT program are to research, develop, and demonstrate component- and subsystem-level technology development that:

- Enable or greatly enhance Earth observation measurements, and
- Reduce the risk, cost, size, volume, mass, and development time of Earth observing instruments.

2. Point of contact concerning this program

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A.44 IN-SPACE VALIDATION OF EARTH SCIENCE TECHNOLOGIES

NOTICE: The In-Space Validation of Earth Science Technologies (InVEST) Program will not be competed in ROSES-2018. InVEST was last competed in ROSES-2017. NASA expects to solicit Earth Science technology flight validation projects through future solicitations. The next opportunity is currently anticipated to be included in ROSES-2020.

1. Objectives

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 concerning this program

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A.45 SUSTAINABLE LAND IMAGING TECHNOLOGY

NOTICE: The Sustainable Land Imaging Technology Program will not be competed in ROSES-2018. NASA expects to continue to solicit sustainable land imaging technology development through future program elements. The next opportunity is currently anticipated to be included in ROSES-2019.

1. Objectives

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. This 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.

2. Program Description

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.

3. Point of Contact for Further Information

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A.46 DSCOVR SCIENCE TEAM

1. Scope of This Program Element

NASA's Earth science research aims to utilize global measurements to better understand the Earth system and interactions among its components, with the ultimate goal of predicting Earth system behavior. Fulfillment of this goal requires both shorter-term process-oriented measurements and longer-term satellite measurements of a limited number of environmental properties. For the latter, a key requirement is the provision of well-calibrated, multiyear measured radiances.

The Deep Space Climate Observatory (DSCOVR) mission is a multiagency (National Oceanic and Atmospheric Administration [NOAA], U.S. Air Force, and NASA) mission launched on 11 February 2015 with the primary goal of making unique space weather measurements from the first Sun-Earth Lagrange point (L1). The L1 point is on the direct line between Earth and the Sun located 1.5 million km from Earth. The spacecraft is orbiting this point in a six-month Lissajous orbit with a spacecraft-Earth-Sun angle varying between 4 and 12 degrees. While the primary science objective of the DSCOVR mission is to provide solar wind thermal plasma and magnetic field measurements to enable space weather forecasting by NOAA, the secondary goal is to provide measurements of the Earth system.

NASA has integrated two Earth-observing instruments—the Earth Polychromatic Imaging Camera (EPIC) and the National Institute of Standards and Technology (NIST) Advanced Radiometer (NISTAR)—into the DSCOVR satellite. User guides and descriptions for these two instruments are available at https://eosweb.larc.nasa.gov/project/dscovr/dscovr_table.

EPIC provides spatially resolved radiances from the sunlit face of the Earth via a 2048 x 2048 pixel charge-coupled device (CCD) in 10 spectral bands (ultraviolet [UV], visible, and near infrared) with a nadir sampling field of view of approximately 8 km. The 10 spectral bands, their Full Width at Half Maximum (FWHM), and some primary applications are listed below:

Spectral Bands (nm)	FWHM (nm)	Primary Application
317.5 ± 0.1	1 ± 0.2	Ozone, SO_2
325 ± 0.1	2 ± 0.2	Ozone
340 ± 0.3	3 ± 0.6	Ozone, Aerosols
388 ± 0.3	3 ± 0.6	Aerosols, Clouds
443 ± 1	3 ± 0.6	Aerosols
551 ± 1	3 ± 0.6	Aerosols, Vegetation
680 ± 0.2	2 ± 0.4	Aerosols, Vegetation, Clouds
687.75 ± 0.2	0.8 ± 0.2	Cloud Height
764 ± 0.2	1 ± 0.2	Cloud Height
779.5 ± 0.3	2 ± 0.4	Clouds

Four pixels are averaged onboard the spacecraft for all spectral bands except 443 nm, yielding downloaded images of 1024 x 1024 elements. The time cadence of these spectral band images from EPIC occurs on a best-effort basis, given ground system and

communication network capabilities, and is no faster than 10 spectral band images every 1.08 hours in summer and every 1.85 hours in winter. The DSCOVR project is providing raw EPIC instrument data and EPIC Level-1 images in CCD counts that are geolocated and corrected for both dark current and stray light. The algorithms used to convert the counts into reflectance are based on the most recent in-flight calibration data, and are found at https://eosweb.larc.nasa.gov/project/dscovr/EPIC_Geolocation_2016-07-08.pdf. These algorithms are subject to change, however, as NASA continually seeks to improve Level-1 calibration, and stray light and dark current correction methods.

EPIC generates the "Earth from sunrise to sunset" Red-Green-Blue (RGB) images available at https://epic.gsfc.nasa.gov. The previous ROSES-14 DSCOVR element (https://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={367F70DC-B8E6-17B1-4308-DEEDF7B7E9A1}&path=closedPast) solicited algorithm development to create the following Level 2 products from EPIC synoptic sunrise-to-sunset observations:

- Global ozone levels
- Aerosol index and aerosol optical depth
- UV reflectivity of clouds over land and ocean
- Cloud height over land and ocean
- Spectral surface reflectance
- Vegetation index and leaf area index

NISTAR measures the absolute "irradiance" as a single pixel integrated over the entire sunlit face of the Earth in four broadband channels:

- A visible to far infrared (0.2 to 100 μm) channel to measure total radiant power in the UV, visible, and infrared wavelengths.
- A solar (0.2 to 4 μm) channel to measure reflected solar radiance in the UV, visible, and near infrared wavelengths.
- A near infrared (0.7 to 4 μm) channel to measure reflected infrared solar radiance.
- A photodiode (0.3 to 1 μm) channel for calibration reference for the cavity radiometers.

EPIC and NISTAR Level 1 products and EPIC Level 2 products are publicly available from the NASA Langley Atmospheric Science Data Center at https://eosweb.larc.nasa.gov/project/dscovr/dscovr_table.

This program element seeks proposals that exploit EPIC Level-1 and/or Level-2 products to address one or more of the science questions articulated in NASA's 2014 Science Plan (https://smd-prod.s3.amazonaws.com/science-pink/s3fs-public/atoms/files/2014_Science_Plan_PDF_Update_508_TAGGED_1.pdf) and potentially to integrate the data from multiple spaceborne, surface, and airborne observation platforms to develop and utilize self-consistent global products.

Proposals are sought for analyses using existing algorithms to deliver EPIC Level-2 or higher science products—possibly with related algorithm maintenance and calibration activities. Proposals for enhanced or new Level-2 or higher product algorithm development (see below) will also be considered. These proposals must be scientifically compelling and clearly describe how the proposed solutions differ from existing algorithms and products. Such proposals must also describe the potential and/or any planned utilization of the new and/or improved algorithms to address scientific questions.

NASA is also seeking proposals that use NISTAR Level-1 products to determine the Earth reflected and radiated irradiance with an accuracy of 1.5% or better, yielding the production of Level 2 shortwave and longwave flux products. Proposals to improve the NISTAR calibrations based on in-flight data will also be considered.

Teams funded under the ROSES-14 DSCOVR element must submit proposals for this ROSES element to obtain continued support.

2. Technical Requirements and Constraints

This program element emphasizes the analysis and validation of geophysical measurements and other derived quantities using available DSCOVR products. Science exploitation proposals in response to this program element must address explicit hypotheses, primarily using standard, currently available DSCOVR data products. NASA will also consider proposals for algorithm maintenance, algorithm enhancement, and new product development, as described below:

- Algorithm maintenance activities are those that are necessary to support the continued production of existing DSCOVR Level 2 products at the current level of quality, with evolution only as needed to respond to changing instrument conditions and/or computing environments.
- Algorithm enhancement involves making improvements to existing algorithms to respond to known shortcomings in currently available products and/or the incorporation of new approaches that can lead to improvements in the products currently available.
- New product proposals are those whose primary objective is to provide additional DSCOVR products beyond those currently available.

While NASA is soliciting proposals for the scientific exploitation of currently available EPIC and NISTAR products, as well as for algorithm maintenance, algorithm enhancement, or new products, the Agency is not committing to funding proposals in each of these areas. Proposals addressing multiple themes (e.g., algorithm maintenance and science exploitation) shall provide separate work plans for each activity.

Proposers of enhanced or new Level-2 or higher products shall be responsible for the development of the algorithm, verifying and documenting its implementation and performance in an Algorithm Theoretical Basis Document (ATBD), and validating the retrieval products. Proposals are expected to detail the instrument-specific algorithm, significant science, supporting and calibration/validation activities, and timelines for delivery of the ATBD and the initial data product release to the community. All resulting

data products are expected to be archived at the Atmospheric Science Data Center at the NASA Langley Research Center.

Proposed calibration and validation activities may involve a single or multiple data products. The scientific justification for such activities must be compelling and should be the focus of the proposed data product or algorithm development effort. New field validation campaigns are not solicited. Proposers may make use of existing field-based observations and requests for additional observations using existing instruments and networks will be considered.

3. Summary of Key Information

Expected program budget for first year of new awards	~ $2.0M
Number of new awards pending adequate proposals of merit	~12-15
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	4 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 Strategic Goals and objectives 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*.
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 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	NNH18ZDA001N-DSCOVR

NASA 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.47 REMOTE SENSING THEORY FOR EARTH SCIENCE

NOTICE: Amended January 31, 2019. The proposal due dates for this program element were previously temporarily changed to "TBD" as a result of the partial government shutdown. This amendment releases new due dates for the effected program elements in Appendix A. For this program element, Notices of Intent are still requested by February 28, 2019 (that has not changed) but the due date for proposals is now April 2, 2019.

December 18, 2018. This amendment presents a new program element in ROSES-2018. Please note that participants on submitted proposals will be asked to provide external (mail-in) reviews of competing proposals (see Section 2). NOIs are requested by February 28, 2019 ~~and proposals are due March 22, 2018~~.

1. Scope of Program

Remote sensing science to establish a theoretical 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 lies at the heart of NASA's mission. Remote sensing science investigations are needed to prepare for new remote sensing measurements of the Earth from space and to ascertain the readiness of candidate technologies for obtaining them. The objective of the Remote Sensing Theory (RST) program element, a multidisciplinary/interdisciplinary program, is to enable major steps in algorithm and future technology development that will ultimately lead to significant advances in remote sensing Earth observing. The program will support fundamental scientific, non-incremental advances in remote sensing theory and radiative transfer, including advancement of retrieval algorithms to be used for space-based remote sensing of the Earth’s atmosphere, oceans, biosphere, cryosphere, land surface, and/or Earth interior.

Recent theoretical developments in physics, chemistry, mathematics, and other fundamental science may be integrated and/or applied to space-based Earth remote sensing. The incorporation of methodologies and techniques developed in other scientific areas, and/or new or novel application of approaches that can be applied to Earth remote sensing, is a particular emphasis of this program. Research to be supported under this program element is expected to address the strengths and weaknesses of the approaches studied by quantifying the associated errors and uncertainties. Validation of proposed theoretical approaches should be outlined and, where feasible based on availability of relevant data (e.g., from airborne instruments), included in the proposed activities; proposals with such validation included will receive programmatic preference over those that do not include the use of available data.

In rare situations, very limited program funds may be made available for a one-time acquisition of the data needed to validate the proposed approaches, solely from airborne sensors supported by the Earth Science Division. Proposers including such data acquisition in their proposals should follow the procedures outlined in the Airborne Science section (4.5) of A.1 Earth Science Research Overview. Such funds would

typically be used to pay for a small number of flight hours obtained in conjunction with an already-planned flight (or set of flights) of the relevant sensor/platform combination. Remote deployments specifically to acquire data will not be supported under this element, and any proposal that includes such acquisition will be considered as non-responsive and returned to the proposer without review.

Specific areas of interest are described below, but these are not exclusive, nor are they predetermined priorities for this program element.

- Theoretical algorithm advances: research to develop fundamental advances to radiative transfer theory and calculations. Advances should be non-incremental and proposers should identify the limitations that may be surpassed. Studies applicable to remote sensing in regions of high heterogeneity, in which existing horizontal and/or vertical variability cannot yet be fully resolved by available or planned remote sensors but will likely have significant effects on retrievals, are of interest.
- Data "fusion": research to develop new approaches for integrative analysis of disparate remote sensing data sets. Innovative concepts and methodologies that merge, combine, or otherwise integrate data of different types (from different satellite sensors, from different wavelength regions, and/or of varying temporal and spatial resolutions) are of interest. Particular weight is given to combinations of active and passive remote sensing or data from two different types of active sensors (e.g., lidar, radar). Proposals based on the fusion of two or more types of passive remote sensing are of lesser interest, especially if they relate to combinations that could have realistically been proposed in response to other calls, e.g., The Science of Terra, Aqua and SUOMI NPP call from ROSES-17 (A.37). Proposals focused on intercalibration of two or more satellite data sets are discouraged for this call; such proposals have been solicited previously through the Satellite Calibration Interconsistency Studies element (A.34) of ROSES-15, and consideration is being given to a follow-on call in ROSES-19 or later.
- Advanced corrections: research to develop improved approaches and/or algorithms for correcting satellite data that take into account known confounding effects. Of special interest are studies that address atmospheric and other corrections for active sensors, including those relevant to observables described in the National Academy of Sciences, Engineering, and Medicine 2017 Decadal Survey, "Thriving on Our Changing Planet: A Decadal Strategy for Earth Observations from Space." Corrections relevant to remote sensing that could be carried out through all types of missions (e.g., those involving constellations of small satellites, hosted payloads, and cubesats) may also be proposed in response to this element.

2. Programmatic Information

The RST program provides funding for the development of improved algorithmic and theoretical approaches for space-based remote sensing of the Earth and its components (atmosphere, ocean, biosphere, cryosphere, land surface, and/or Earth interior). It is designed to foster general advances of a fundamental nature not specifically tied to an existing or planned sensor. However, the types of remote sensing techniques and approaches planned to be incorporated in the observables identified in

the National Academies of Sciences 2017 Decadal Survey are appropriate to this program.

This program will support between 12 and 15 investigations with a total funding of approximately $2.0M per year for proposals of no longer than 3-year duration, although a period of performance of no more than two years is encouraged. Responses to this program are expected to be of a one-time nature; proposers should have no expectation of continuity from follow-ons to this program. It is expected that results associated with the work in proposals selected in response to this element will have advanced the capability to the point that any follow-on proposal that leverages the success of the funded work would be competitive in an existing technology, R&A, or flight mission science proposal. Proposers should clearly indicate the program(s) and/or mission(s) to which they would expect to apply for any subsequent funding.

Proposers who have been funded based on the previous RST element in ROSES-14 are strongly discouraged from proposing continuation of their previously-funded projects. Should some proposers propose a follow-on to their previous projects, the proposals must address the success and specific accomplishments of those projects, explain how the new proposal differs from the earlier one and, as noted above, very clearly indicate the strategy for obtaining any future funding from existing technology, R&A, and/or mission-related programs. NASA is unlikely to support more than 1 or two such proposals. Extension proposals based significantly on the need for more time to complete the initially-proposed work will be considered as non-responsive and returned without review.

Proposers to this element will be invited, and are expected, to provide external (mail-in) reviews of several other proposals received in response to this call. The main drivers for this approach (which differs from the usual practice) are quality of the reviews and review process efficiency. Mail-in reviews, submitted via NSPIRES, will address scientific/technical merit only. Unconflicted members of the review panel will be aware the mail-in reviews are submitted from conflicted individuals, and the panel may consider technical points raised in the external reviews or disregard them if the review appears as biased. The final evaluation of the submitted proposals used by the program officer to recommend decisions to the selection official will, as always, be written exclusively by peer review panels composed of non-conflicted experts who will discuss their reviews as well as the multiple mail-in reviews for each proposal.

3. Summary of Key Information

Expected annual program budget for new awards	~ $2.0M
Number of new awards pending adequate proposals of merit	12-15
Maximum duration of awards	3 years; proposals of shorter duration are encouraged where appropriate.
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, 2019
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 relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES-2018 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 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	NNH18ZDA001N-RST
NASA point of contact concerning this program	Lucia Tsaoussi Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-4471 Email: Lucia.S.Tsaoussi@nasa.gov

A.48 THE PLANKTON, AEROSOL, CLOUD, OCEAN ECOSYSTEM (PACE) MISSION SYSTEM VICARIOUS CALIBRATION

NOTICE: February 22, 2019. This amendment presents a new program element in ROSES-2018. Notices of Intent are strongly encouraged by March 26, 2019 and proposals are due May 23, 2019. Answers to submitted questions will be added as a Frequently Asked Question (FAQ) posted on the NSPIRES page for this program element.

1. Scope of Program

1.1 Introduction

The National Aeronautics and Space Administration (NASA) is seeking ways to provide or develop, if needed, *in situ* instruments, systems, and approaches for the post-launch vicarious calibration of the Plankton, Aerosol, Cloud, ocean Ecosystem (PACE; https://oceancolor.gsfc.nasa.gov) Ocean Color Instrument (OCI). Ocean color "vicarious" calibration refers to a final bias adjustment to the calibrated, spectral, top-of-atmosphere radiances observed by an ocean color instrument. Proposals must consider the PACE Vicarious Calibration Plan (https://pace.oceansciences.org/documents.htm). Additional documents with sample vicarious calibration for ocean color requirements include:

- the PACE Science Definition Team report (https://pace.oceansciences.org/docs/PACE_TM2018-219027_Vol_2.pdf),
- the International Ocean Color Coordinating Group (IOCCG) Report 13 (http://ioccg.org/wp-content/uploads/2015/10/ioccg-report-13.pdf),
- the IOCCG/Committee on Earth Observing Satellites (CEOS) Ocean Color Radiometry-Virtual Constellation white paper on the International Network for Sensor Inter-comparison and Uncertainty assessment for Ocean Color Radiometry (INSITU-OCR) (http://www.ioccg.org/groups/INSITU-OCR_White-Paper.pdf), and
- the World Meteorological Organization's Systematic Observation Requirements for Satellite-Based Data Products for Climate 2011, Update Supplemental details to the satellite-based component of the Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC (2010 Update) (https://library.wmo.int/doc_num.php?explnum_id=3710).

In the ROSES-2014 call *A.3 Ocean Biology and Biogeochemistry: Ocean Color Remote Sensing Vicarious (In Situ) Calibration Instruments* (https://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={E9007FB5-975A-A0C9-B8C6-8D65C78D5552}&path=closedPast), three selections were made to pursue initial technology development for system vicarious calibration of the PACE OCI. Since then, the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) has invested in system vicarious calibration development following identification of requirements for the Copernicus Ocean Colour

Vicarious Calibration Infrastructure, which focuses on the Sentinel-3 Ocean Colour and Land Instrument (OLCI) (https://www.eumetsat.int/website/wcm/idc/idcplg?IdcService=GET_FILE&dDocName=PDF_COP_OCEAN_COL_CAL&RevisionSelectionMethod=LatestReleased&Rendition=Web). Requirements for ocean color system vicarious calibration (SVC) for NASA and Copernicus are synergistic, and have been developed under the auspices of the Committee on Earth Observations (CEOS) Ocean Color Radiometry-Virtual Constellation (OCR-VC), therein proposers are encouraged to meet as many joint requirements for collaborative purposes as possible.

The deliverables for this program element encompass a primary and a secondary goal. The primary goal is for development, implementation, and pre-launch deployment of an *in situ* SVC capability for OCI (to be in the water and tested one year before the PACE Launch Readiness Date, which is currently August 2022). The secondary goal is development and testing of related/complementary instruments or approaches to be used for validation of OCI ocean color, aerosol, and/or cloud data products. Both deliverables will enable generation of data records of Essential Climate Variables (ECVs, https://gcos.wmo.int/en/essential-climate-variables).

1.2 Background and Justification

NASA is a member of the White House National Science and Technology Council's Subcommittee on Ocean Science and Technology (SOST). The PACE mission and its associated data products and observations support the SOST report "Science and Technology for America's Oceans: A Decadal Vision" (https://www.whitehouse.gov/wp-content/uploads/2018/11/Science-and-Technology-for-Americas-Oceans-A-Decadal-Vision.pdf). This vision identifies five goals to advance U.S. ocean science and technology and the nation in the coming decade: (1) Understand the Ocean in the Earth System, (2) Promote Economic Prosperity, (3) Ensure Maritime Security, (4) Safeguard Human Health, and (5) Develop Resilient Coastal Communities. The PACE mission will provide observations that support strategic objectives such as (1), in support of a blue economy, as well as other applications with societal benefits. Ultimately, the PACE SVC system and validation of its data products will ensure climate-quality data.

1.2.1 *Vicarious Calibration for Ocean Color*

Earth's ocean supports a nearly one-trillion-dollar annual global economy. Increasing climate variability and change occurring in the Earth system impacts aquatic ecology, chemistry, and biology, as well as aerosol particles and clouds, which, in turn, affects resource management, conservation, and economics. Satellite ocean color data provide information for understanding Earth's living ocean and for improving forecasts of Earth system variability and its impacts and feedback on ocean ecosystems and biogeochemistry (e.g., fisheries, carbon cycle, harmful algal blooms and public health, marine resources, land/ocean interactions, etc.). A satellite ocean color mission can achieve these objectives by providing climate-quality global ocean color measurements that are essential for understanding aspects of the Earth system, such as the carbon cycle and its interrelationship with climate change, and by expanding our understanding

about ocean ecology and biogeochemistry. The success of an ocean color mission relies on a combination of satellite remote sensing, field measurements (e.g., ship, mooring, and drifter), Earth system modeling, and synthesis efforts designed to address specific science questions.

The ability of an ocean color mission to meet its key science objectives depends primarily upon the quality of the ocean ecosystem, biogeochemistry, and aerosol and cloud data products derived from radiometric data collected by the sensor. To produce a time series of spectral data of sufficient quality for ocean color research, the ocean color sensor must meet stringent calibration and validation data requirements for performance, uncertainties in the retrievals, and stability over time. The NASA PACE mission's ocean color science applications require highly accurate spectral remote sensing reflectances ($R_{rs}(\lambda)$ and sr^{-1}). Maintaining sufficient accuracy over the lifetime of the mission requires a robust SVC program that complements the onboard calibration devices and enables routine verification and performance assessment of the ocean color instrument calibration while on orbit. Highly accurate *in situ* measurements of $R_{rs}(\lambda)$ will provide the principal source of surface truth for operational SVC.

The current requirement for the systematic error of OCI in the blue-green spectral region for oligotrophic-mesotrophic waters is ~0.5%. This stringent value is justified by the high accuracy requirements established for utilizing satellite ocean color products in research and operational investigations, most notably climate change research. Such a level of accuracy can be achieved with SVC: the adjustment of prelaunch calibration coefficients using spectral top-of-atmosphere (TOA) radiances predicted from *in situ* measurements through modeling of atmospheric radiative processes (by applying the same models and codes used for the standard ocean color atmospheric correction process). In practice, the outcome of SVC is the minimization of combined uncertainties resulting from satellite absolute prelaunch calibration and the specific models/algorithms applied to determine primary radiometric products (e.g., $R_{rs}(\lambda)$) from TOA radiance. SVC should be performed using *in situ* radiometry ideally collected with dedicated systems to ensure a high degree of accuracy and full traceability to SI (Système international d'unités) standards. Ideally, the SVC site should also be located in a region where variability and complexity of the atmospheric and oceanic optical properties are low to minimize additional sources of uncertainty due to temporal and spatial sampling differences between the satellite observation and the *in situ* measurement. Historically, atmospheric measurements have not accompanied the ocean SVC measurements. Inclusion of atmospheric aerosol observations (e.g., sun-photometer measurements) may be desirable to support in-depth SVC site characterization, calibration match-up exclusion criteria metrics, and validation of PACE aerosol data products.

Heritage NASA sensors rely on measurements made off Lana'i (Hawaii) by the Marine Optical BuoY (MOBY, https://www.mlml.calstate.edu/moby), an open ocean location exhibiting high spatial homogeneity (both for atmospheric and marine optical properties), high stability (within limits of seasonal changes), low cloudiness, and known atmospheric-marine optical properties. Recent literature has revisited the requirements for a SVC site (Zibordi and Melin, 2017). For any given satellite-*in situ* $R_{rs}(\lambda)$ pair,

different observational conditions (likely related to different viewing geometry, atmospheric and marine optical properties) become a source for uncertainties in the vicarious calibration process. However, collecting many paired observations over all seasons minimizes this uncertainty, such that the time series of observations converges on single spectral vicarious calibration gain factors with uncertainty defined by target climate change applications. The convergent spectral gain factors are then used to adjust TOA reflectances measured by the instrument over its full time series. For the Sea-Viewing Wide Field-of-view Sensor (SeaWiFS) mission (1997-2010; http://oceancolor.gsfc.nasa.gov/SeaWiFS/), this convergence required more than two years. One goal of the PACE mission is to minimize uncertainties in vicarious calibration gain factors within the first year of operation. Multiple SVC sites, particularly if observational requirements and spectral ranges are coordinated with any international investments (e.g., Copernicus), may offer additional information and alternative sources of data. However, these sites should be equivalent in terms of measurement accuracy, traceability, and observation conditions, as different complexities of the atmosphere might lead to inaccurate determinations of the aerosol type and consequently to the determination of substantially different adjustment factors for the prelaunch calibration coefficients. SVC site location must be explained and justified in this context.

1.2.2 *Validation of Aerosols, Clouds, and Ocean Color Data Products*

This program element is primarily directed toward ocean color vicarious calibration. Calibration for aerosol particle and cloud measurements is encouraged if it is an inseparable part of the ocean color vicarious calibration proposed effort. A solicitation that will include calibration and validation of aerosol particle and cloud data products will be issued closer to the PACE launch.

The 2011 report from the National Research Council, *Assessing the Requirements for Sustained Ocean Color Research and Operations* (https://www.nap.edu/catalog/13127/assessing-the-requirements-for-sustained-ocean-color-research-and-operations), focused, among other things, on outlining requirements for establishing and maintaining validation programs over the long term. This report indicated that validation programs are required to ensure the algorithms for generating data products from satellite radiances are credible with data users, and the models and procedures used to process the datasets are working appropriately. To derive and validate the desired ocean color data products from water-leaving radiance, *in situ* data representing a large dynamic range of global ocean conditions for a given data product, starting with water-leaving radiances, are needed for algorithm development and product validation. These *in situ* data need to be collected, quality-controlled, properly archived and documented, and made widely and publicly available through a database such as the SeaWiFS Bio-optical Archive and Storage System (SeaBASS, https://seabass.gsfc.nasa.gov). The report concluded that all ocean color missions require science data product validation programs as a key step for reprocessing of ocean color observations and for establishing uncertainty levels for ocean color mission

data products. The PACE Science Definition Team report reinforced the need for validating all PACE mission data products.

The purpose of including PACE data product validation in this program element is to acknowledge that SVC and validation of ocean color radiometry ($R_{rs}(\lambda)$) can share common instrument technologies and measurement platforms that are not mutually exclusive. While this program element is primarily focused on development, testing, and implementation of a sustained, rigorous ocean SVC system, it is recognized that: (1) SVC instrument development could result in technologies suitable for additional deployment for validation of ocean color radiometric data products; (2) an SVC system for the PACE mission could incorporate a mix of measurement platforms (e.g., satellites, aircraft, and *in situ* platforms such as ships and buoys), commercial off-the-shelf instrumentation, or investments in new technology that additionally support validation of ocean color, aerosol, and cloud data products; and (3) systems for validation of planned PACE OCI data products potentially require lead time for elevating instrument Technology Readiness Levels. Proposers should indicate how their proposed SVC system or the technologies to be developed might be used for validation of PACE science data products. This could include, but is not limited to, establishment of multiple sites (e.g., one for SVC, others for validation), development or commercialization of instruments deployed independent of SVC for validation purposes, and/or establishment of a multi-instrumented instrument platform(s) enabling SVC as well as additional science data product validation. As needed, coordination and collaboration with other domestic and international research and space agency partners is welcome.

1.2.3 *Key characteristics of PACE*

In the summer of 2019, PACE will reach its Key Decision Point-C (KDP-C) to codify observational requirements and enter its Final Design and Implementation phase (Phase C). Technical documents and presentations related to the mission, including its Science Definition Team report and an emerging series of NASA Technical Memoranda, can be found on the PACE website (https://pace.oceansciences.org/documents.htm). PACE's primary instrument (the Ocean Color Instrument, OCI) consists of two spectrometers that continuously span the ultraviolet-to-orange and orange-to-near-infrared spectral regions, with an additional seven discrete shortwave infrared bands. This instrument will be complemented by two small multi-angle polarimeters with spectral ranges that span the visible-to-near-infrared region. Key characteristics of the PACE observatory include:

- The Ocean Color Instrument (OCI), built at Goddard Space Flight Center (GSFC)
- The Hyper Angular Research Polarimeter (HARP-2), contributed by the Earth and Space Institute at the University of Maryland Baltimore County (UMBC)
- The Spectro-polarimeter for Planetary Exploration (SPEXone), contributed by a Netherlands-based consortium consisting of the Netherlands Institute for Space Research (SRON) and Airbus Defence and Space Netherlands
- 675.5 km altitude and 13:00 local equatorial crossing time

- Sun synchronous, polar, ascending orbit with 98º inclination
- Fall 2022 launch, 3-year design life, 10 years of fuel

See also https://pace.oceansciences.org/mission.htm. The OCI design follows that of SeaWiFS, with a rotating telescope, a half-angle mirror, and a depolarizer. OCI will also acquire monthly lunar observations that illuminate all science detector elements for a lunar calibration time-series, as well as perform daily instrument characterizations using solar diffusor(s). HARP-2 is a hyper-angular imaging polarimeter that will see Earth simultaneously from multiple viewing angles using a modified Philips prism design to collect simultaneous measurements of linear polarization in three orientations. SPEXone uses a spectral modulation technique that encodes the degree and angle of linear polarization into a modulation of the radiance spectrum. Additional instrument specifications for OCI, HARP-2, and SPEXone appear in Table 1, below.

Table 1 Additional Instrument Specifications

	OCI	HARP-2	SPEXone
Ultraviolet–near-infrared (UV-NIR) range [bandwidth]	Continuous from 345-890* nm in 5 nm steps [5]	440, 550, 670 [10] nm and 870 [40] nm	Continuous from 385-770 nm in 2-4 nm steps
Shortwave infrared (SWIR) range [bandwidth]	940 [45], 1038 [75], 1250 [30], 1378 [15], 1615 [75], 2130 [50], and 2260 [75] nm	None	None
Polarized bands	None	All	Continuous from 385-770 nm in 15 to 45 nm steps
Number of viewing angles [degrees]	Fore-aft instrument tilt of ±20º to avoid Sun glint	10 for 440, 550, 870 nm; 60 for 670 nm [spaced over 114º]	5 [-57º, -20º, 0º, 20º, 57º]
Swath width	±56.5º [2663 km at 20º tilt]	±47º [1556 km at nadir]	±4º [100 km at nadir]
Global coverage	1-2+ days	2 days	~1 month
Ground pixel	1 km at nadir	3 km	2.5 km
Heritage	N/A	AirHARP, CubeSat	AirSPEX
Institution	GSFC	UMBC	SRON

* The mission carries a goal of extending the shortest wavelength to 320 nm.
\+ 2-day coverage when limited to solar and sensor viewing angles of 75º and 60º, respectively

Although a proposed SVC system that supports calibration and validation of multi-angle polarimetry will be favorably considered, this support is not a requirement of this call.

A core PACE mission requirement is development of the data products in Table 2 (with corresponding uncertainties) from OCI alone.

Table 2 OCI Data Products

Data Product	Uncertainty
Water-leaving reflectances from 350 to 400 nm	0.0057 or 20%
Water-leaving reflectances from 400 to 600 nm	0.0020 or 5%
Water-leaving reflectances from 660 to 710 nm	0.0007 or 10%
Total aerosol optical depth at 380 nm	0.06 or 40%
Total aerosol optical depth at 440, 500, 550 and 675 nm over land	0.06 or 20%
Total aerosol optical depth at 440, 500, 550 and 675 nm over oceans	0.04 or 15%
Fine mode fraction of aerosol optical depth over oceans at 550 nm	±25%
Cloud layer detection for optical depth < 0.3	40%
Cloud top pressure of opaque (optical depth > 3) clouds	60 hPa
Optical thickness of liquid clouds	25%
Optical thickness of ice clouds	35%
Effective radius of liquid clouds	25%
Effective radius of ice clouds	35%

Each uncertainty is defined as the maximum of the absolute and relative values when both are provided, and for Level-2 satellite data processing (geophysical values in the original satellite coordinate system). The water-leaving reflectance requirements are defined for ≥50% of the observable deep ocean (depth ≥ 1000 m). The other requirements are defined for ≥65% of the observable atmosphere. PACE will produce a large suite of additional geophysical products from OCI including, but not limited to, spectral marine inherent optical properties (e.g., absorption and scattering coefficients), phytoplankton pigment concentrations, metrics related to phytoplankton physiology and carbon stocks, water paths for liquid and ice clouds, and data products to support land and applications studies (see, e.g., the PACE Science Definition Team report). The inclusion of multi-angle polarimetry on the observatory should enable production of atmospheric and oceanic data products that exceed the capabilities of OCI alone, such as aerosol and hydrosol refractive indices, and further facilitate coupled ocean-atmosphere retrievals (see, e.g., the PACE Science Definition Team report). While terrestrial applications are not the mission focus, PACE's observations will also provide information on radiative properties of land surfaces and characterization of the vegetation and soils that dominate their reflectance.

1.3 Proposal Research Topic

1.3.1 *Vicarious Calibration for Ocean Color*

This program element focuses on delivery of the at-launch vicarious calibration system hardware, approach, and software to support the SVC of the NASA PACE mission's OCI. As previously mentioned, domestic and international efforts are underway in parallel to develop preliminary designs of sufficiently robust *in situ* vicarious calibration and validation systems in support of current and future ocean color satellite missions. Proposers are encouraged to meet as many joint requirements for collaborative purposes as possible. The required *in situ* SVC instrument system(s) to support PACE ocean color science and applications **must** include the following features:

1. Spectral range from 345-890 nm at < 3 nm resolution (ideally 1 nm) – such that the spectral range of the SVC system(s) mirror that of OCI
2. Spectral radiometric uncertainty lower than 4% in the blue-green spectral region and of approximately 5% in the red, combining uncertainty contributions from instrument absolute calibration, characterization (including at least spectral calibration, nonlinearity, stray light perturbation and polarization sensitivity, temperature dependence, and, if applicable, geometrical and in-water response), environmental perturbation, and data processing (with National Institute for Standards and Technology [NIST] traceability)
3. Spectral radiometric stability on the order of 1% per deployment (with NIST traceability)
4. Capability for autonomous field operation
5. Capability for operation from launch – one year plus the three years of prime mission life
6. Full laboratory and field characterization of all of the above requirements versus NIST standards prior to deployment
7. Full autonomous delivery of data, in proper formats, fidelity, and latency, to enable NASA PACE mission science in near real time

Proposals are expected to explicitly describe one or more strategies for verifying instrument performance both pre- and post-launch, including cross comparisons with independent data sources (e.g., additional radiometric instrumentation and/or radiative transfer simulations). All strategies should identify methodologies as well as both pre- and post-launch data sources to be incorporated into performance verification.

Proposals are expected to explicitly describe all instrument calibration and data (post-) processing algorithms and methods to be employed to generate both calibrated (ir)radiances (including all surface/sky/depth-resolved values and intermediate products, as appropriate to the proposed instrument system[s]) and $R_{rs}(\lambda)$.

Proposals are expected to highlight synergies with other (e.g., Copernicus) related SVC activities, systems, and sites, if possible.

PACE Project Science and Science Data Segment (within the NASA GSFC Ocean Biology Processing Group, OBPG; https://oceancolor.gsfc.nasa.gov) members will be

available to interface with awarded Principal Investigators (PIs) for implementation, evaluation, and testing of SVC approaches and/or algorithms. Project Science and Science Data Segment (SDS) designees will participate in vicarious calibration team activities, including scientific discussions, measurement discussions, algorithm development and retrieval activities, and associated algorithm/retrieval testing and implementation activities (as appropriate). These interactions will resolve any outstanding data processing and distribution issues for PACE mission data prior to launch and post-launch. Proposals must outline a strategy for interaction with the Project Science and SDS teams including, but not limited to, data transfers, data formats, data processing and post-processing strategies, sharing of algorithms and software, acceptable data collection latencies (the PACE Project expects delivery of SVC data both during deployment and for post-deployment-calibration), and SVC support for PACE instrument data reprocessings. PIs should plan on interacting with the PACE Project several times each year.

All PACE Level-0, -1, -2, and -3 data products (http://science.nasa.gov/earth-science/earth-science-data/data-processing-levels-for-eosdis-data-products/) and science data processing software/source code/algorithms from all instruments on the observatory and SVC will be incorporated into the NASA Ocean Color website (http://oceancolor.gsfc.nasa.gov) to be publicly distributed according to NASA Science Mission Directorate (SMD) open data access policies (https://science.nasa.gov/earth-science/earth-science-data/data-information-policy).

PIs will caucus with Project Science Team, Program Science Team, and SDS within 1-2 months of the start date of the award to review the awarded SVC systems and any updates to the OCI concept that have been realized since the time of this writing that may have relevance to the SVC design concept(s).

NASA anticipates selecting up to two teams in response to this program element and down-selecting to one team within twelve months of the start dates of the two awards. Each proposal, within the body of the proposal, should provide a detailed schedule and methods for any development and the path and timeline for system deployment. Due to the planned downselect after twelve months, proposers must not plan any development beyond six months and must spend the remaining six months collecting data. Commercial availability of the instrument will factor in to the downselect decision, with an agency desire to move away from custom instrument(s). The final selected team should plan on full deployment and preliminary operation of the SVC system one year before the Launch Readiness Date, which is currently August 2022. Preliminary operation will include interaction with the PACE Project Science Team and the SDS to evaluate the full SVC process using Visible Infrared Imaging Radiometer Suite (VIIRS) or equivalent satellite data records as a test bed, with the purpose of achieving a high system readiness level before PACE's launch, as well as a full year of characterization for the SVC site(s).

1.3.2 *Additional Requirements*

Complementary routine field efforts at the SVC site(s) are expected to support characterization of the site(s) and any future satellite missions via verification of data quality through the quantification of uncertainties affecting data products. Such field work should be explicitly described in responses to this program element. Additional field work to support a PACE Validation Team will be the focus of a near- or post-launch solicitation.

The proposed effort must identify and advance the Technology Readiness Level (TRL, https://esto.nasa.gov/technologists_trl.html) of the proposed instrument(s). The proposed effort is expected to have an entry TRL between 4 and 5. The required deliverable from this program element will be a fully tested, field deployable instrument at TRL 6, with the instrument ready to support the PACE OCI with verified data quality and uncertainties sufficient for satellite remote sensing product validation.

International Principal Investigators (PIs) from institutions in countries outside the U.S. are free to propose to this program element on a no-exchange-of-funds basis. PIs from institutions outside the U.S. should indicate their desire for participation to the NASA points of contact listed in Section 3 .

2. Programmatic Information

This program element provides additional details governing the proposed activities that supersede the general guidelines announced in the *NASA Guidebook for Proposers Responding to a NASA Research Announcement* (incorporated by reference into this ROSES solicitation) and supersede the ROSES solicitation defaults, as described in Section I(g) of the *ROSES Summary of Solicitation*. The most recent edition of the *NASA Guidebook for Proposers* may be accessed on the web at http://www.hq.nasa.gov/office/procurement/nraguidebook/.

2.1 Proposal Content and Submission

2.1.1 *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 the proposal review activities and, therefore, is of considerable value to both NASA and the proposer. NOIs shall be submitted electronically via NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) by the due date given in Section 3. Since NOIs submitted after the deadline may still be useful to NASA, late NOIs, as well as indications of intent NOT to propose on an earlier NOI submission, may be submitted by email to the NASA points of contact in Section 3 of this program element.

Prospective proposers are requested to submit any questions in writing to paula.bontempi@nasa.gov no fewer than 30 days before the proposal due date so that NASA may provide as much information as possible. Answers to submitted questions will be added as a Frequently Asked Question (FAQ) posted on the NSPIRES

page for this program element. It is the proposer's responsibility to stay up-to-date by regularly checking the NSPIRES website, subscribing to the NSPIRES mailing lists (by logging in at http://nspires.nasaprs.com/ and checking the appropriate boxes under "Account Management" and "Email Subscriptions"), and/or checking the ROSES-18 RSS feed for updates and amendments to this solicitation.

2.1.2 *Proposal Content*

2.1.2.1 Proposal Summary (Abstract)

Each proposal shall include, as part of the NSPIRES cover pages, a proposal summary that describes the proposed work in no more than 300 words. The proposal summary shall include: (a) objectives and benefits, (b) an outline of the proposed work and methodology, (c) the period of performance, and (d) entry and planned exit TRL.

2.1.2.2 Scientific/Technical/Management Section (Project Description)

This section must include the following content information in subsections that use the same titles in the bulleted list below. Failure to provide any of this material may be cause for the proposal to be judged as noncompliant and returned without further review. The Project Description is limited to 15 nonreduced, single-spaced typewritten pages. Standard proposal style formats shall be in accordance with Section 2.2 of the *Guidebook for Proposers.* Proposals that exceed the 15-page limit will be truncated at 15 pages. The Project Description Section shall include the following information:

1. Description – Describe the existing capabilities and/or capabilities that need to be developed and how those capabilities would meet specified vicarious calibration instrument(s) requirement(s). Clearly state specific requirements that are being targeted, as well as any requirements that may not be fully met. Also, the proposers must clearly demonstrate an understanding of the full system life cycle from design through continued, prolonged operations in the field.
2. Justification – Explain why this particular capability or approach would meet the requirement(s).
3. Comparative Instrument Assessment – Describe the anticipated advantages of this instrument and/or approach compared to those currently in use - e.g., reduction of size, mass, power, volume, or 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 the starting point for the instrument, system, or approach and the exit or success criteria for the proposed activity. It is required that the proposed system be TRL 6 and ready for deployment at the end of the funded development period.

   TRL definitions can be found at https://esto.nasa.gov/technologists_trl.html. The proposer shall identify the entry TRL, the planned exit TRL, and success

criteria in their proposal. The proposer shall substantiate the entry TRL in the proposal.

5. Research Management Plan – Proposers 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 schedule chart that identifies critical milestones. At least three milestones per twelve-month period must be defined.

   Subcontracting portions of the research project is acceptable, but overall management and reporting are the responsibility of the proposing organization.
6. Personnel – Provide a list of key personnel and identify experience related to the proposed activity. Proposers should be sure to include personnel with science, technology development, and instrument development skills on 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 Project Description 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.
8. Special Matters – Proposers should include a brief description of the organization, its facilities, and previous work experience relevant to the proposal.
9. Funding profile – Provide an estimate of life cycle cost for the system, including projected field maintenance over the expected deployed life of the system.

In addition, a Quad Chart will be required – proposers must provide a summary chart (quad chart) that shall contain the following information:

- Upper Left Quadrant: "Description and Objectives"
- Lower Left Quadrant: "Approach" and "Co-Is/Partners"
- Upper Right Quadrant: A visual, graphic, or other pertinent information
- Lower Right Quadrant: "Milestone Schedule" 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 15-page limit for the Project Description Section.

2.2 Award Information

2.2.1 *Funding*

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 NASA determines 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 (see Section 2.2.3 of this program element).

The funding available for this program element will limit the number and magnitude of the proposals awarded. The Earth Science Division expects up to two proposals will be selected for the system vicarious calibration program element, and the value of each award is expected to be in the range of approximately $1M per year.

Proposers are encouraged to offer cost sharing. If a cost sharing arrangement is proposed, appropriate data rights recognizing the proposer's contributions, as well as the Government's rights to access, will be negotiated prior to award.

2.2.2 *Period of Performance*

The minimum period of performance is 12 months. The total proposed period of performance must not exceed 48 months. Grants may be awarded for up to a four-year performance period. The vicarious calibration program element will have an annual review after the first 12-month period of performance with a downselect to one award thereafter. The PACE Program Scientists and Project Team will make this determination based on the progress in the first 12-month period relative to the timeline, schedule, and goals and objectives proposed. Proposals must define clear, measurable milestones to be achieved for each year of performance in order to warrant continuation in the second, third, and fourth years.

2.2.3 *Type of Award*

All selected proposals will result in the award of grants, cooperative agreements, or intra- or inter-Government transfers, as appropriate. Contracts are specifically excluded as an award vehicle for this program element. If a commercial organization wants to receive a grant or cooperative agreement, cost sharing is required unless the commercial organization can demonstrate 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.

2.3 Evaluation Criteria

Evaluation process and criteria are given in Section VI.(a) of the *ROSES Summary of Solicitation* and Appendix D of the *NASA Guidebook for Proposers*.

The evaluation of relevance includes the applicability of the proposed investigation to ocean color remote sensing vicarious (*in situ*) calibration instruments and specifically includes the following factors:

- The degree to which the proposed development meets or exceeds the objective of ocean color remote sensing vicarious (*in situ*) calibration measurements/requirements
- The degree to which the proposers demonstrate understanding of the PACE mission objectives and the functions and needs of the *in situ* vicarious calibration
- The potential of the instrument, once matured for field deployment, to support future Earth science NASA ocean color missions
- The potential for the instrument, system, or approach to have commercial benefits

In addition to the definition given in Appendix D of the *NASA Guidebook for Proposers*, the second evaluation criterion "intrinsic merit" specifically includes the following factors:

- Feasibility and merit of the proposed instrument, system, or approach to achieve the development requirements
- Potential for the instrument or system to fully meet TRL 6 criteria for future deployment
- Degree to which the full life cycle of the system is proposed and defended, including design, development, laboratory testing, field deployment, retention of calibration in the field, and maintenance of the system while on station
- Degree of innovation of the instrument, system, or approach, if merit is highly reviewed
- Past performance and related experience in the proposed area
- Qualifications of key personnel and adequacy of facilities, staff, and equipment to support the proposed activity to ensure the team has strong development skills, as well as any leveraging/teaming such as recent Small Business Innovation Research (SBIR) awards/awardees
- Feasibility of obtaining the potential reduction in risk, cost, size, and development time, with the proposed instrument, system, or approach

The third criterion is cost reasonableness. In addition to the factors given in the *NASA Guidebook for Proposers*, this evaluation criterion specifically includes the following factors:

- Adequacy and realism of proposed milestones and associated success criteria.
- Reasonableness of the proposed cost (given in Sections 2.2.1 and 3 of this program element).
- Projected estimate of life cycle cost for the system, including projected field maintenance over the expected deployed life of the system.
- Heritage of the proposing organization in delivering engineering and science instruments reaching TRL 6 and beyond.
- Adherence to sound and consistent management practices appropriate to the TRL of the proposed task (exit at TRL 6 for field deployment).
- Commitment of the organization’s management to the proposed instrument, system or approach (evidenced by prior teaming arrangements, etc.). Proposers should identify any previous investment by the proposing organization/program

and provide supporting documentation of any prior investment relevant to their proposal. This supporting documentation is not included in the 15-page limit for the Project Description Section.

Cost sharing is not part of the cost criterion. Cost sharing may become a factor at the time of selection when NASA is deciding between proposals of otherwise equal scientific and technical merit.

2.4 Technical Reporting Requirements

Once awarded, all status information, presentation material, and report deliverables applicable to this program element are to be submitted to the web-based Earth Science Technology Office (ESTO) Reporting System (ERS). A user account on the ERS will be provided to the PI upon award. Due to NASA Information Technology (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.

The following deliverables shall be required of awarded proposals. In cases where subcontract arrangements 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 *Initial Plans and Reports*

Within 15 days of award, the PI must provide an updated Project Plan, initial Quad Chart, initial TRL assessment, and a monthly cost plan for the entire period of performance. The project plan, initial (entry) Quad Chart, cost plan, and initial TRL assessment (and supporting data) should be created in the ESTO ERS.

The project plan shall identify plans for all technical, schedule, and resource activities for the proposed life of the project.

As described in Section 2.1, a summary Quad Chart is required, containing the following information:

- Upper Left Quadrant: "Description and Objectives"
- Lower Left Quadrant: "Approach" and "Co-Is/Partners"
- Upper Right Quadrant: A visual, graphic, or other pertinent information
- Lower Right Quadrant: "Milestone Schedule" and "Entry TRL"

PIs are required to update the Quad Chart and TRL assessment at least annually or more often, as appropriate.

2.4.2 *Quarterly Technical Reports*

The quarterly technical report shall focus on the preceding three-month's efforts. Each report shall address the following information:

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 address the status of major tasks and the variance from the planned versus the 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.

The PI shall upload the Quarterly Technical Reports to the appropriate location in the ERS at three-month intervals, starting on the three-month anniversary date of the start date specified in the award vehicle. In months in which the PI is providing an interim or annual review, the requirement for a quarterly report is superseded by the interim or annual review requirements discussed in the next two sections.

Reports shall be submitted in PDF, Microsoft Word, or 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 including ESTO, the program science staff, and the PI to review and discuss each report.

2.4.3 *Interim Reviews*

The PI shall provide an Interim Review at the end of the first six-month calendar period commencing from the date of award and at twelve-month intervals thereafter. The PI must provide a presentation summarizing the work accomplished and results leading up to this Interim Review. The presentation must include the following information:

1. Describe the primary findings, 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 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, maintained and shown at all reviews. A cost data sheet shall be created and maintained, showing total project costs obligated and costed, along with a graphical representation of the project cost profile to completion.
4. Provide a summary of anticipated results at the end of the task.
5. At the second review and subsequent reviews, address the comments and recommendations resulting from the most recent review.

The Interim Review will be conducted via teleconference. The PI shall upload the Interim Review presentation to the appropriate location in the ERS at least three working days prior to the review. Within ten days following the review, the PI shall upload the presentation, updated in accordance with comments and discussion resulting from the review, to the appropriate location in the ERS.

2.4.4 *Annual Reviews*

The PI shall provide an Annual Review at the end of each twelve-month calendar period commencing from the date of award. The Annual Reviews are similar to the Interim Reviews and include all of the products required at an Interim Review with the following exceptions:

1. The review is held at the PI's facility or a mutually agreed-to location.
2. The PI may provide a laboratory demonstration, if appropriate, to show technical results and status.
3. The PI shall 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 contributing to the overall success of the research project.
4. The Annual Review should be comprehensive and should cover the progress over the previous twelve months.

The PI shall upload the review package to the appropriate location in the ERS at least three working days prior to the review. The PI shall upload the presentation, updated in accordance with comments and discussion resulting from the review, to the appropriate location in the ERS within ten days after the review.

2.4.5 *Final Review and Final Report*

The PI shall provide a Final Review at the completion of the activity. For at least one team that will not move forward following the deselection, this Final Review will be after a 12-month period. Instructions on the final report for the team(s) not moving forward will be given following the downselect review following the first year of work. The Final Review is similar to the Annual Reviews and includes all of the products required at an Annual Review. In addition, 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 advance the TRL to the next level.

The written Final Report shall include the following information:

1. Background of the project, including the science rationale for conducting this 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; description of 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 implement the system vicarious calibration

6. Updated Quad Chart
7. A final Accomplishments Chart that contains the following information (a template is available in the e-Book):
   - Upper Left: "Description and Objectives"
   - Upper Right: A visual, graphic, or other pertinent information
   - Middle: "Accomplishments"
   - Bottom: "Co-Is" (name and affiliation), "Entry TRL" and "Exit TRL"

The PI shall upload the Final Report and updated Final Review presentation to the appropriate locations in the ESTO ERS within thirty (30) days of the final review. The PI is also expected to update the Accomplishment Chart and TRL assessment on the ERS under the "Quad Chart" section and "TRL" section, respectively.

3. Summary of Key Information

Expected program budget for first year of new awards	~$3.2M; estimated total funding available is $5-8M over four years
Number of new awards pending adequate proposals of merit	Up to two, downselect to one after 12-months
Maximum duration of awards	Minimum 1-year / Maximum 4-year awards
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	~3-4 months after proposal due date.
Page length 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 to NASA	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*.
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 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) 518-4726)

Funding opportunity number for downloading an application package from Grants.gov	NNH18ZDA001N-PACE
NASA points of contact concerning this program	Paula Bontempi Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone (202) 358-1508 Email: paula.bontempi@nasa.gov Parminder Ghuman Science Mission Directorate Earth Science Technology Office Telephone: (301) 286-8001 Email: p.ghuman@nasa.gov

A.49 CARBON MONITORING SYSTEM: CONTINUING PROTOTYPE PRODUCT DEVELOPMENT

NOTICE: February 22, 2019. This amendment presents a new opportunity: Carbon Monitoring System in this program element. Notices of Intent are requested by March 25, 2019 and proposals are due May 23, 2019.

Proposers to this program element are not required to provide a data management plan via the NSPIRES cover page question. Instead, that is superseded by instructions in the instructions below that require more detailed descriptions in the body of the proposals. See Section 2.2.8 below.

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 a prototype carbon monitoring system.

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); and Global Ecosystem

Dynamics Investigation (GEDI, launched December 5, 2018)) and missions in development (i.e., Orbiting Carbon Observatory-3 (OCO-3); 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, and carbon management research.

2. Research Solicited

NASA requests proposals for investigations that will advance products toward the CMS end goal: development of a prototype carbon monitoring system from an Earth's system perspective. Geographic 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 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 (e.g., LBA, EXPORTS, AfriSAR, etc.).

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 will be considered non-responsive.

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

- Use remote sensing data products to produce and evaluate existing prototype CMS system approaches for potential decision support activities;
- Develop or refine data products related to the near- or long-term accumulation and fluxes of terrestrial carbon stocks in tropical biomes using satellite or airborne remote sensing, with an emphasis on regional scales, using bottom-up and/or top-down models;
- Develop and/or refine aquatic carbon sources, sinks, and fluxes using data products or approaches that integrate, or provide the basis for integrating, remote sensing data from current or future NASA missions. This includes studies that will use remote sensing data products to further develop and refine bottom-up processes with top-down stock and flux assessments. Also considered will be studies that advance remote sensing-based approaches to reduce uncertainty in defining the impact land cover changes (e.g., forest degradation, disturbance) have on aquatic systems, including their effects on land-to-river and land-to-ocean carbon fluxes studies, and quantification of carbon in coastal ecosystems;
- Use stakeholder interests and requirements to understand and engage the user community for carbon products and/or evaluate current and planned NASA CMS products with regard to their value for decision-making by these users, and to assist in having existing products used for stake-holder activities. Priority will be given to proposals where potential stakeholders have in-kind contributions to ensure transfer of CMS activities into their own ongoing or future activity.

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 and priority 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 2.2.6).

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. Proposers must clearly explain how the proposed work will address stakeholder interests in their studies and contribute to CMS ST activities to understand and engage the user community for carbon monitoring products.

Many of the studies funded through the ROSES-2016 CMS program element (A.7; see PDF document with titles and abstracts of ROSES-2016 awards) have one additional year of funding remaining. Proposals to further develop or expand upon funded ROSES-2016 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 teleconference calls and email. Proposals are not currently being solicited for the Science Team leader; the ST Lead selected during the ROSES-2016 CMS program element will remain Lead for the duration of any selected awards from this competition. It is anticipated that proposals for ST Lead will be solicited in a future ROSES call.

2.2.3 *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. 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.

2.2.4 *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).

2.2.5 *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. organization. For more information, see http://science.nasa.gov/researchers/sara/faqs/#14.

2.2.6 *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.

2.2.7 *Work Effort and Current and Pending Support*

Proposers should use NASA'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*.

2.2.8 *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 2019 funding identified for CMS efforts, $6.1M is already allocated to ongoing research commitments from prior years. Therefore, $3.9M in FY 2019 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 Section C.2 of 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	$3.9M
Number of new awards pending adequate proposals of merit	~8-15
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	September 2019
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 to NASA	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	NNH18ZDA001N-CMS
NASA 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 Paula Bontempi Telephone: 202-358-1508 Email: Paula.Bontempi@nasa.gov Hank Margolis Telephone: (202) 358-4760 Email: Hank.A.Margolis@nasa.gov

APPENDIX B. HELIOPHYSICS RESEARCH PROGRAM

B.1 HELIOPHYSICS RESEARCH PROGRAM OVERVIEW

1. Overview

NASA's heliophysics strategic objective 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 goals defined in the *NASA 2014 Science Plan* (available at https://science.nasa.gov/about-us/science-strategy) and 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) and its purpose is to enable achieving these goals, which 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.

The Heliophysics Research Program seeks to understand phenomena, on a broad range of spatial and temporal scales, the fundamental processes that drive them, how these processes combine to create space weather events, and to enable a capability for predicting future space weather events. 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.

The program supports investigations of the Sun, including processes taking place throughout the solar interior and its atmosphere, as well as and 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 fields and waves, and coupling to the solar wind and ionospheres. It supports the physics investigations of the terrestrial mesosphere, thermosphere, and ionosphere, including the coupling of these phenomena to the lower atmosphere and magnetosphere.

The program elements are as follows:

- B.2 Heliophysics Supporting Research (H-SR)
- B.3 Heliophysics Technology and Instrument Development for Science (H-TIDeS)
- B.4 Heliophysics Guest Investigators (H-GI/Open)

- B.5 Heliophysics Grand Challenges Research – Theory, Modeling and Simulations (H-GCR/TMS) – Not solicited this year
- B.6 Heliophysics Living With a Star Science (H-LWS)
- B.7 Heliophysics Data Environment Enhancements (H-DEE)
- B.8 Heliophysics Guest Investigators – Global Observations of Limb and Disk and Ionospheric Connection Explorer Guest Investigator (H-GI GOLD/ICON)
- B.9 Heliophysics Grand Challenges Research – Science Centers (H-GCR/SC)
- B.10 Heliophsyics Early Career Investigator Program (H-ECIP)
- B.11 Heliophysics U.S. Participating Investigator (H-USPI)
- B.12 Heliophysics Space Weather Operations to Research (H-SWO2R)

It is the overall purpose of each of the program elements to contribute as effectively and directly as possible to the achievement of the NASA Heliophysics strategic objective. Priority for selection is given to those proposals that most clearly demonstrate the potential for such contributions.

The ROSES NRA and Appendix B allows for all award types, but the default for program elements in Appendix B is that NASA does not intend to award contracts as it would not be appropriate for the nature of the work solicited. Any program elements that may issue contracts will say so explicitly. Please read the program elements carefully.

1.1 Data Management

All proposals to Appendix B will have to address data management. For all programs, but B.7 H-DEE, proposers must present a data management plan (DMP), or an explanation of why one is not necessary given the nature of the work proposed, by responding to the compulsory NSPIRES cover page question about the DMP. The kinds of proposals that require a data management plan on the cover pages are described in the NASA Plan for increasing access to results of Federally funded research and in the Service and Advice for Research and Analysis (SARA) Frequently Asked Questions (FAQs) about Data Management Plans (DMPs). For proposers to B.7 H-DEE, the minimum DMP requirement is superseded by instructions in the program element that place more detailed descriptions into the body of the Scientific/Technical/Management section of proposals. See, Section 2 of B.7 H-DEE.

1.2 Data Eligibility

NASA spacecraft mission data to be used in proposed work must be available in the Solar Data Analysis Center (SDAC), Space Physics Data Facility (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. This is applicable to ROSES Heliophysics elements B.2 (H-SR), B.4 (H-GI Open), B.6 (H-LWS), B.8 (H-GI GOLD/ICON), B.9 (H-GCR/SC), and B.10 (H-ECIP).

1.3 Two-Step Process and Duplication

Proposal submission to all elements in Heliophysics will continue using a two-step process proposal submission process (see Section IV(b)vii of the ROSES *Summary of Solicitation*), in which a Step-1 proposal is required. The title, science goals, and investigators cannot be changed between the Step-1 and Step-2 proposals. All

Heliophysics programs will continue reviewing 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. The evaluation of Step-1 proposals will not be in effect in ROSES. All compliant proposals submitted to these calls will be either "encouraged" or "invited" to submit a Step-2 proposal. Proposers to H-GI, H-SR, HTIDeS, H-ECIP are limited to one Step-1 proposal per Principal Investigator (PI or Science PI) per program element, i.e., they can submit one and only one proposal as PI to each.

Proposers may not submit Step-2 proposals for the same or essentially the same work to more than one program element concurrently. 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 is active for a particular submitted proposal until the PI is notified 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-2017 proposal may not be submitted in response to ROSES-2018). 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.

2. Recent Trends in Proposal Selection Rates

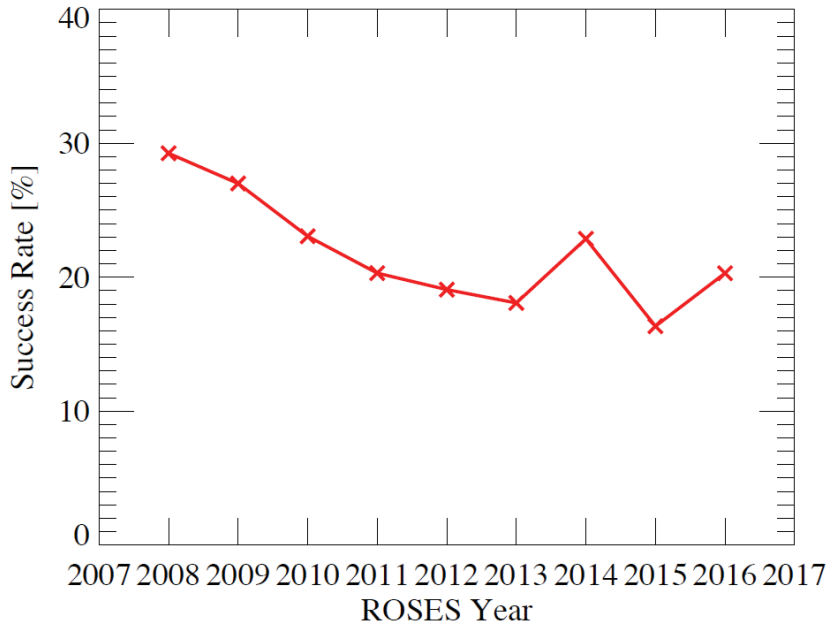
The Heliophysics research budget that supports analysis of Heliophysics System Observatory (HSO) data is competed through ROSES and continues to experience high demand through increased numbers of proposals submitted by the community. As a result, the success rate of proposals submitted to the ROSES portfolio that Heliophysics offers had declined (Figure 1) in the period of ROSES-2008 to ROSES-2013 and has stabilized since.

At the time of writing, complete data on full proposal submissions for ROSES-2017 is not available, but initial indications are that proposal submission numbers are not declining substantially as compared to the rates seen in the ROSES-2013 through ROSES-2016 solicitations. Possible causes for continuing high submission rates are sustained success rates under 25% since ROSES-2010.

The Encourage/Discourage approach, i.e., peer review of three-page Step-1 proposals, for H-GI and H-SR program elements in ROSES-2014 and ROSES-2015 has been analyzed and found not to be as meaningful and effective as hoped for in identifying proposals with insufficient scientific merit. It, therefore, has been discontinued.

Beginning in ROSES-2016, the H-SR program scope has been expanded, requiring higher levels of commitment of the PI (or science lead) to funded projects than before with the goal of increasing the science return. This approach is continued in ROSES-2018. While it was observed that this larger scope led to a reduction of proposal submissions, due to a larger cost per proposal the H-SR success rate is expected to be to be the same in ROSES-2017 as it was in ROSES-2016.

Figure 1: The selection rates over the ROSES years 2008-2016.



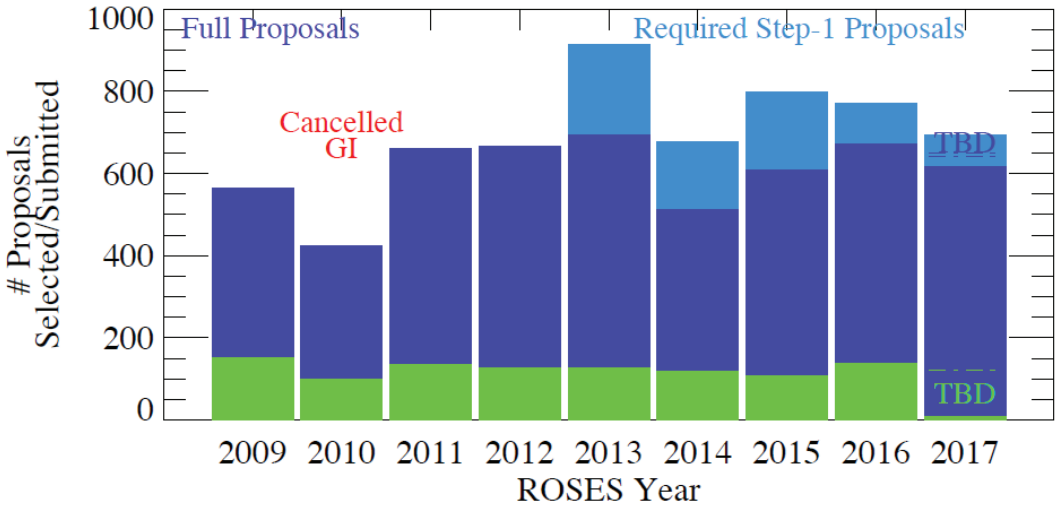


Figure 2: Step-1 and full proposals submitted by ROSES year along with selections, where available. In the bar chart, green indicates the awards, dark blue shows Step-2 proposals, and light blue shows the Step-1 proposals.

On a positive note, the overall outlook for success rates in ROSES-2017, which competes Fiscal Year 2018 funds, is expected to improve from the full implementation of the 2013 Decadal Survey "Diversify, Realize, Integrate, Venture, and Educate" (DRIVE) initiative. The Heliophysics Division is committed to strengthening the Heliophysics Research Program.

3. Program Elements

A brief description of each program element offered in the Heliophysics Research Program is given below. Note that the program elements underwent major restructuring between ROSES-2012 and ROSES-2013. The ROSES-2013 structure is generally maintained in the current ROSES. Please note also that there are opportunities added this year (B.8 through B.12). 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.12.

3.1 Heliophysics Supporting Research (H-SR):

In order to increase the science return from funded investigations and to avoid duplication and overlap of proposal opportunities, in particular between H-GI and H-SR, a larger scope, introduced in ROSES-2016, will be maintained. Heliophysics SR awards are research investigations that employ a variety of techniques, including theory, numerical simulation, modeling, analysis, and interpretation of spacecraft data. This increased scope of investigations must be of sufficient breadth as to require approximately one full time equivalent (FTE) per year to achieve successful completion of the project. As a result, the anticipated average award size has been increased, as well. The investigations that will be of highest priority to the H-SR program will be those that use data from current or historical NASA spacecraft, together with theory and/or numerical simulation to address one of the four Heliophysics Decadal Survey goals. Proposals focused on non-NASA data are now allowed. However, such proposals must demonstrate that the proposed work is necessary to make a significant contribution to addressing one or more Decadal Survey questions. Moreover, all data used must be in a publicly accessible archive at least 30 days before the Step-2 submission deadline.

H-SR supports investigations of the solar interior, solar photosphere, solar chromosphere, transition region, and corona; particle acceleration, transport, modulation in the heliosphere, heliospheric plasma processes, turbulence, waves, composition, interplanetary coronal mass ejections/magnetic clouds and of the outer heliosphere and the interstellar boundary; solar wind – magnetosphere coupling, dayside outer magnetosphere, inner magnetosphere, magnetosphere-ionosphere coupling and magnetotail; ionosphere – atmosphere coupling, neutral atmosphere and solar output-ionosphere/atmosphere coupling; and other planetary magnetospheres. The Heliophysics Supporting Research program is described in Program Element B.2.

3.2 Heliophysics Technology and Instrument Development for Science (H-TIDeS):

The H-TIDeS program solicits proposals for technology and instrument development investigations that are relevant to NASA scientific goals in Heliophysics. The H-TIDeS program seeks to investigate key Heliophysics science questions by addressing the best possible (i) science and/or technology investigations that can be carried out with instruments flown on suborbital sounding rockets, stratospheric balloons, International Space Station (ISS), or other flights of opportunity; (ii) state-of-the-art instrument technology development for instruments that may be proposed as candidate

experiments for future space flight opportunities; (iii) laboratory research; (iv) and CubeSats.

The H-TIDeS program element has four separate components:

Low Cost Access to Space (LCAS) investigations may be science investigations in and of themselves or proof-of-concept experiments for techniques/detectors that enable new Heliophysics science. LCAS includes rides on research balloons, sounding rockets, the ISS, airborne platforms, commercial reusable suborbital rockets, and other flights of opportunity. LCAS investigations that launch into space in order to return scientific data are expected to make direct contributions to the science of Heliophysics.

Instrument and Technology Development (ITD) investigations have as their objective the development of instrument technologies that show promise for use in scientific investigations on future Heliophysics science missions, including the development of laboratory instrument prototypes, but not of flight hardware. Instrument development proposals are not necessarily expected to apply the results of their efforts to science questions within the time period of the proposed effort. They must, however, demonstrate that there is a (are) specific scientific problem(s), for which the development is a necessary precursor.

The Laboratory Nuclear, Atomic, and Plasma Physics (LNAPP) subelement supports studies that probe fundamental physical processes and produce chemical, spectroscopic, plasma, and nuclear measurements that support spacecraft measurements and atmospheric models.

The CubeSats subelement is an additional flight of opportunity class, separate from LCAS, where investigations can be purely scientific studies or proof-of-concept experiments for techniques/detectors that enable new Heliophysics science. Similar to LCAS, launches into space in order to return scientific data are expected to make direct contributions to the science of Heliophysics.

The Heliophysics Technology and Instrument Development for Science program with subelements Low-Cost Access to Space (LCAS), Instrument and Technology Development (ITD), Laboratory Nuclear, Atomic and Plasma Physics (LNAPP), and CubeSats is described in Program Element B.3.

3.3 <u>Heliophysics Guest Investigators (H-GI/OPEN andH-GI GOLD/ICON):</u>

The Heliophysics Guest Investigators (H-GI) program was strongly endorsed by the 2013 Decadal Survey. This program is offered for investigations that draw extensively upon the data sets from the missions of the Heliophysics System Observatory. The focus of the solicited research continuously evolves to ensure that the most important questions identified for recently launched Heliophysics missions are addressed and that high-value data products of currently operating missions of the HSO are created to enable significant advances in Heliophysics science. There are two distinct opportunities in Appendix B this year:

The Heliophysics Guest Investigators open program (H-GI/OPEN) is described in Program Element B.4.

The Global Observations of Limb and Disk and Ionospheric Connection Explorer Guest

Investigator (H-GI GOLD/ICON) will be described in Program Element B.8 later this year.

3.4 Heliophysics Grand Challenges Research (H-GCR/TMS and H-GCR/SC):

Another program that was strongly supported in the Decadal Survey is the Heliophysics Grand Challenges Research program. As recommended, the goals of this program are specifically designed to support investigations of complex problems that fall within the general realm of Heliophysics and whose full resolution has remained elusive. Work on such problems has traditionally been carried out by independent research groups that employ observational, theoretical, and modeling-based approaches. Increasingly, major advances in the field are taking place as a result of the close interactions among observers, theorists, and modelers. Thus, a coherent attack on the most challenging broad problems requires the efforts of a synergistically interacting group of multidisciplinary teams led by a single Principal Investigator, so as to enable deep and transformative science. The H-GCR program is open for proposals in ROSES. One program element is planned: Heliophysics Science Centers (SC). The Theory, Modeling, and Simulations (TMS) element is not solicited in ROSES this year as it currently is fully subscribed. The Heliophysics Grand Challenges Research Science Centers program element (H-GCR/SC) will be offered for the first time as part of the ROSES this year. The particulars of this program will be described in an amendment later in this ROSES year (see Program Element B.9).

3.5 Heliophysics LWS Science (H-LWS):

The goal of NASA's Living With a Star (LWS) Program is to develop the scientific understanding needed to effectively address those aspects of Heliophysics science that affect life and society. To ensure this, the Heliophysics LWS Science program solicits proposals for Focus Teams which coordinate large-scale investigations that cross discipline and technique boundaries, leading to an understanding of the system linking the Sun to the Solar System both directly and via the heliosphere, planetary magnetospheres, and ionospheres. 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, but this component of the LWS program will not be solicited in ROSES-2018. The details of the Living With a Star Science program for ROSES-2018 will be described in Program Element B.6.

3.6 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. These studies are carried out in support of the Heliophysics strategic goals and subgoals in NASA's 2014 Strategic Plan and Chapter 4.1 of the *NASA 2014 Science Plan*. The recommended priorities of the Heliophysics community are also discussed in the *2013 National Research Council Decadal Strategy for Solar and Space Physics report, Solar and Space Physics: A Science for a Technological Society*. Note particularly the sections dealing with the "DRIVE" initiative, more specifically "R" and "I," and the discussion in Appendix B.

The H-DEE program encompasses the data environment needs throughout Heliophysics, including Solar, Heliospheric, and Geospace Sciences (Magnetosphere and Ionosphere/Thermosphere/Mesosphere [ITM]).

As part of a mission-oriented agency, the Heliophysics Research Program 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, even if of considerable merit, will not be given high priority for funding through this solicitation. In turn, the "Infrastructure" subelement of the former "H-IDEE" program has been dropped.

Proposers should take into account the special needs driven by the increasing complexity of missions, the associated increasing complexity and volume of data, and the need for innovative and enabling technologies. For proposers to B.7 H-DEE there will be no NSPIRES cover page question about a data management plan. This is superseded by instructions in the program element that place more detailed descriptions into the body of the Scientific/Technical/ Management section of proposals. See Section 2 of B.7 H-DEE.

The Heliophysics Data Environment Enhancement program is described in Program Element B.7.

3.7 Heliophysics Early Career Investigator Program (H-ECIP):

The Heliophysics Early Career Investigator Program (H-ECIP) 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 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, to educate, empower, and inspire the next generation of space researchers. The Heliophysics Early Career Investigator Program will appear in program element B.10.

3.8 Heliophysics U.S. Participating Investigator (H-USPI):

The ROSES program element for Heliophysics Explorer U.S. Participating Investigator (H-USPI) will be released in conjunction with the Heliophysics Explorer Mission of Opportunity as program element B.11. The purpose is to solicit potential Heliophysics Explorer Mission of Opportunity (MO) 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.

3.9 Heliophysics Space Weather Operations to Research (H-SWO2R):

In order to support operations-to-research (O2R) efforts, NASA, partnered with NOAA, has established the Heliophysics Space Weather Operations-to-Research (H-SWO2R) program, which is a component of the Heliophysics Research Program. For the purpose of this opportunity, NASA and NOAA have identified the scope of this program element as improving forecasts of the background solar wind, solar wind structures, and coronal mass ejections using solar and solar wind data and models, if possible employing data assimilation or machine-learning techniques. The Heliophysics Space Weather Operations to Research program element will appear as B.12.

B.2 HELIOPHYSICS SUPPORTING RESEARCH

NOTICE: In order to avoid duplication and overlap of proposal opportunities, between Heliophysics Guest Investigators (H-GI) and Heliophysics Supporting Research (H-SR) in particular, the H-SR program continues to solicit investigations with a larger scope than H-GI.

Proposals to this program will continue to be taken by the two-step process in which a Step-1 proposal, submitted by an Authorized Organizational Representative (AOR) is required. See Section 3 for details.

Check for NASA spacecraft mission data compliance as specified in the overview B.1.

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.

Proposing teams must demonstrate the expertise necessary to cover the combination of techniques required. Awards are expected to be in the range of approximately $200K per year – $250K per year. The Heliophysics Supporting Research program 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.

1.1 Overview

The Heliophysics Supporting Research program replaces the former supporting research elements of the Geospace Science program and the Solar and Heliospheric Science program entirely. Laboratory Research, Instrument and Technology Development, and Low Cost Access to Space proposals are not solicited with Heliophysics Supporting Research, but instead fall under ROSES program element B.3 Heliophysics Technology and Instrument Development for Science (H-TIDeS).

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 should address one of the four Heliophysics Decadal Survey goals (listed below). 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.

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) 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.

1.2 Data Usage

Proposals with a major focus on analyzing non-NASA data, but that still include a required substantial NASA data analysis and/or interpretation aspect, must demonstrate that the proposed work is necessary to make a significant contribution to addressing one or more Decadal Survey questions.

All data, whether of NASA or non-NASA origin, must be available in a public archive 30 days prior to the Step-2 (full-proposal) deadline. Proposals that do not contain a substantial NASA data analysis and/or interpretation aspect or that use data that is not archived 30 days prior to the full-proposal deadline will be declared noncompliant and may be returned without review. 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 Organizing Science Areas

The Heliophysics Supporting Research program has established four broad categories and 13 science areas for the purpose of organizing the evaluation and peer review. The four categories mirroring the four subdisciplines of Heliophysics are Sun, Heliosphere, Magnetosphere, and Ionosphere-Thermosphere-Mesosphere (ITM). The 13 science areas are listed below; some of these science areas fit within more than one broad category. Each proposal must choose one of the four broad categories and one of the 13 science areas.

1. Solar Interior
2. Solar Transient Events
3. Solar Atmosphere
4. Particle Acceleration, Transport, Modulation in the Heliosphere
5. Heliospheric Plasma Processes, Turbulence, Waves, Composition
6. Interplanetary Coronal Mass Ejections / Magnetic Clouds
7. Outer Heliosphere and the Interstellar Boundary
8. Solar Wind – Magnetosphere Coupling
9. Inner Magnetosphere
10. Magnetosphere – Ionosphere Coupling / Magnetotail
11. Ionosphere – Atmosphere Coupling
12. Neutral Atmosphere
13. Solar Output – Ionosphere/Atmosphere Coupling

System science proposals that touch on more than one of these science areas are encouraged; for the purpose of organizing the review, investigators should choose the

one that is most relevant. Proposals addressing the magnetospheres or the ionospheres of other planets are permitted, but must not duplicate proposals sent to other programs.

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.

2. Submission and Evaluation Guidelines

2.1 General Considerations

Each Principal Investigator (PI), or the Science PI, if applicable, is allowed to submit one and only one Step-1 proposal to this program element. The expectation is that the Principal Investigator (or science lead) will invest a substantial portion of their time, of the order of 30%, to the investigation. The scope and necessary tasks of the investigation must be of sufficient breadth that, in order to achieve successful completion of the project, on the order of an entire full-time equivalent (FTE) per year would be required. 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. 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-SR program (see Section 2.2 below) or if they fail to meet submission guidelines specified below (Section 3).

2.2 Limitations and 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. Currently funded investigators must show how their new proposed effort is different and not duplicative with current awards;
- Model or tool development and/or new data analysis techniques, where this effort constitutes more than 50% of a three-year effort;
- The routine, long-term gathering of observational data;
- Investigations with the main purpose of supporting ground-based infrastructure and facilities

3. Two-Step Submission Guidelines

To streamline the proposal process (submission, evaluation, and administration), 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*.

A Step-1 proposal is required and must be submitted electronically by the Step-1 due date (see below and Table 2 and Table 3 of ROSES). The Step-1 proposal must be submitted by the organization 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 Step-1 proposal title, science goals, and investigators (Principal Investigator, Co-Investigators, Collaborators, Consultants, and Other Professionals) cannot be changed between the Step-1 and Step-2 proposals. 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.

3.1 Step-1 Proposal Content

Proposers should refer to the "Instructions for Submitting a Step-1 Proposal" under "Other Documents" on the NSPIRES page for this program. The Step-1 proposal is restricted to the 4000-character Proposal Summary text box on the NSPIRES web interface cover pages.

The Step-1 proposals must include the following:

- The science goals and objectives to be addressed by the proposal;
- The relevance of the problem to one or more of the four Decadal Survey goals.
- A brief statement of the methodology to be used, including what data, models, and analysis will be used for completing the investigation.

The NSPIRES system for proposal submission requires that Step-1 proposals include a summary (i.e., abstract) describing the proposed work as outlined above. The proposal summary is entered directly into a text field in NSPIRES. No PDF attachment is required or 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 invited by NSPIRES when they are able to submit their Step-2 proposals.

Step-1 proposals may be declared noncompliant if they fail to meet submission guidelines specified in Sections 3.2 and 3.3 or if they are outside the scope of the H-SR program, as discussed in Section 1. PIs of noncompliant proposals will not be eligible to submit the associated Step-2 proposal and will receive a letter to this effect.

3.2 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 in the *ROSES Summary of Solicitation*). 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. The Step-2 proposal title, science goals, and investigators (Principal Investigator, Co-Investigators, Collaborators, Consultants, and Other Professionals) must be the same as those in the Step-1 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.

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 via the SARA web page at http://science.nasa.gov/researchers/suggested-reviewers/.

Proposers are expected to provide mail-in reviews for one to three proposals in this competition. Much of the science expertise lies in the PI/Co-I community, because, increasingly, nearly the entire Heliophysics community proposes. In order to maintain a high caliber review process, it is important to get the additional mail-in reviews to cover all proposals fairly. Proposers will be contacted via NSPIRES regarding reviews.

3.3 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 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 one or more of the four high-level science goals from the most recent Heliophysics Decadal survey listed in Section 1.1 must be demonstrated;
- 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.

3.4 Step-2 Compliance and Evaluation Criteria

All Heliophysics programs will continue reviewing Step-2 proposals for compliance. Step-2 proposals that are not compliant with formatting requirements (e.g., margins, font sizes, line spacing) may be rejected without review. See Section IV(b)ii of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers* for details. In particular users of LateX formatting must specify the appropriate paper size (US letter) and font size.

Proposals that have changed the scientific scope from that of their Step-1 proposal may be declared noncompliant.

Compliant proposals will be evaluated according to the criteria specified the *NASA Guidebook for Proposers*. These criteria are intrinsic scientific and technical merit, relevance to NASA's objectives, and cost realism/reasonableness.

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.

As indicated in the *Guidebook for Proposers*, the evaluation of cost realism/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.

4. Available Funds

It is expected that there will be approximately ~$6M available in Fiscal Year (FY) 2019 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.

5. Award Types

As begun in 2013, 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 no longer award contracts. An institution that has received a contract previously can receive funds as a grant by not charging a fee.

6. Summary of Key Information

Expected program budget for first year of new awards	~$6M
Number of new awards pending adequate proposals of merit	~25-30
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 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*.
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 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	NNH18ZDA001N-HSR
NASA 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.3 HELIOPHYSICS TECHNOLOGY AND INSTRUMENT DEVELOPMENT FOR SCIENCE

NOTICE: Proposal submission to Heliophysics Technology and Instrument Development for Science (H-TIDeS) will be performed 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 (AOR). In addition, selected R&T Flight Proposals for LCAS and CubeSats with a total proposed life-cycle cost greater than or equal to $3.5 million will be required to submit a Concept Study Report for evaluation and down selection. See Section 5 of this program element for details.

1. Scope of Program

The Heliophysics Technology and Instrument Development for Science (H-TIDeS) program 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.

1.1 Overview

The H-TIDeS program combines technology elements previously separated within the old Solar, Heliosphere, Magnetosphere, and ITM (ionosphere-thermosphere-mesosphere) Science Supporting Research and Technology programs.

Supporting Research studies are found under ROSES Program Element B.2 Heliosphysics Supporting Research (H-SR). Guest Investigator studies are found under ROSES Program Element B.4 Heliophysics Guest Investigators.

Advancement in heliophysics science requires the development and application of innovative new technologies and capabilities. H-TIDeS seeks to enhance the ability to achieve significant progress toward the scientific and technical challenges in heliophysics in the coming years.

H-TIDeS 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, development of prototype technologies, and demonstration in a relevant environment. Promising technologies, such as instruments, sensors and detectors can then be proposed to demonstrate the technologies on Research and Technology (R&T) flights, as described below. R&T flights are used to demonstrate the new technologies, and to also acquire scientific data, as applicable. To advance the Technology Readiness Levels of promising technologies or explore new science in a low-cost manner, 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 includes innovative technology development and instruments that may be proposed as candidate experiments for future space flight opportunities (see Section 3 below).
- R&T Flight Program: This includes technology and associated science investigations that can be carried out with instruments flown on suborbital rockets, stratospheric balloons, suborbital reusable launch vehicles, or other platforms, collectively referred to as Low Cost Access to Space (LCAS), as well as CubeSats (see Section 4 below).

H-TIDeS investigations are carried out in support of NASA's Heliophysics Science Strategic Objective "to understand the Sun and its interactions with Earth and the solar system, including space weather", and three overarching science goals, from the *Science Mission Directorate Science Plan for 2014* (https://science.nasa.gov/about-us/science-strategy):

> Science Goal 1: Explore the physical processes in the space environment from the Sun to the Earth and throughout the solar system;
> Science Goal 2: Advance our understanding of the connections that link the Sun, the Earth, planetary space environments, and the outer reaches of our solar system;
> Science Goal 3: 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.

Proposals to all H-TIDeS programs shall link the proposed work to the NASA Heliophysics Science Plan as ocumented in the proposal traceability matrix (Table 1 at the end of Section 5 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)

The three 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 and/or observational objectives (C); however, the investigation might only make progress toward their proposed science question(s) (A) and toward the top science goal(s) (B) without fully achieving them.

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, instrument, and mission (as appropriate) requirements. Instructions for proposal submission are provided in Section 5.

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 solar and space physics. 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 instrument, sensor/detector concepts that show promise for use in scientific investigations on, or give rise to future heliophysics missions, including the development of laboratory instrument prototypes, sensors and detectors, instrument components, etc., but not of major space flight hardware. 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 components of such instruments to the point where complete instruments may be proposed in response to future Announcements of Opportunity.

Either new concepts or methods to improve the performance of existing instruments or sensors 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. CubeSats are an example of these small satellites and are built from a set of standardized subunits that each measure 10x10x10 cm and weigh 1.33 kg (designated '1U'). It is expected that the proposed science investigations would, by necessity, push the current technology state-of-the-art, and involve innovative thinking, advanced engineering, and technology development for instruments and/or spacecraft systems. As such, NASA seeks to make ITD awards across a range of mission concepts requiring new technologies that will enable smaller missions in deep space.

4. R&T Flight Program

This year, this new sub-element has been defined to include two categories: Low Cost Access to Space (LCAS) and CubeSats, which will be described in Sections 4.1 and 4.2 respectively. Proposals submitted to the R&T Flight Program shall have the following characteristics:

1. The investigation objectives address NASA Heliophysics Science Goals;
2. The investigator develops instrumentation/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 (Section 7 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 commercial suborbital Technology Mission Directorate. The Science Mission Directorate also provides launch opportunities for CubeSats and International Space Station payloads. Detailed information, including suborbital and orbital 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) Suborbital Reusable Launch Vehicles (sRLV);
(iv) Research Investigations utilizing the International Space Station;
(v) Use of Short Duration Orbital Platforms (CubeSats and other Flights of Opportunity)

Note: "Short Duration" in (v) above refers to the Suborbital program plan mission assurance level defined by NPR 7120.8.

Export Control Laws specific to the R&T Flight Program: Export licenses are required for all foreign nationals accessing flight programs. R&T Flight Program Principal Investigators (PIs) should contact the corresponding program office regarding PI responsibilities in this arena. Procuring the required State Department licenses can take some time, and PIs are urged to begin the process well before team members need access to the actual flight hardware. More information on this can be found in the NASA Guidebook for Proposers.

4.1 Low-Cost Access to Space (LCAS)

The Low-Cost Access to Space (LCAS) component supports investigations addressing NASA Heliophysics Science Goals using investigator-developed instrumentation (with

or without new technology development) that must be completed through suborbital or orbital flights. LCAS is expected to lead the way in the development of a large fraction of the instrument concepts for future solar, heliospheric, magnetospheric, and ionosphere-thermosphere-mesosphere (ITM) missions. LCAS-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 for preparing future leaders of NASA space flight missions, such as junior researchers and graduate students.

4.2 CubeSats

New this year is the CubeSat Program, which provides focused development of a new technology development and research tool that has demonstrated unique potential for rapid advances toward some Heliophysics Science Objectives (https://www.nap.edu/catalog/23503/achieving-science-with-cubesats-thinking-inside-the-box). The CubeSat program supports the development of CubeSats which could fulfill Heliophysics Science as well as Technology and Instrument Development goals as described in the 2014 NASA Science Plan available at https://science.nasa.gov/about-us/science-strategy/. CubeSats are defined as free-flying spacecraft of less than or equal to 6U form factor, and consistent with CubeSat Design Specifications (referenced in www.cubesat.org). CubeSat investigations are solicited to achieve: 1) validation of scientific observables for future space missions, 2) executing intrinsically meritorious science investigations, and 3) advancement of the technology readiness levels of future space flight sensors, detector, instruments and supporting technologies. In addition, CubeSat missions provide an important opportunity for preparing future leaders of NASA space flight missions, by involving the investigation teams in all system aspects of achieving science goals via space flight.

H-TIDeS CubeSat missions are anticipated to be flown through the NASA HEOMD CSLI Program (https://www.nasa.gov/directorates/heo/home/CubeSats_initiative). The H-TIDeS Program Office will facilitate the application to CSLI for the appropriate flight opportunity. Alternative CubeSat flight opportunities may be proposed to the H-TIDeS CubeSat program, but the specific details, including risk management, must be provided in the proposal.

5. Proposal Submission Guidelines

Each Principal Investigator is allowed to submit one and only one Step-1 proposal (Section 5.1 of this program element) to each sub-element (LNAPP, ITD, R&T Flight Program) of this solicitation. The Principal Investigator is expected to invest a substantial portion of his/her time, 10-30%, 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 collaborators is discouraged, and collaborators are expected to have defined tasks in the project. 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.

For LNAPP, ITD and R&T Flight Program proposals less than $3.5 million for total proposed life-cycle cost, H-TIDeS uses a binding two-step proposal process (See section IV(b)vii of the *ROSES Summary of Solicitation* and below for more information). R&T Flight proposals for LCAS and CubeSats with a total proposed life-cycle cost greater than or equal to $3.5 million, called R&T-Prime, will be submitted and evaluated via a new process. The R&T-Prime proposals will be evaluated on the basis of the same criteria (see Section 5.2 of this program element). However, recent experience has shown that, for proposals falling into the R&T-Prime category, it is extremely difficult to fully evaluate the technical, schedule and cost aspects of proposals with the level of detail provided in normal H-TIDeS proposals. Thus, R&T-Prime proposals will be required to include a formulation phase in their proposal schedule for 4 months and at a cost not to exceed $40K. Following the formulation phase, it is required that a Concept Study Report (CSR) be submitted for evaluation. At this Key Decision Point (KDP), the CSRs will be evaluated and the successful proposals will be invited to proceed to implementation phase. The CSRs are required to address the following:

- Develop the system architecture
- Completion of the mission and preliminary system designs
- A System Engineering Management Plan (Ref. NASA NPR 7123.1B)
- Preparation of the project plan for implementation

Successful R&T-Prime proposals will receive a detailed CSR guidance document prior to the start of the formulation phase. All PIs will be notified of the results of the evaluation, and the successful PIs will be awarded the funding to proceed to implementation.

Note: The $40K - 4 month formulation phase should be built into the budget and schedule as part of the Step-2 proposals (see Section 5.2.1.2).

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 through the NASA Science URL http://science.nasa.gov/researchers/suggested-reviewers when submitting a Step-1 proposal.

The guidelines for submitting all Step-1 and Step-2 proposals are provided in the following sections.

5.1 Step-1 Proposals

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 Step-1 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, instrument, and mission (as appropriate) requirements. The Step-1 proposal must address the requirements of the program that the proposal is being submitted to (LNAPP, ITD, and R&T Flight Program).

A Step-1 proposal is required and must be submitted electronically by the Step-1 due date (see Tables 2 and 3 of ROSES). Proposers should refer to the "Instructions for

Submitting a Step-1 Proposal" under "Other Documents" on the NSPIRES page for this program. An Authorized Organizational Representative (AOR) from the PI's institution must submit the Step-1 proposal. No budget is required. Only proposers who submit a Step-1 proposal are eligible to submit a full proposal (Step-2). Full (Step-2) proposals must have the same scientific goals and investigation objectives proposed in the Step-1 proposal. In addition, the Step-1 proposal title and investigators (Principal Investigator, and all Co-Investigators and Collaborators) may not be changed between the Step-1 and Step-2 proposals. The expected format and compliance evaluation criteria are described below. Submission of the Step-1 proposal does not obligate the proposers to submit a Step-2 (full) proposal later. Each Principal Investigator is allowed to submit one and only one Step-1 proposal for each sub-element described in Sections 2, 3 and 4 of this program element.

5.1.1 Step-1 Proposal Format and 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 and investigation objectives to be addressed by the proposal;
- A brief description of the methodology (data, models, facilities, instrumentation, and, if relevant, flight systems) to be used to address the science goals and objectives.

The NSPIRES system for proposal submission requires that Step-1 proposals include a summary (i.e. abstract) describing the proposed work as outlined above. The proposal summary is entered directly into a text field in NSPIRES. No PDF attachment is required or 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 by NSPIRES when they are able to submit their Step-2 proposals.

Step-1 proposals will be declared noncompliant if the proposed work is outside the scope of the H-TIDeS program, as described in previous sections. PIs of noncompliant proposals will not be eligible to submit a Step-2 proposal and will receive a letter to that effect. All compliant Step-1 proposal PIs will be invited to submit a corresponding Step-2 proposal.

5.2 Step-2 Proposals

A Step-2 (full) proposal must be submitted electronically by the Step-2 due date given in Tables 2 and 3 of ROSES. An Authorized Organizational Representative (AOR) from the institution of the PI must submit the Step-2 proposal. A budget and other specified information is required. The Step-2 proposal title, Principal Investigator, and all Co-Investigators and Collaborators must be the same as those in the Step-1 proposal. Step-2 proposals must contain the same scientific goals and investigation objectives proposed in the Step-1 proposal. Proposers must have submitted a Step-1 proposal to be eligible to submit a Step-2 proposal. A Step-2 proposal cannot be submitted if the corresponding Step-1 proposal was deemed noncompliant.

Proposers are expected to respond to requests to conduct mail-in reviews for up to four proposals in this competition. 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 get these mail-in reviews to cover all proposals fairly.

Important Note: A science traceability matrix is required for every Step-2 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 (at the end of Section 5 of this program element).

Budget

Budgets are expected to cover complete investigations, including payload development and construction, instrument calibration, launch activities, and data analysis. The aforementioned "launch activities" to be included in the budget do not include the standard CSLI-provided launch services described in Section V(b)v of the *ROSES Summary of Solicitation*. The cost of launch for a single, ≤ 3U, spacecraft to Low Earth Orbit (LEO) will be provided under the NASA/HEOMD CubeSat Launch Initiative (CSLI) at no cost to the investigation. For this standard case proposers should merely 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 Section V(b)v of the *ROSES Summary of Solicitation*) 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.

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 rocket or balloon 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.

5.2.1 *Step-2 Proposal Content*

Proposers should refer to the PDF entitled "How to submit a Step-2 proposal" that will appear under "Other Documents" on the NSPIRES page for this program after the Step-1 proposal due date. The process for preparation and submission of the Step-2 (full) proposals is that for any other ROSES proposal. Guidelines for content and formatting of Step-2 full proposals are specified in Table 1 in the *ROSES Summary of Solicitation*.

Requirements for the proposal content for the specific sub-elements are provided in Sections 5.2.1.1 and 5.2.1.2. In addition, 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 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 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 for ITD proposals, the term "mission" refers to future mission(s) envisioned to address the proposed science question and utilizing the 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 (at the end of Section 5 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. Special requirements for public release of observational data obtained through the R&T Flight Program are noted in Section 5.2.1.2. ITD and LNAPP 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 provided for the NSPIRES cover pages will suffice for this requirement in the case of ITD and LNAPP proposals. R&T Flight proposals should elaborate on their plan in the Step-2 proposal, as noted in Section 5.2.1.2.

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 at the end of Section 5 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. 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 in Table 3 at the end of Section 5 of this program element. The primary technology area refers to the technology areas defined in the NASA Space Technology Roadmaps (https://www.nasa.gov/offices/oct/home/roadmaps/index.html).

5.2.1.1 *Step-2 Proposals for ITD and LNAPP*

ITD and LNAPP 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 necessarily 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.

5.2.1.2 *Step-2 Proposals for R&T Flight Program*

Step-2 proposals to the R&T Flight Program must be for a complete investigation, based on clearly defined investigation objectives that address scientific questions appropriate for (this or future) heliophysics missions linked back to Heliophysics Science Goals. 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 to the requirements for all H-TIDeS proposals discussed in previous sections, R&T Flight 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 Scientific/Technical/Management (S/T/M) section of proposals is restricted in the number of pages (see Section 7 of this program element). In addition to the content requirement provided in Table 1 of *ROSES Summary of Solicitation*, the S/T/M section must include the following information:

- The investigation 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;
- A science traceability matrix;
- 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 do not need to be named.
- A discussion of the plan for management, analysis, interpretation, and public dissemination of the data.

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 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.

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 these investigations is NPR 7120.8. Typically, management compliance of projects conducted under the NASA Sounding Rocket and Balloon Programs is ensured by their respective Program Offices. Proposals for flight investigations using other flight opportunities (International Space Station (ISS), CubeSat, Flight of Opportunity, etc.) must provide a management plan explicitly compliant with NPR 7120.8.

Proposals to the R&T Flight Program (LCAS and CubeSats) 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 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 directly for an estimate of the Government Furnished Equipment (GFE) cost of the desired support. It is advisable that PIs contact the 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. Investigations using Flights of Opportunity spaceflight must include a statement from the organization providing the flight stating the proposed investigation is manifested on the relevant mission.

For CubeSats, this information is a table specifying the expected mass/size, power, and telemetry budgets, including reserves, the orbit characteristics (perigee, apogee, inclination), and access-to-space methodology. Three additional pages (up to 23 total) are permitted for CubeSat proposals, given the added necessity of describing the CubeSat spacecraft systems (e.g., attitude control, telemetry, power, space environment survivability, etc.). The three additional pages must be in a clearly labeled section that describes only the CubeSat spacecraft systems.

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.

R&T Flight 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 Step-2 proposal submission, but it does not count against the proposal page limit. Investigations using Flights of Opportunity spaceflight must include a statement from the organization providing the flight stating the proposed investigation is manifested on the relevant mission. All ISS payload investigations must obtain a letter of mission feasibility from the ISS Research Integration Office. This does not apply to CubeSats dispensed from the ISS.

Step-2 R&T-Prime proposals (total PI managed cost ≥$3.5M) are of the same format as other R&T Flight Program Step-2 proposals with the following exception: The schedule and budget must include provision for a formulation phase (4 months, and up to $40K). For planning purposes, the schedule in Section 7 should be used. While NASA will endeavor to meet the targeted dates for formulation and implementation phase selection announcements, unanticipated budget and programmatic issues may force changes in these dates and so this schedule does not represent a commitment on the part of NASA. One primary objective of this schedule is to announce the implementation phase down-select in time to allow those declined at that stage to re-submit to the 2019 H-TIDeS NRA.

Table 1. Example Science Traceability Matrix

A. Science Goal(s)	B. Science Questions	C. Investigation Objective Requirements			Mission, or 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%	

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, The Moon, Mars, Others inside the Solar System, Outside the Solar System, Foundational Knowledge)	Select up to 3.
Start TRL	Refer to Table 3 of this program element.
Estimated End TRL	Refer to Table 3 of this program element.
Anticipated Benefits	

Table 3. NASA Technology Readiness Level (TRL) Definitions
Source: NPR 7123.1B, NASA Systems Engineering Processes and Requirements

NASA TRL	Definition
1	Basic principles observed and reported.
2	Technology concept and/or application formulated.
3	Analytical and experimental critical function and/or characteristic proof of concept.
4	Component and/or breadboard validation in laboratory environment.
5	Component and/or breadboard validation in relevant environment.
6	System/sub-system model or prototype demonstration in a relevant environment.
7	System prototype demonstration in an operational environment.
8	Actual system completed and “flight qualified” through test and demonstration.
9	Actual system flight proven through successful mission operations.

6. Award Duration and Type

The maximum duration of LNAPP and ITD awards is three years. Although most R&T Flight awards are also three years in duration, a four-year proposal may be accepted to develop a new, highly meritorious investigation through its first flight. H-TIDeS will not award contracts.

For R&T-Prime proposals invited to conduct a 4-month formulation phase, the first year will include: 4 months for formulation and submission of a CSR, 2 months for evaluation of CSR, 6 months of implementation (if CSR evaluation is successful and proposal is recommended for implementation).

6.1 Proposals from Multiple Institutions

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.

7. Summary of Key Information

Projected program budget for first year of new awards	LCAS: $7M CubeSats: $5M ITD: $4M LNAPP: $0.8M
Anticipated number of new awards pending adequate proposals of merit	LCAS: 6-8 CubeSat: 3-5 ITD: 10-15 LNAPP: 4-6
Maximum duration of awards	LCAS and CubeSats – 4 Years; ITD and LNAPP – 3 years.
Due date for all Step-1 Proposal	See Tables 2 and 3 of this ROSES NRA
Due date for all Step-2 (full) proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of LNAPP, ITD, R&T Flight Investigations	6 months after Step-2 proposal due date.
Planning date for start of R&T-Prime formulation phase investigations: Planning date for start of R&T-Prime implementation phase:	3 months after Step-2 proposal due date 2 months after submission of the Concept Study Report.
Page limit for the central Science-Technical-Management section of proposal. See also Chapter 2 of the *NASA Guidebook for Proposers*	ITD and LNAPP: 15 pages LCAS Sounding Rocket, Balloon, sRLV, ISS & Flight of Opportunity: 20 Pages CubeSat: 23 Pages
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 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	NNH18ZDA001N-HTIDS
NASA 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.4 HELIOPHYSICS GUEST INVESTIGATORS - OPEN

NOTICE: Step-2 proposals are limited to ten (10) pages. Investigations focused on Global Observations of Limb and Disk (GOLD) or the Ionospheric Connection (ICON) Explorer data are not permitted; these investigations should be submitted under element B.8. Check for NASA spacecraft mission data compliance as specified in the overview B.1. Proposals to this program will 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 (AOR), see Section 3.

1. Scope of Program

The Heliophysics Guest Investigator (H-GI) "Open" 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. It also allows scientists who are not associated with a mission team to participate in the mission science. In ROSES-2018, there are two program elements that are part of the GI-program. Proposals that use primarily data from either the Global Observations of Limb and Disk (GOLD) or the Ionospheric Connection (ICON) Explorer mission are not permitted for this program element. Investigations using primarily data from these missions should submit to element B.8.

1.1 Overview

The H-GI Open (HGIO) program is for investigations whose primary emphasis is the analysis of data from currently operating missions. It provides support for analysis of observations from both extended missions and from missions in their prime phase (Phase E). Proposals should either (1) address the goals of the mission(s) that generated the data on which the investigation is focused, or (2) for investigations that go beyond the mission goals, proposals must address one or more of the four high-level science goals from the most recent Heliophysics Decadal Survey *Solar and Space Physics: A Science for a Technological Society* https://www.nap.edu/read/13060/chapter/1:

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.

In support of any H-GI 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. Additionally, data from

non-NASA sources must still follow the guidelines set forth in B.1 and be publicly available 30 days before the Step-2 deadline. In any such instance, the proposal must clearly demonstrate that the theory, models, and/or data in question are necessary for interpretation of the HSO data and are not, themselves the primary object of the investigation. Development of new models and theories is not solicited.

The list of operating HSO missions is found at: https://science.nasa.gov/missions-page?field_division_tid=5&field_phase_tid=29

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.

Additionally, prospective investigators must demonstrate that the proposed effort can be accomplished using data that was publicly available 30 days before the Step-2 submission deadline. Most Heliophysics data may be found through the Heliophysics Data Portal (HDP) found at http://heliophysicsdata.sci.gsfc.nasa.gov/websearch/dispatcher. If an investigation is proposing to use data that cannot be found at this source, it must provide a publicly accessible web address where the data can be accessed to verify that it is publicly available.

1.2 Organizing Science Areas

The Heliophysics Guest Investigator program has established four subdisciplines and 13 science areas for the purpose of organizing the evaluation and peer review. The four subdisciplines of Heliophysics are Sun, Heliosphere, Magnetosphere, and Ionosphere-Thermosphere-Mesosphere (ITM). Each PI will have to choose one of the four as the focus of their investigation. Please do not choose Heliosphere meaning Heliophysics. You are required to select one of the four subdiciplines within Heliophysics.

The 13 science areas are listed below. Some of these science areas fit within more than one broad category. Each proposal must choose one of the four subdisciplines of Heliophysics and one of the 13 science areas:

1. Solar Interior
2. Solar Transient Events
3. Solar Atmosphere
4. Particle Acceleration, Transport, Modulation in the Heliosphere
5. Heliospheric Plasma Processes, Turbulence, Waves, Composition
6. Interplanetary Coronal Mass Ejections/Magnetic Clouds
7. Outer Heliosphere and the Interstellar Boundary
8. Solar Wind – Magnetosphere Coupling
9. Inner Magnetosphere
10. Magnetosphere – Ionosphere Coupling/Magnetotail
11. Ionosphere – Atmosphere Coupling
12. Neutral Atmosphere
13. Solar Output – Ionosphere/Atmosphere Coupling

System science proposals that touch on more than one of these science areas are encouraged, but for the purpose of organizing the review, investigators must choose the one area that is most relevant. Proposals addressing the magnetospheres or the ionospheres of other planets are permitted, but must not duplicate proposals sent to other programs.

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 at least one month of labor to the investigation in order to adequately oversee 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. 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-GI program (see Section 2.2 below) or if they fail to meet submission guidelines specified below (Section 3).

2.2 Limitations and Scope

Proposals outside the scope of H-GI may be declared noncompliant based on either the Step-1 or Step-2 proposal. These include the following:

- Proposals that do not focus on analysis of data from currently-operating HSO 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;
- 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;
- Proposals focused on the use of GOLD/ICON data. GOLD/ICON data may be used as a secondary resource (provided they meet the data availability requirements in B.1), but they must not be a primary object of the investigation.

A PI or a Co-I on a qualifying Heliophysics mission may also propose as a PI or Co-I to the H-GI 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.

3. Two-Step Submission Guidelines

To streamline the proposal process (submission, evaluation, and administration), 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*.

A Step-1 proposal is required and must be submitted electronically by the Step-1 due date (see below and Tables 2 and 3 in the *ROSES Summary of Solicitation*). The Step-1 proposal must be submitted by the organization 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 Step-1 proposal title, science goals, and investigators (Principal Investigator, Co- Investigators, Collaborators, Consultants, and Other Professionals) cannot be changed between the Step-1 and Step-2 proposals. 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.

3.1 Step-1 Proposal Content

Proposers should refer to the "Instructions for Submitting a Step-1 Proposal" under "Other Documents" on the NSPIRES page for this program. 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:

- 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 for investigations that go beyond the mission goals, the relevance to one or more of the four Decadal Survey goals.

The NSPIRES system for proposal submission requires that Step-1 proposals include a summary (i.e., abstract) describing the proposed work as outlined above. The proposal summary is entered directly into a text field in NSPIRES. 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 by email when they are able to submit their Step-2 proposals.

3.2 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 below and Tables 2 and 3 in the *ROSES Summary of Solicitation*). 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. The Step-2 proposal title, science goals, and investigators (Principal Investigator, Co-Investigators, Collaborators, Consultants, and Other Professionals) must be the same as those in the

Step-1 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.

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 via the SARA web page at http://science.nasa.gov/researchers/suggested-reviewers/.

Proposers are expected to provide mail-in reviews for one to three proposals in this competition. Much of the science expertise lies in the PI/Co-I community because, increasingly, nearly the entire Heliophysics community proposes. In order to maintain a high caliber review process, it is important to get the additional mail-in reviews to cover all proposals fairly.

3.3 Step-2 Proposal Format

The process for preparation and submission of the Step-2 (full) proposals is the same as for any other ROSES proposal. Guidelines for content and formatting full proposals are specified in Table 1 of ROSES and the *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation*.

The Scientific/Technical/Management section is restricted to ten (10) pages 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 goals of the mission(s) on whose data the investigation is focused; or if the proposed work goes beyond the goals of the mission(s), then relevance to one or more of the four high-level science goals from the most recent Heliophysics Decadal Survey listed in Section 1.1 must be demonstrated;
- 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.

3.3.1 *Step-2 Proposal Formatting Requirements*

All proposals submitted to ROSES must strictly conform to the formatting rules. Proposals that violate the rules may be rejected without review or declined following review if violations are detected during the evaluation process.

- The Scientific/Technical/Management section must not exceed the 10-page limit specified in this Program Element.
- Margins: no less than 1 inch on all sides, with a page size of 8.5 × 11 inches.
- Font: Times New Roman, 12-point or larger. If an alternate font is used, it must meet the requirement of having, on average, no more than 15 characters per inch. 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, on average, 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 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%. Expository text necessary for the proposal may not be located solely in figures or tables, or their captions.

Guidelines for submitting Step-2 full proposals, other than those listed above, are specified in the *NASA Guidebook for Proposers*. Where they conflict, the guidelines above supersede those found in the Guidebook.

3.4 Step-2 Evaluation Criteria

Step-2 proposals that are not compliant with format requirements may be rejected without review. See Subsection 3.3.1 of this program element, Section IV (b) ii of the *ROSES Summary of Solicitation*, and the *NASA Guidebook for Proposers* for details. Proposals that have changed the scientific scope from that of their Step-1 proposal may be declared noncompliant.

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 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-GI program element will be assessed based on criteria discussed in Section 1. Each proposal must demonstrate that the investigation is relevant and of high priority.

Cost realism/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 laid out in the proposal work plan.

4. Available Funds

It is expected that there will be approximately $5.88M available in Fiscal Year (FY) 2019 to support new Heliophysics GI investigations selected through this program element. It is anticipated that there may be $4.79M in 2020 and $5.18M in 2021. It is expected that the combined 3-year total budget of most proposals would not exceed $525K.

5. Award Types

As begun in 2013, the H-GI program will primarily award funds through three vehicles: (1) grants, (2) interagency transfers, and (3) awards to NASA Centers. The H-GI program will not award contracts. An institution that has received a contract previously can receive funds as a grant by not charging a fee.

6. Summary of Key Information

Expected annual program budget for new awards	See Section 4
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 the ROSES NRA
Due date for full Step-2 proposals	See Tables 2 and 3 of the ROSES NRA
Page limit for the central Science-Technical-Management section of proposals	10 pp; see also Table 1 of ROSES and the *NASA Guidebook for Proposers*
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*.
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 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	NNH18ZDA001N-HGIO
NASA point of contact concerning this program	Terry Onsager Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1615 Email: terrance.g.onsager@nasa.gov

B.5 HELIOPHYSICS GRAND CHALLENGES RESEARCH-THEORY, MODELLING AND SIMULATIONS

NOTICE: The Heliophysics Grand Challenges Research – Theory, Modelling and Simulations Program is not being offered in ROSES-2018. All existing Fiscal Year 2019 program funds were competed in ROSES-2016.

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B.6 HELIOPHYSICS LIVING WITH A STAR SCIENCE

NOTICE: Amended January 30, 2019. The proposal due dates for this program element were previously temporarily changed to "TBD" as a result of the partial government shutdown. This amendment releases new due dates for the effected program elements in Appendix B. For this program element Step-1 proposals are due March 12, 2019 and Step-2 proposals are due May 9, 2019.

Amended December 14, 2018. This amendment presents final text for this program element. ~~Step-1 proposals are due February 14, 2019 and the Step-2 proposals are due March 29, 2019.~~

The Strategic Capabilities and The Cross-Discipline Infrastructure Building components are not being competed in ROSES-2018.

The requirement to address potential contribution to the Focused Science Team effort was changed in ROSES 2017 (see Section 8.2.2). Please note that the proposer's response to this requirement will be provided in a 4000-character text box on the NSPIRES cover page not in the 15-page main body of the proposal. Section 8.2.3 explains how the evaluation criteria explicitly include assessment of the potential contribution to the Focused Science Team effort.

The Data Use policy for the LWS Science Element in ROSES 2018 is described in Section 1.1

Proposal submission to this program element is by a two-step process, in which a Notice of Intent is replaced by a required Step-1 proposal. See section 8 for details.

Targeted Science Team proposals, whereby a single large proposal covers the entire breadth of a Focused Science Topic, will not be permitted in ROSES-2018.

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. A primary goal of the LWS program is to provide scientific understanding, with the potential for prediction, of the Heliosphere as a system. This includes an understanding of the space weather conditions from the Sun to the Earth and throughout the interplanetary medium, as well as the Sun-climate connection.

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. Because Strategic Capabilities and Cross-Disciplinary Infrastructure Building programs are fully subscribed, only the Targeted Investigations will be competed in this announcement.

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 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).

1.1 Data Use in the Living With a Star Program

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.

For successful completion of the proposed project, proposals to this program may only use data that is in a publicly available archive at least 30 days prior to the Step-2 deadline. 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 element's point of contact at least 10 days before the Step-1 deadline.

After an award is made, projects may incorporate new data that becomes available 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 Principal Investigator.

While the inclusion of useful ground-based observations is allowed, proposals are expected to incorporate space-based observations so collaboration between space-based and ground-based observers are permitted. Further, the Step-2 evaluation process (see Section 8.2.3) 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. The Strategic Capabilities, Cross-Discipline Infrastructure Building, and Tools and Methods

The Strategic Capabilities and Cross-Discipline Infrastructure Building components of the LWS element are not be competed in ROSES-2018. For Strategic Capabilities, issues regarding topic(s), budgets, and anticipated awards are still being examined and need to be resolved prior to an announcement. It is anticipated that Strategic Capabilities will be competed in ROSES 2019. Cross-Discipline Infrastructure Building is fully subscribed at present. Tools and Methods may be competed as part of ROSES-2019.

3. Scope of Program Element - Targeted Investigations

The stated goal of LWS, that of achieving an understanding of those aspects of the Sun-Solar System that have direct impact on life and society, 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.

The Targeted Investigations component this year consists of four Focused Science Topics (FSTs).

3.1 Focused Science Topics

The Focused Science Topics (FST) permitted as the objectives for proposals this year are as follows:

1) Mid-latitude and Equatorial Dynamics of the Ionosphere-Thermosphere System (described in section 4);
2) Origins, Acceleration and Evolution of the Solar Wind (described in section 5);
3) Understanding the Response of Magnetospheric Plasma Populations to Solar Wind Structures (described in section 6);
4) Understanding Global-scale Solar Processes and their Implications for the Solar Interior (described in section 7).

Detailed descriptions of each FST are listed below. NASA desires a balance of research investigation techniques for each topic, including theory, modeling, data analysis, observations, and simulations. In previous ROSES calls, proposals could be individual proposals that would form part of a team or Targeted Science Teams (TSTs) that form prior to submission under a single Principal Investigator (PI) and submit a single TST proposal that attacks the entire breadth of the Focused Science Topic. However, such TSTs will not be permitted this year and the FST teams will be formed from the selected individual proposals based on panel evaluations and programmatic considerations.

Because of the structure of the LWS FST program element, the results of these investigations often times have an applied component where the results may be used for prediction. As a result, understanding the uncertainty associated with these results is an essential part of this program. Consequently, all proposals must address data and model uncertainty (see section 8.2.3).

LWS Science will pursue one of the recommendations in Chapter 10 of the 2013 Heliophysics Decadal Survey that NASA "work toward doubling the size of Individual-Principal-Investigator grants." 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 $185K - $225K. (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 FTE 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 and merit and investigative techniques, NASA anticipates forming teams of ~5-7 selections for each of the four FST topics. The expected duration of FST awards is four years.

3.2 Focused Science Teams

Once selected, these investigators will form a team in order to coordinate their research programs. In order to foster the collaborations required to coordinate these team research efforts, one of the PIs will serve as the Team Leader for the Focused Science Topic for which he/she proposed. This PI will receive supplemental funding, as necessary, to support costs associated with these duties after the selection process is completed. Proposers are encouraged to propose to act as a Team Leader and, if they do so, should include a brief section at the end of their proposal describing how they would lead the team effort. Up to one extra page of the proposal is allowed for this proposed effort.

All proposers for Focused Science Topics should include sufficient travel funds in their proposed budgets to cover two team meetings per year to be held on the U.S. coast furthest from their home institutions. This assumes that one meeting per year will be held in conjunction with a major U.S. scientific meeting. Successful teams will participate in a Kickoff Workshop were 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. Guidance for the Team Development process will be provided by NASA.

4. FST #1: Mid-latitude and Equatorial Dynamics of the Ionosphere-Thermosphere System

4.1 Target Description

It is well known that during magnetic storms heating occurs first at high latitudes. Energy is transferred from the magnetosphere to the ionosphere-thermosphere (IT) through Joule heating and particle precipitation. Equally well known are the dramatic positive and negative ionospheric storm effects that undoubtedly result from this input and the complex IT interactions. However, we do not understand how this energy and dynamics are transferred to mid- and equatorial latitudes to form the plasma density and total electron content (TEC) distribution observed there as well as irregularities/ scintillation. To date much of what is known about the dynamics of mid-, low- and equatorial latitude electrodynamics is largely based on observations from a few

incoherent scatter radars and individual single ground observatories. In very recent years extended ground GPS arrays have offered global scale dynamics from TEC observations and can potentially track the propagation of TIDs. Although much phenomenological insight has been gained into the complex dynamics at those latitudes, the link to physical processes that result in scintillation and TEC dynamics is not understood. It is not surprising that IT responses observed recently by satellites such as C/NOFS and recent ground instrumentation have been unpredictable and unexpected. Specifically, the significant longitudinal variability now seen in multiple IT properties is not at all understood and has become a barrier for the ongoing global density modeling effort that is necessary to improve TEC and scintillation forecasting capabilities.

There has been significant speculation on the possible causes of longitudinal electrodynamics variability, which includes: (a) the disturbance dynamo, which is the large-scale neutral wind system responsible for transferring energy from high to low latitudes and across the equator, and/or large scale atmospheric and ionospheric waves (TADs and TIDs) (b) the longitudinal difference in the neutral wind magnitude and direction, (c) the coupling between lower atmosphere and ionosphere (possibly source for non-migrating tides and localized gravity wave activity), (d) the longitudinal difference in the magnetic field orientation and magnitude at low latitudes. However, due to the uneven distribution of suitable ground-based instrumentation, and lack of consistent low-inclination missions, these speculations have not been validated or confirmed. The longitudinal distributions of ground-based instruments (GPS, ground magnetometers, imagers, radars, ionosondes, lidars, etc) are now getting better and can be utilized both for the low latitude longitudinal electrodynamics observations as well as for latitudinal transport of waves and energy from high latitudes to equatorial latitudes.

Understanding the latitudinal energy transport between higher and lower latitudes as well as the longitudinal variability of mid-, low-, and equatorial latitude electrodynamics is essential to the following LWS strategic science areas (SSA): SSA-4 Physics-based TEC Forecasting Capability, and SSA-5 Physics-based Scintillation Forecasting Capability. This topic is timely as it will advance our current state of understanding and capability to forecast scintillation and TEC structure at low latitudes and prepare the research path for multiple upcoming missions (ICON, GOLD, etc.)

4.2 Goals and Measures of Success

The goal of this FST is to understand mid and low latitude plasma density structure that affects scintillation as well as TEC variability and to accurately model the physical sources that drive it. Up-to-date simulation results should be compared with pertinent observations to quantify both our success level and the gaps in our understanding. Measures of success include, but are not limited to:

- The accurate determination of the longitudinal structure of low and equatorial latitudes of plasma density and plasma drifts.
- The determination of the details of vertical plasma motions.
- Specification and quantification of the effect of energy transport (TIDs/TADs) to this longitudinal structure.

- Quantification of a relationship between the longitudinal structure and scintillation effects

4.3 Types of Investigations

We seek investigations that will take advantage of historical, ongoing and future observations from space (e.g., C/NOFS, GRACE, TIMED, etc.) and supporting observations from the growing deployment of mid-, low-, and equatorial latitude ground instrumentation of all kinds, and in combination with empirical and physics based models. Data assimilation techniques are also encouraged. Scientific questions addressed by selected investigations should include, but are not limited to, the following:

- What is the mid-, low-, and equatorial latitude structure of plasma density, particularly during geomagnetically active periods, and how does the magnetic field longitudinal orientation and magnitude affect it?
- How does the disturbance dynamo contribute to transferring energy from high to low latitudes and across the equator?
- What is the role of TIDs and TADs?
- How does the longitudinal difference in the neutral wind magnitude and direction affect longitudinal structure and scintillation?
- How does the coupling between lower atmosphere and ionosphere (possibly source for non-migrating tides and localized gravity wave activity) contribute and affect TEC and scintillation?

4.4 Predictability, Interaction with User Communities, and Uncertainty:

Given the potential relevance of this FST with the upcoming GOLD and ICON missions, proposers should consider potential overlap of the FST and the anticipated observations of those two missions. Given the data policy in Section 1.1, however, proposals must not require the use of data from these two missions to address and achieve closure their science questions. Rather, the impact of the potential future observations from these missions may be considered as a possible source of future data.

All studies must consider data and model uncertainty and how sources of error impact the results (see Section 8.2.3).

5. FST #2: Origins, Acceleration and Evolution of the Solar Wind

5.1 Target Description

The supersonic, super-Alfvenic solar wind arises from the million-Kelvin solar corona, where the heating processes generating these temperatures and the role of small-scale waves, turbulence and field dynamics are far from being understood. In-situ solar wind turbulence observations show a dissipation range, which is direct evidence of ongoing turbulent heating believed to operate throughout the heliosphere, from the low corona out to the heliosheath. Subsurface solar convection powers all its mass loss, generates magnetic fields, excites solar flares through magnetic reconnection, and drives coronal mass ejections, Alfvénic waves, ion–cyclotron waves, and the various turbulent processes that evolve throughout the heliosphere. Understanding the origin, acceleration and evolution of the solar wind is critical for predicting virtually all forms of

space weather. This FST directly relates to SSA-0, which focuses on physics-based understanding of the variability of solar magnetic fields and particles.

This FST covers the array of physical processes involved in the solar wind's origin and evolution: the sources of different solar wind types and their connection to different coronal structures; the micro-physics of particle velocity distribution functions, their anisotropies and nonthermal characteristics; the role of turbulence and wave-particle interactions in heating and acceleration; and the energization driven by structures, such as shocks, current sheets and/or magnetic reconnection.

This FST addresses a range of science questions, including: What specific observables can be derived from and used to test solar wind models? What existing observations can be used to validate solar wind models, ranging from the kinetic to the AU scales? Furthermore, in preparation for the next decade of exploration of the inner heliosphere and corona with Solar Orbiter and Solar Probe Plus, how can the anticipated observations drive theoretical developments?

5.2 Goals and Measures of Success:

The primary goal of this FST is to advance our understanding of the origin, acceleration and evolution of the solar wind for future predictive models.

A key component of this FST will be the inter-comparison and testing of competing solar wind models, better constraining them using an array of solar wind in-situ and remote sensing observations, and the development of observational metrics to evaluate their strengths and limitations. The outcome will improve solar wind modeling capabilities. Direct observations across a range of temporal and/or spatial scales may be used to determine how large-scale features evolve in the origins of solar wind. Measures of success include, but are not limited to the:

- Determination of how magnetic scales couple to enable the release of material that form the wind
- Clarification of how plasma turbulence evolves and dissipates to heat and accelerate solar wind plasma
- Evaluation of how energy propagates across different regions of the corona and through the transition region
- Determination of the relationship between charge-states and elemental abundances and how they are set
- Understanding of nano-flares and magnetic reconnection and how stored electromagnetic energy is transfer to particles
- Evaluation of processes that heat and accelerate the solar wind plasma in the low corona

It is anticipated that future observations may transform our understanding of the origins and acceleration of the solar wind. In preparation, models need to be defined and tested and to establish specific metrics that can be used for validation. This will allow future predictive models to be developed and tested efficiently as new observations of the solar wind emerge.

5.3 Types of Investigations

The nature of this research effort requires the interdisciplinary combination of observational, theoretical, and numerical studies, including the following subtopics:

- waves, turbulence, and/or structures and their role in the heating of the solar wind plasma
- reconnection as an energy source that drives and/or heats the solar wind
- electron transport and heat conduction
- minor ions and their role in the origin and the evolution of the solar wind
- non-Maxwellian velocity distribution functions and their role in non-equilibrium solar wind thermodynamics
- small-scale energy release processes (nano-flares, etc.) and their role in the origin of the solar wind
- solar wind source models based on charge state and elemental composition
- mass flux, solar wind power, and their relationship to the large-scale magnetic field and small-scale dynamics
- differential studies of the spectrum of solar wind types that arise from different global-scale magnetic topologies
- evolution of solar wind properties through the solar cycle

Studies within this program will combine theoretical, numerical, and observational methods. The successful outcome of each research effort will rely on high-quality data analyses from past and present missions – such as Helios 1 and 2, Wind, ACE, Ulysses, STEREO, SOHO, SDO, IRIS, DSCOVR, etc. – to facilitate the robust comparison and constrain models with measurements. The effort could also rely on high-performance computing to facilitate multi-scale modeling activities.

5.4 Predictability, Interaction with User Communities, and Uncertainty:

One motivation of this FST is to advance our understanding of the origins, acceleration and evolution of the solar wind with a goal to identify observational metrics that test solar wind models and to develop the understanding needed to advance predictive solar wind models. The FST should demonstrate how the expected advances will be relevant for prediction of solar wind properties.

Given the potential relevance of this FST with the Parker Solar Probe and upcoming Solar Orbiter missions, proposers should consider potential overlap of the FST and the anticipated observations of those two missions. Given the data policy in Section 1.1, however, proposals must not require the use of data from these two missions to address their science questions. Rather, the impact of the potential future observations from these missions may be considered as a possible source of future data.

All studies must consider data and model uncertainty and how sources of error impact the results (see Section 8.2.3).

6.0 FST #3: Understanding the Response of Magnetospheric Plasma Populations to Solar Wind Structures

6.1 Target Description:

Plasma populations govern space weather conditions within the Earth's magnetosphere. Energetic particles cause single-event upsets and deep dielectric charging in spacecraft electronics and may be harmful to humans in space. While we understand that magnetospheric dynamics is driven by the solar wind, we only understand the first order responses of the magnetospheric populations. Their nonlinear response to different driving conditions, involving coupling and feedback between populations, magnetosphere and ionosphere, wave particle interactions is still poorly quantified.

Many aspects of current geospace modeling efforts rely on simple parameterizations and do not take into account the complexities of different solar wind drivers, or even more the timescales for geoeffective coupling, or the combined effect of multiple driving parameters that can result in dramatically different responses from those to individual drivers. Solar wind can change the locations of the magnetopause and plasmapause, can change the configuration of the global magnetic and electric fields and can drive the generation of Ultra Low Frequency, Very Low Frequency, and Extremely Low Frequency waves that can interact with particles. Understanding and predicting when and where radiation effects related to space weather may occur requires detailed knowledge of the how particle radiation is driven by the solar wind. This topic is well suited to make significant advances in our understanding of low-to-high energy particle dynamics, and hence will lead to next-generation modeling and forecasting models - important for effective mitigation of geomagnetic storms.

This FST is relevant to LWS TR&T Strategic Science Areas (SSAs): SSA-0: Solar electromagnetic, energetic particle, and plasma outputs driving the solar system environment and inputs to Earth's atmosphere; SSA-1: Geomagnetic Variability; and SSA-6: Radiation Environment.

6.2 Goals and Measures of Success

This FST is targeted at improving our understanding of how particular structures in the solar wind affect global fields and particle populations from a whole systems approach. Measures of success include, but are not limited to, studies that provide:

- Improved empirical models for the magnetospheric plasma environment as a function of solar wind and geomagnetic conditions.
- Improved first principle models capable of predicting the time-dependent response of magnetospheric plasma populations to varying solar wind conditions.
- Validation of the models, and specification of intrinsic errors during selected extreme events.

6.3 Types of Investigations

Investigations that address this FST include, but are not limited to:

- The development of the quantitative models for magnetospheric plasma populations.

- Studies which utilize multipoint ground-based and spacecraft observations of magnetospheric and solar wind conditions.
- The examination of how particular structures in the solar wind determine the spatial and temporal evolution of the magnetospheric plasma populations.
- Case studies that utilize empirical models and/or global numerical simulations.
- Investigations involving machine learning, and the development of global simulations capable of assimilating both in situ and remote observations.

6.4 Predictability, Interaction with User Communities, and Uncertainty

Proposals should identify potential Scientific/User Community that would benefit from specific prediction capabilities generated by the proposed work. In addition, the proposal should provide a brief statement on how particular user communities could utilize the results.

All studies must consider data and model uncertainty and how sources of error impact the results (see Section 8.2.3).

7.0 FST #4: Understanding Global-scale Solar Interior Processes and the Implications of Changes in the Solar Interior on the Heliosphere

7.1 Target Description

The particulate and electromagnetic outputs of our star are modulated by the behavior of the Sun's magnetic field. That field, on timescales from seconds to millennia, controls the interaction between the Sun and the heliospheric environment. Unfortunately, the processes that drive the genesis and much of the evolution of global-scale magnetic field are largely hidden from direct observation. As a result, models of solar magnetic flux origins have attempted to explain the generation and evolution of the magnetic field using assumptions about the internal flow fields including temporally varying differential rotation, meridional flows, and zonal flows, as well as estimates of magnetic field emergence, reconnection, and diffusion. Recent observations, however, have highlighted the presence of more complex meridional circulation patterns and significant differences in evolution of the higher latitudes that may play a major role that has not been previously investigated. The assimilation of time-variable, large-scale, internal solar dynamics into models of solar magnetic flux origins is essential for forecasting solar magnetism and activity. These models will support attempts to predict the resulting geomagnetic effects across numerous timescales making this FST relevant to SSA-0, SSA-1, and SSA-2.

This FST should develop a consensus set of observational constraints for the latitudinal and temporal variation of meridional circulation, the solar rotation profile, etc., using state-of-the-art observations and data analysis techniques from historical and contemporary data archives. This FST will bring together observers to provide information on the internal flows, with solar interior modelers to provide the simulations, and data assimilation experts to construct a framework to integrate observations and models.

The overarching goal of this FST is to produce a data-driven model for solar magnetic flux production to enable forecasting of active latitude and longitude regions on time

scales ranging from years to decades. Bringing together observers, analysts, modelers, and theorists to work together is a necessary prerequisite to the development of a forecast capability for solar activity across spatial and temporal scales, in readiness for the ~2022-23 maximum of solar cycle 25 in direct support of Parker Solar Probe and Solar Orbiter mission science.

7.2 Goals and Measures of Success

The results of this FST will advance our understanding of the time-variable and large-scale internal solar dynamics, magnetic field creation, and emergence. Success can be measured by the degree to which the team improves the forecasting of solar inputs to heliospheric and terrestrial atmosphere models beyond solar rotational time scales.

The team will develop a "consensus" set of observational constraints of surface and interior flows that extend the present reliance of the modeling community on sunspot archives, including hemispheric and broader latitudinal dependence. The team will demonstrate how to assimilate observations into models of the flows and magnetic dynamo activity of the solar interior. Measures of success are the prediction of the magnitude and timing of the next solar cycle maximum and the prediction of active latitudes during the next solar cycle.

Validation of predictive tools will be addressed through hindcast comparisons with legacy observations.

7.3 Types of Investigations

The following list covers a broad range of topics and activities that could be included in the FST Team. It is not anticipated, however, that this complete set of topics will be included in the selected FST Team.

- Theory and modeling of large-scale flows and generation of magnetic fields in the solar interior.
- Novel data analysis techniques: Methods tailored to measure large-scale flows in the photosphere and solar interior 1) with appropriate spatial resolution 2) that reach to high latitudes. These can be combined with observational and numerical studies to identify monthly to decadal timescale variations in internal flows, and studies of how these affect internal dynamo action.
- Inversion techniques: Development of new helioseismic methods for pushing the range of validity in latitude and in depth (shallowness) of the various diagnostics, including the use of multiple-line techniques with different sensitivities to the presence of magnetism. Use of feature-finding algorithms: Investigations that explore existing community resources (e.g., the Heliophysics Events Knowledgebase; HEK) and develop methodologies for identifying and tracking features in magnetograms and solar imaging in contemporary and legacy data to derive further information about global-scale flows.
- Use of ancillary observations as additional constraints: Investigations that explore the relationships and differences between global-scale evolution observed in the low and high latitudes using data of the photosphere, chromosphere and corona in addition to archived measures of the solar wind and sun-as-a-star radiative properties.

- Observational studies of the spatial structure of internal and surface solar flows, and numerical studies of how these affect internal dynamo processes and flux emergence latitudes. This includes diagnostic intercomparisons and validation, with observational investigations including helioseismology (based on observations or numerical simulations), the nature of super-granulation, giant cells, etc.
- Studies to develop assimilative methods required to incorporate observed solar flows into flux evolution and dynamo models. This includes data assimilation into predictive tools for near-real-time updating, which is encouraged. The investigations must emphasize how development enables predictive capabilities.

7.4 Predictability, Interaction with User Communities, and Uncertainty

Given the potential relevance of this FST with the Parker Solar Probe and upcoming Solar Orbiter missions, proposers should consider potential overlap of the FST and the observations of those two missions. Given the data policy in Section 1.1, however, proposals must not require the use of data from either of these two missions to address their science questions. Rather, the impact of the potential future observations from these missions may be considered as a possible source of data or application of FST Team results. In addition, NASA science and human exploration programs rely on understanding the strength and timing of future solar variability for planning through the use of numerous models of solar activity and the terrestrial response.

All studies must consider data and model uncertainty and how sources of error impact the results (see Section 8.2.3).

8. Submission and Evaluation Process

To streamline the proposal process (submission, evaluation, and administration), this program uses a two-step proposal submission process (see the overall description of a two-step process in the ROSES *Summary of Solicitation* Section IV(b)vii).

In addition to the general requirements and restrictions (e.g., in Table 1 of the *ROSES Summary of Solicitation* and in B.1 Heliophysics Research Program Overview) this program element has specific compliance constraints for both format (e.g., Sections 8.1.1 and 8.2.1) and content, e.g., involving data (see Sections 1.1 and 8.2.3). These compliance rules ensure fairness and are enforced strictly by the Heliophysics Division. Proposals that are deemed non-compliant will typically be returned without review or, if not caught until during or after the review, will typically be declined despite any merits that may have been found by peer review.

8.1 Step-1 Proposals

Proposers should refer to the "Instructions for Submitting a Step-1 Proposal" under "Other Documents" on the NSPIRES page for this program element.

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-2018. The Step-1 proposal must be submitted by the organization's Authorized Organizational Representative (AOR). No budget or other uploaded files are required. Only proposers who submit a Step-1 proposal are eligible to submit a Step-2 proposal. Step-1 proposals will be checked for compliance,

but they will not be evaluated. The Step-1 proposal title, science goals and objectives, and investigators (Principal Investigator, Co-Investigators, Collaborators, Consultants, and Other Professionals) cannot be changed between the Step-1 and Step-2 proposals. 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.

8.1.1 *Step-1 Proposal Format*

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 and objectives to be addressed by the proposal.
- A brief description of the methodology to be used to address the goals and objectives.
- A brief description of "Proposed Contributions to the Focused Science Team Effort" (see Section 8.2.2 for the material to be summarized).

The NSPIRES system for proposal submission requires that Step-1 proposals include a summary (i.e., abstract) describing the proposed work as outlined above. The proposal summary is entered directly into a text field in NSPIRES. No PDF attachment is required or permitted for Step-1 proposal submission. All information for the proposal summary will be entered within the 4000-character Proposal Summary text box on the NSPIRES web interface cover pages. Proposers will be notified by email when they are able to submit their Step-2 proposals.

8.2 Step-2 Proposals

Proposers should refer to the "Instructions for Submitting a Step-2 Proposal" under "Other Documents" on the NSPIRES page for this program element. A Step-2 (full) proposal must be submitted electronically by the Step-2 due date (see below and Tables 2 and 3 of ROSES). The Step-2 proposal must be submitted by the organization Authorized Organizational Representative (AOR). A budget and other specified information is required. The Step-2 proposal title, science goals and objectives, and investigators (Principal Investigator, Co-Investigators, Collaborators, Consultants, and Other Professionals) must be the same as those in the Step-1 proposal.

Proposers must have submitted a Step-1 proposal to be eligible to submit a Step-2 proposal. Proposers that have received a noncompliance letter are not eligible to submit a Step-2 proposal.

Proposers may be expected to provide mail-in reviews for one to three proposals in this competition. Much of the science expertise lies in the PI/Co-I community, because, increasingly, nearly the entire Heliophysics community proposes. In order to maintain a high caliber review process, it is important to get the additional mail-in reviews to cover all proposals fairly.

8.2.1 *Step-2 Proposal Format*

All proposals submitted to ROSES must strictly conform to the formatting rules. Proposals that violate the rules may be rejected without review or declined following review if violations are detected during the evaluation process.

- The Scientific/Technical/Management section must not exceed the length specified in this Program Element (see Section 9 below).
- Margins: No less than 1 inch on all sides.
- Page size: The PDF must be set for a standard US letter page size of 8.5 × 11 inches.
- Font: Times New Roman, 12-point or larger. If an alternate font is used, it must meet the requirement of having, on average, no more than 15 characters per horizontal inch, including spaces. 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, on average, no more than 5.5 lines per vertical 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 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%. Expository text necessary for the proposal may not be located solely in figures or tables, or their captions.

General agency guidelines for proposals are specified in the *NASA Guidebook for Proposers* but the requirements in this program element supersede those found in the Guidebook (see Section I(g) of the *ROSES-2018 Summary of Solicitation*). Instructions for the mechanics of submitting Step-2 full proposals will be downloadable as a PDF file entitled "How to create and submit a Step-2 Proposal (PDF)" under "Other documents" on the NSPIRES page for this program element after Step-1 submissions are complete.

8.2.2 *Required Additional Section in Step-2 Proposal Front 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 4000-character plain text box on the NSPIRES cover pages and this will be peer reviewed as part of the evaluation of relevance (see Section 8.2.3). 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 will be declared noncompliant and will typically be returned without review or, if not caught until during or after the review, will typically be declined despite any merits that may have been found by peer review.

This section must summarize the following three topics:

- The relevance of the proposed study to the scientific objectives (Goals and Measures of Success) of the Focused Science Topic outlined in Sections 4.2, 5.2, 6.2, or 7.2,
- The potential contributions of the proposed study (Type of Investigation) to the Focused Science Team's effort outlined in Sections 4.3, 5.3, 6.3, or 7.3, 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 4.2, 5.2, 6.2 or 7.2. For proposals that address a Type of Investigation that is listed in Sections 4.3, 5.3, 6.3, or 7.3, 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 Focused Science Topic 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. Finally, a set of milestones should indicate the anticipated timing of the major achievements during the course of the proposed study. These metrics and milestones may change once the FST 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 "Proposed Contribution to the Focused Science Team Effort" portion of the proposal is evaluated.

8.2.3 *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 ROSES, will also be evaluated. The Intrinsic Merit and Cost criteria will be evaluated primarily as specified in the *ROSES-2018 Summary of Solicitation* and the *NASA Guidebook for Proposers*, but Relevance is handled differently, see below.

The evaluation of Intrinsic Merit will consider only information contained within the 15-page main body of the proposal (the Scientific/Technical/Management section). Most proposals are expected to describe a complete scientific study (i.e., clearly identified science questions and a project that achieves closure on those questions); however, this program element also accepts proposals that lack a complete scientific study but do 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.

As mentioned above (sections 4.4, 5.4, 6.4, or 7.4), all proposals must address data and model uncertainty. This is described in section 3.13 of the 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." The treatment of uncertainty will be evaluated by the review panel as a methodology issue (intrinsic merit) and will be assigned a strength or weakness based on the treatment presented in the proposal. Proposers are free to choose any appropriate method of uncertainty analysis but it must be clearly addressed in the body of the proposal. Proposals that fail to address uncertainty will be assigned a Major Weakness in the evaluation and may be considered unselectable.

The evaluation of the Potential Contribution to the Focused Science Team (Section 8.2.2) will serve as the Relevance evaluation. Please note that the review panel will

consider only the response to this NSPIRES cover page question (described in Section 8.2.2) in the evaluation of this criterion.

Evaluation of Cost Reasonableness will compare the scope of the proposed study and the proposed resources (personnel-time allocated, necessary computer resources, etc.).

Also, as part of the review process, the evaluation will include the determination of whether the proposal violates the restrictions in Section 1.1, including the use of data not in a publicly available archive 30 days before the Step-2 deadline. If possible, proposers should include a link or links to the data set(s) to be used in the proposed study. Non-compliant proposals may be returned without review.

9. Award Types

The Heliophysics LWS Science 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. Please also see the *ROSES-2018 Summary of Solicitation*, Section II a.

10. Summary of Key Information

Expected annual program budget for new awards	~$4.8 M
Number of new awards pending adequate proposals of merit	~ 21 – 26
Maximum duration of awards	4 years
Due date for Step-1 proposals	See Tables 2 and 3 of ROSES
Due date for Step-2 proposals	See Tables 2 and 3 of ROSES
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 pp; one extra page permitted for proposals to be Team Leader of a Focused Science Topic; 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 the FSTs in this program element are, by definition, relevant to NASA. See Section 8.2.3 regarding evaluation criteria.
General information and overview of this solicitation	See the *ROSES-2018 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 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	NNH18ZDA001N-LWS
NASA points of contact concerning this program	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 Janet Kozyra Heliophysics Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1258 Email: janet.kozyra@nasa.gov 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

B.7 HELIOPHYSICS DATA ENVIRONMENT ENHANCEMENTS

NOTICE: Proposal submission to all calls in Heliophysics will be done 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 (AOR). See Section 3 for details.

This year, Resident Archives are not 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.

Likewise, the Value-Added Enhancements portion of the HDEE will not be offered this year while the approach to be taken in this area is being reconsidered. Any thoughts or suggestions should be shared with either J. Hayes or D. A. Roberts.

Note that the scope of the call for Data Upgrades has changed. Most importantly, no proposals will be accepted for upgrading data from active missions, and proposals of larger scope (and thus higher dollar value) than in the past will be considered.

Proposers to this program element are not required to provide a data management plan via the NSPIRES cover page question. 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. See Section 2.2 below.

1. Introduction

The Heliophysics Data Environment Enhancements (H-DEE) program 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 B.1 of this ROSES NRA.

The work carried out for this program should be in support of the Heliophysics strategic goals and objectives in NASA's 2014 *Strategic Plan* and Chapter 4.1 of the NASA *2014 Science Plan* (https://science.nasa.gov/about-us/science-strategy). The recommended priorities of the Heliophysics community are also discussed in the National Research Council Decadal Strategy for Solar and Space Physics report, *Solar and Space Physics: A Science for a Technological Society* (http://www.nap.edu/catalog/13060/solar-and-space-physics-a-science-for-a-technological-society). Note particularly the sections of the Decadal report dealing with the "DRIVE" initiative, more specifically "R" and "I," and the discussion in Appendix B.

The H-DEE program encompasses the data environment needs throughout Heliophysics, including Solar, Heliospheric, and Geospace Sciences (Magnetosphere and Ionosphere/Thermosphere/Mesosphere [ITM]).

As part of a mission-oriented agency, the Heliophysics Research Program 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, even if of considerable merit, will not be given high priority for funding through this solicitation.

2. Heliophysics Data Environment Enhancements (H-DEE)

The basic building blocks of the NASA Heliophysics Data Environment (HPDE) are well-documented, carefully calibrated, and easily used data products, typically the result of the reduction of numbers from spacecraft telemetry to the physical quantities that enter the equations we use to model space plasmas. Many such datasets were produced before the era of standard formats and inexpensive storage devices, and others have been served more recently in a variety of ways from specialized web sites. This call solicits proposals (Data Upgrades) to upgrade datasets that are of continuing value but that do not currently fit easily into the HPDE. Resident Archives will no longer be supported; these are no longer needed as the data from current missions is flowing directly to Final Archives.

As detailed in the Heliophysics Scientific Data Management Policy (found at http://hpde.gsfc.nasa.gov), which gives further information about the HPDE, the Final Archive for Space Physics data, where the data will be preserved and served for the long-term, is the NASA Space Physics Data Facility (SPDF). Solar data are handled by NASA's Solar Data Analysis Center (SDAC), although the specific archiving arrangements are currently being dealt with on a case-by-case basis. Proposers working with solar data should expect to work with SDAC, the Heliophysics Data and Model Consortium (HDMC), and NASA Headquarters on a long-term plan. (The HDMC oversees work under the H-DEE grants.) In most cases, solar data will be expected to be in FITS format with a copy of the data provided to SDAC.

In recent years, NASA Heliophysics (HP) has developed standard ways of registering data products and thereby enabling searches for HP data. Most HP data products are now described in terms of the Space Physics Archive Search and Extract (SPASE) Data Model (see http://www.spase-group.org/ for information on SPASE and http://heliophysicsdata.gsfc.nasa.gov for a "public face" to the registry) that provides a uniform terminology and an associated registry service. The SPASE description of data products can be done directly by the data provider, but the SPASE group should be able to provide descriptions, as needed. Thus, people undertaking data projects under this call should determine what product(s) will require SPASE descriptions and, as needed, contact the SPASE group via https://hpde.gsfc.nasa.gov/spase_metadata.html for providing SPASE descriptions.

A frequent problem with past data is that it has been stored in a wide variety of idiosyncratic formats for various reasons. A major goal of Data Upgrade proposals will be to put data in uniform, sustainable formats. For solar physics data, this should be Flexible Image Transport System (FITS), and for space physics data Common Data Format (CDF) is the format of choice. Some Ionosphere, Thermosphere, Mesosphere (ITM) data are closely allied to Earth Sciences, and thus, NetCDF is appropriate. ASCII

is acceptable as a "format," as long as the files are well described, but the self-documenting formats are to be preferred. The archives can offer help with data formats.

In summary, this call solicits proposals designed to upgrade existing Heliophysics data products to improve the quality, utility, and accessibility of datasets relevant to Heliophysics research. Possible upgrades include placing datasets online, translating datasets into more readily accessible formats, improving the data quality, and improving metadata. Note that the term "dataset" as used here can apply only to data products derived directly from (primarily) NASA-funded instruments, and not to higher-level datasets derived from the results of data analyses, data assimilation, and modeling. The latter "upgrades" should be done in the context of a standard research proposal and documented in the data plan for that proposal. This year, no upgrades of products will be accepted from currently active missions. Such data products should be dealt with through the missions or through the science research proposal route just mentioned.

2.1 Programmatic Considerations

Proposals must discuss the relationship of the proposed effort to the present, as well as anticipated, state of knowledge in the field, to the relevant datasets that should be available from any related planned missions, and to any related NASA community research efforts.

All proposals to this call should address two general areas:

I. Science Rationale. The science rationale includes:

a. Key objectives and their scientific importance;
b. Relationship to NASA strategic plans and the HP data policy; and
c. Uniqueness or scientific advantages of the proposed approach compared to alternatives.

II. Architecture and Implementation Approach. The architecture and implementation approach includes:

a. Technical approach and its requirements and feasibility;
b. Data products to be enhanced;
c. Metadata and documentation of products and required ancillary data or enhancements;
d. Use of standard data formats; and
e. Compatibility with the Space Physics Archive Search and Extract (SPASE) Data Model.

The above issues will all be addressed naturally by following the format required in Section 2.2.

It is anticipated that approximately $500K will be made available to support new selections for Data Environment Enhancements, all for Data Upgrades. In the past these awards have been typically for $50K or less, but this year there is no suggested amount. This opens the door to more time intensive or difficult restoration work, but it is not meant to encourage larger budgets without very detailed justification (see below). The projects should, as in the past, be limited to one year except in very unusual cases.

Submitting a proposal to this program element implies that if an award is made, a copy of any data product will be made public, including via one of the two discipline archives:

the Space Physics Data Facility (SPDF), or the Solar Data Analysis Center (SDAC). Other plans for data delivery and archiving must be supported with cogent reasons.

Proposers to this program element are not required to provide a data management plan via the NSPIRES cover page question. 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. See Section 2.2 below.

2.2 Data Upgrades Proposals

Funding is intended to support small, short-term (typically one year) awards to improve the quality, utility, and accessibility of datasets relevant to Heliophysics research. Priority will be given to those proposals from data providers of NASA-sponsored datasets, but other data relevant to HP research will be considered.

A proposal for a Data Upgrade 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):

- *Products to be Produced*: A clear description of the products to be produced, including the time span covered; the physical quantities to be included with their temporal and/or spatial resolution; and the format(s), coordinate system(s), and processing level(s) (e.g., calibrated in physical units or not, the former being far preferable).
- *Scientific Utility*: An argument for why the datasets involved were scientifically useful in the past and for how the proposed upgrade will make them more useful in the future. 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 justification that merely stated: "This work supports long-term data projects" without specific examples would be inadequate. A better justification might be: "The following three groups are awaiting this data product to be able to do these cutting-edge scientific studies …"
- *Method of Production*: How the upgrade will be produced, including a presentation of relevant algorithms.
- *Demonstration of Improvement*: A demonstration that the proposed upgrade represents a significant improvement in the quality and/or utility of the data, its format, and/or its accessibility. “Before and after” graphs are especially helpful, and the validation of techniques and results (including, e.g., error bars) must be discussed.
- *Current Data Status*: The current status of the data and a demonstration that the data can still be retrieved from their current storage medium. Examples of the improved product are expected; if these are not available, specific arguments that these can be produced will be needed.
- *Data Volume*: A statement of the current data volume, the expected data volume after processing, and the fraction of the data expected to be recovered.
- *Metadata Plan*: A plan for providing required metadata and ancillary data and descriptions needed for independent scientific usability. A plan for providing SPASE

descriptions of products, usually in conjunction the SPASE group or a NASA HP data center (SPDF or SDAC), should be included.

- *Archive and Dissemination Plan*: A clear discussion of how the resource will be placed in an HP Data Archive for general access or otherwise made easily available, and a description of the documentation to be provided of the dataset as required for scientific use.
- *Need for Resources*: A discussion that demonstrates that the requested resources are necessary and sufficient for success in achieving the proposed upgrade. A good resource discussion will include: how many hours of what specific level of support person are required and why; what can or cannot be automated and why; and what level of science support is needed in terms of FTEs.

The discussion of each of these points may be brief, but each point must be clearly addressed, and addressing these points is all that is required for a proposal. The Scientific/Technical/Management section (including figures) of proposals shall be no more than five pages.

3. Submission and Evaluation Process

3.1 Step-1 Proposals

To streamline the proposal process (submission, evaluation, and administration), 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*. A Step-1 proposal is required and must be submitted electronically by the Step-1 due date (see below and Tables 2 and 3 in the *ROSES Summary of Solicitation*). Proposers should refer to the "Instructions for Submitting a Step-1 Proposal" under "Other Documents" on the NSPIRES page for this program. The Step-1 proposal must be submitted by the organization 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. Full (Step-2) proposals must contain the same science goals proposed in the Step-1 proposal. In addition, the Step-1 proposal title and investigators (Principal Investigator, and Co-Investigators, Collaborators, Consultants, and Other Professionals) may not be changed in between the Step-1 and Step-2 proposals. The expected format and compliance evaluation criteria are described below. Submission of the Step-1 proposal does not obligate the offerors to submit a Step-2 (full) proposal later.

3.1.1 Step-1 Proposal Format and 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 data products to be upgraded, and an overview of the upgrade that is expected.

The NSPIRES system for proposal submission requires that Step-1 proposals include a summary (i.e., abstract) describing the proposed work as outlined above. The proposal summary is entered directly into a text field in NSPIRES. No PDF attachment is required or 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.

3.1.2 Step-1 Evaluation Criteria

NASA may determine Step-1 proposals to be noncompliant based on the requirements listed in Section 2 and its subsections. PIs of noncompliant proposals will not be eligible to submit the associated Step-2 proposal and will receive a letter to this effect.

3.1.3 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 via the SARA web page at http://science.nasa.gov/researchers/suggested-reviewers/.

3.2 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 in the *ROSES Summary of Solicitation*). The Step-2 proposal must be submitted by the organization Authorized Organizational Representative (AOR). A budget and other specified information is required. The Step-2 proposal title, Principal Investigator, and all Co-Investigators, Collaborators, Consultants, and Other Professionals must be the same as those in the Step-1 proposal. Step-2 proposals must contain the same scientific goals proposed in the Step-1 proposal.

Proposers must have submitted a Step-1 proposal to be eligible to submit a Step-2 proposal. Proposers that have received a letter of noncompliance are not eligible to submit a Step-2 proposal.

Proposers may be asked to provide mail-in reviews for one to three proposals in this competition. Much of the science expertise lies in the PI/Co-I community, because increasingly, much of the Heliophysics community proposes. In order to maintain a high caliber review process, it can be important to get the additional mail-in reviews to cover all proposals fairly.

3.2.1 Step-2 Proposal Content

Proposers should refer to the PDF entitled "How to submit a Step-2 proposal" that will appear under "Other Documents" on the NSPIRES page for this program after the Step-1 proposal due date. The process for preparation and submission of the Step-2 (full) proposals is that for any other ROSES proposal. Guidelines for content and formatting of Step-2 full proposals are specified in the *ROSES Summary of Solicitation*, except where superseded by this program element (e.g., the 5-page limit).

Proposals should include the following within their Scientific/Technical/Management section: clear descriptions of (1) specific Heliophysics scientific problems that could be

addressed with the upgraded data in conjunction with other HP resources, (2) the importance of the problems, and (3) the details of the technical approach to providing the promised data. Proposals should be clear on how data will be made to conform to the Heliophysics Data Policy. The answers to the above points should arise naturally in following the required format in Section 2.2.

3.2.2 Step-2 Proposal Format

Step-2 proposals that are not complaint with format requirements and page limit may be rejected without review. See Section IV (b) ii of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers* for further details.

- The Scientific/Technical/Management section must not exceed five pages.
- Margins: no less than 1 inch on all sides, with a page size of 8.5 × 11 inches.
- Font: Times New Roman, 12-point or larger. If an alternate font is used, it must meet the requirement of having, on average, no more than 15 characters per inch. 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, on average, 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 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%. Expository text necessary for the proposal may not be located solely in figures or tables, or their captions.

Guidelines for submitting Step-2 full proposals, other than those listed above, are specified in the *NASA Guidebook for Proposers*. The Guidelines above supersede those found in the *Guidebook*.

3.2.3 Step-2 Evaluation Criteria

Compliant proposals will be evaluated according to the criteria specified in the *NASA Guidebook for Proposers*. These criteria are intrinsic scientific and technical merit, relevance to NASA's objectives, and cost realism/reasonableness.

The evaluation of scientific and technical merit will include:

- Compelling nature and scientific priority of science goals enabled by the Data Upgrade, 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 Upgrade now.
- Appropriateness and feasibility of the methodology, including the appropriateness of the selected algorithms for completing the investigation 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 Data Upgrade.

Cost realism/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.

4. Available Funds

It is anticipated that approximately $500K will be made available to support new selections for Data Environment Enhancements, all for Data Upgrades, with no prescribed limit on the individual proposal amount. Proposals are expected to be for one year, with a second year possible with strong justification.

5. Summary of Key Information

Expected program budget for first year of new awards	$500K, see Section 4.
Number of new awards pending adequate proposals of merit	~1-12
Maximum duration of awards	1 year, with a possible second year in unusual cases
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
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*.
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 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 or (800) 518-4726)

Funding opportunity number for downloading an application package from Grants.gov	NNH18ZDA001N-HDEE
NASA 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.8 GLOBAL OBSERVATIONS OF LIMB AND DISK / IONOSPHERIC CONNECTION EXPLORER (GOLD/ICON) GUEST INVESTIGATORS

NOTICE: This Program element has been delayed to ROSES-2019, at which point the data streams will be stable for both missions. The final text of this program element will be included in ROSES-2019 and Step-2 proposals will be due no less than 90 days from the release of the final text.

1. Scope of Program

The Heliophysics Guest Investigators program is a component of the Heliophysics Research Program. It consists of two program elements: The Open Heliophysics Guest Investigator (H-GIO) program (B.4) is offered for investigations that draw extensively upon the data sets from the missions of the Heliophysics System Observatory (HSO), and this program element, GOLD/ICON Guest Investigators (B.8), only for investigations that primarily use data from the Global Observations of Limb and Disk (GOLD) and Ionospheric Connection (ICON) Explorer Missions.

Program element B.8, the GOLD/ICON GI was released on February 14, 2018 as a placeholder with due dates "TBD" with the intention of soliciting it in ROSES-2018. However, because of scheduling issues, B.8 GOLD/ICON GI will not be included in 2018. It is our intention to solicit proposals for GOLD/ICON GI in ROSES-2019.

The NASA point of contact concerning this program is:

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Science Mission Directorate
NASA Headquarters
Washington, DC 20546-0001

Telephone: (202) 358-1615

Email: **terry.onsager@noaa.gov**

B.9 HELIOPHYSICS GRAND CHALLENGES RESEARCH-SCIENCE CENTERS

NOTICE: The Heliophysics Division will not be soliciting Grand Challenges Research Program Science Centers as program element B.9 of ROSES-2018. Instead, potential proposers are directed to B.13 Heliophysics Phase I DRIVE Science Centers.

Contact Information

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B.10 HELIOPHYSICS - EARLY CAREER INVESTIGATOR PROGRAM

NOTICE: Amended September 11, 2018. The Step-2 proposal due date for this program element has been delayed to September 21, 2018 to allow proposers without power from hurricane Florence to submit.

Amended July 2, 2018. The Step-2 proposal due date for this program element has been deferred to September 13, 2018.

Amended April 10 2018. The Step-2 proposal due date for this program element has been deferred to August 7, 2018 to allow more time to review the larger than expected number of Step-1 proposals.

Corrected March 14, 2018. An erroneous parenthetical reference in Section 2 has been struck through. The due dates remain unchanged.

Proposals to this program element will be submitted by a "binding" two-step process, in which only Step-1 proposals that are "invited" to continue to a Step-2 proposal can do so. The proposal title, science goals and objectives, and investigators may not be changed between the Step-1 and Step-2 proposals. See Section 3 for details of specific Step-1 requirements for this program. Step-1 proposals are due March 20, 2018, and Step-2 proposals are due June 14, 2018.

All proposals submitted to ROSES must strictly conform to the formatting rules. Proposals that violate the rules may be rejected without review or declined following review if violations are detected during the evaluation process. See Section 3.3 for details.

In response to the comments on the ROSES-2017 draft text of this program element, a FAQ has been posted on the NSPIRES page for this program element under "Other Documents". To understand the changes between the draft and the final solicitations, review this document.

1. Overview

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, 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.

The Early Career Investigator Program 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. Further background material concerning relevant research objectives can be found in 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).

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) 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.

System science and interdisciplinary proposals are encouraged. Proposals addressing the magnetospheres or the ionospheres of other planets are permitted, but must not duplicate proposals by the same PI sent to other programs. See section 1.3 of the Heliophysics Research Program Overview in program element B.1 of ROSES-2018.

A draft version of this Early Career Investigator Program in Heliophysics, was released for community comment in ROSES-2017. This call represents a pilot program to examine the feasibility of creating an incentive program for top-performing early career heliophysicists. Depending on the outcomes of this call and contingent upon future funding, future calls may be issued through ROSES to support early career heliophysicists in future years. It is intended that this program element will be solicited every two years. The ECIP awards are expected to be in the range of approximately $125K/year – $175K/year and may be up to five years in duration but award amounts and durations will be based on the justifications provided in the proposal.

2. Scope and Limitations [**Corrected March 14, 2018]**

The proposed research must be relevant to the goals and objectives of the Heliophysics division, see above. Proposals submitted to this program element must be led by a single, eligible investigator (see Section 2.1 for eligibility) serving as the Principal Investigator (PI). A Science PI and Institutional PI are permissible only for cases where the institution does not allow research or un-tenured faculty to lead proposals. No Co-Principal Investigators are permitted. Unpaid Co-Is are allowed and their role must be explained. In addition, up to two, named early career Co-I's may receive funding. Students and postdoctoral fellows may participate as supported team members. The proposed research may include collaborations. Proposers are strongly encouraged to read the *Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/, particularly Appendix B for the definitions of team member roles like Collaborator vs. Co-Investigator.

An early career researcher is allowed to be part of one and only one Step-1 proposal to this program element in a paid role as a PI or Co-I. The expectation is that the Principal Investigator (or designated Science PI) will invest a substantial portion of their time, of the order of 25% or more, to the investigation. Within the proposing team, the PI and

any team members must each have specific and defined tasks in the project, and the tasks must be critical to the completion of the project. Use of Collaborators is encouraged. 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 ~~(see Section 2.2 below)~~ or if they fail to meet submission guidelines specified below (Section 3).

NASA will cover salary (up to three months) for civil servant 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 civil servant salary for other agency personnel is requested as part of the proposal, the budget justification 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 fellows who are directly involved in the proposed research and/or for all other normal research expenses, such as costs incurred in field experiments, purchase of equipment and/or supplies, computing, travel, consistent with normal grant rules. If research collaboration is a component of the proposal, it is presumed that the collaborator(s) have their own means of research support. With sufficient justification small costs are allowed for consultants, other professionals, or subcontractors.

2.1 Eligibility

An ECIP proposal PI (or Science PI) and any paid early career Co-I's must have a Ph.D. conferral date on or after January 1, 2008 (but see also third 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 (see Section III(a) of the ROSES *Summary of Solicitation* regarding the no exchange of funds policy).
2. Be in a tenure-track or non-tenure-track position in either teaching or research or both, 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. Those in temporary positions with a fixed end-date (like post-doctoral fellowships or other term-limited positions) are not eligible, unless they are actively in transition to a permanent position by the time of receiving funding.
3. 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 point of contact in Section 6, below, prior to the Step-1 due date to propose. NASA will provide a written response within three weeks.
4. Not hold or have held academic tenure (or equivalent at an academic institution)
5. Not be a current or former recipient of the Presidential Early Career Award for Scientists and Engineers (PECASE) award.

3. Proposal Preparation, Submission, and Evaluation

Consistent with standard practice in Appendix B, to facilitate proposal review, this program element uses a two-step proposal submission process described in Section 1.3 the Heliophysics Research Program Overview in B.1 and Section IV(b)vii of the ROSES *Summary of Solicitation*. Moreover, due to the anticipated high number of submissions, this program element will use the "binding" two-step submission in which only Step-1 proposals that are "invited" can continue to a Step-2 proposal.

Step-1 and Step-2 proposal content and formatting is determined by the instructions in this program element, in the ROSES *Summary of Solicitation*, and *NASA Guidebook for Proposers*, in that order. See also Section I(g) of the ROSES *Summary of Solicitation*. Both Step-1 and Step-2 proposals must be formatted in accordance with the formatting rules described in Section 3.3. Both Step-1 and Step-2 proposals must be uploaded as PDF attachments, with content as described below. Both Step-1 and Step-2 proposals must be submitted electronically by an Authorized Organizational Representative (AOR) of the proposing organization by 11:59 pm eastern time on the due date in Tables 2 and 3 of this ROSES NRA. Both Step-1 and Step-2 proposals will be evaluated according to the criteria described in Section 3.4 below.

The Heliophysics Division wants to identify early career researchers who have the potential to develop new scientific ideas and effectively pursue and promote them and lead the community in new directions. To achieve that goal, (both Step-1 and Step-2) proposals to this program element include an extra component not described in Table 1 of ROSES or the *Guidebook*: a statement of the potential of the PI for scientific leadership. Scientific leadership includes both direct research contributions and service to the Heliophysics community. This section should outline a PI's goals, plans, experiences, attributes, and achievements that, when considered in combination with the other proposal components, show scientific leadership, as broadly construed. See the special leadership evaluation criterion in Section 3.4, below.

3.1 Step-1 Proposals

Proposers should refer to the "Instructions for Submitting a Step-1 Proposal" under "Other Documents" on the NSPIRES page for this program element.

Step-1 proposals must be uploaded as a PDF file and submitted electronically by the Step-1 due date in Tables 2 and 3 of this ROSES NRA. The Step-1 proposal must be submitted as described above by an AOR of the proposing organization. No budget is requested for the Step-1 proposal. Only proposers who submit a Step-1 proposal and are invited to submit a Step-2 proposal will be able to do so. Proposers will be notified by NPSIRES whether they are invited to submit their Step-2 proposals. Step-1 proposals will be checked for compliance and peer-reviewed, see below. The Step-1 proposal title, science goals and objectives, and investigators (Principal Investigator, Co-Investigators, Collaborators, Consultants, and Other Professionals) may not be changed between the Step-1 and Step-2 proposals. 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.

3.1.1 *Step-1 Proposal Content*

The Science/Technical/ Management section of each Step-1 proposal is restricted to 3 pages (not including references). It must include the following information:

- A description of the science goals and objectives to be addressed by the proposal.
- A description of the methodology to achieve the goals and objectives.
- A brief description (~1/2 page) of the PI's leadership potential (see above and the Evaluation Criterion in Section 3.4 below).
- In the Step-1 proposal, proposers are strongly encouraged to communicate the scientific impact and context of their proposal at a basic level that does not require detailed domain knowledge.

Each Step-1 proposal must also include a Biographical sketch/CV of up to 2 pages for the Principal Investigator. Step-1 proposals may not include biographical sketches/CVs for other team members.

Step-1 proposals should not include a table of work effort, current and pending support, or other additional components of Step-2 proposals (e.g., found in Table 1 of the ROSES *Summary of Solicitation*.

In addition to the Step-1 proposal uploaded as a PDF, the NSPIRES system for proposal submission requires that all proposals include a summary (i.e., abstract) in the 4000-character "Proposal Summary" text box on the NSPIRES web cover pages.

3.2. Step-2 Proposals

Proposers should refer to the "Instructions for Submitting a Step-2 Proposal" which will be posted under "Other Documents" on the NSPIRES page for this program element. A Step-2 (full) proposal must be submitted electronically as described above by an AOR of the proposing organization. A budget and other specified information is required. The Step-2 proposal title, science goals and objectives, and investigators (Principal Investigator, Co-Investigators, Collaborators, Consultants, and Other Professionals) must be the same as those in the Step-1 proposal. Only proposers who have been "invited" to submit a Step-2 proposal via NSPIRES will be able to do so.

3.2.1 *Step-2 Proposal Content*

The Science/Technical/Management (S/T/M) section of the Step-2 proposal must contain a detailed description of the proposed research in no more than 15 single-spaced pages including figures and tables. See Table 1 in the ROSES *Summary of Solicitation* for a checklist of the standard components of a proposal. Moreover, the 15-page S/T/M section of Step-2 proposals must include a 1-page leadership statement, see the description above in Section 3. and the special leadership evaluation criterion in Section 3.4, below.

3.3. Proposal Format

All proposals submitted to ROSES must strictly conform to the formatting rules. Proposals that violate the rules may be rejected without review or declined following review if violations are detected during the evaluation process.

- The Scientific/Technical/Management section must not exceed the length specified in this Program Element for that type of proposal (See Section 7 below).

- Margins: no less than 1 inch on all sides.
- Page Size: the PDF must be set for a standard US letter page size of 8.5 × 11 inches.
- Font: Times New Roman, 12-point or larger. If an alternate font is used, it must meet the requirement of having, on average, no more than 15 characters per horizontal inch, including spaces. 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, on average, no more than 5.5 lines per vertical 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 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%. Expository text necessary for the proposal may not be located solely in figures or tables, or their captions.

3.4 Evaluation Criteria

Proposals will be reviewed in two phases, Step-1 and Step-2. The limit for the Science/Technical/ Management section of Step-1 proposals is 3 pages in length, not including references and a CV of up to 2 pages. The H-ECIP Step-1 proposals will be reviewed for relevance, intrinsic scientific/technical merit, and leadership potential (see below) of the PI by a combination of unconflicted mail-in reviewers from the science community and NASA Headquarters personnel. Due to the anticipated high number of submissions, and the need to find unconflicted reviewers, Step-1 proposers are strongly encouraged to communicate the impact and context of their proposal at a basic level that does not require detailed domain knowledge.

The limit for the Science/Technical/ Management section of Step-2 proposals is 15 pages. Compliant, invited, Step-2 proposals will be evaluated according to the criteria specified in Section VI(a) of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*. These criteria are (1) intrinsic scientific/technical merit and (2) relevance, and (3) cost reasonableness. Cost reasonableness includes assessing the amount of work to be accomplished versus the amount of time proposed. Only necessary Co-I's and Collaborators should be included, and their specific tasks and roles in the investigation must be clearly laid out in the proposal work plan. The *NASA Guidebook for Proposers* states, "NASA strongly encourages PIs to specify only the most critically important personnel to aid in the execution of their proposals." Cost sharing is not required nor is it part of the evaluation criteria.

In order to evaluate the leadership potential of the early career PI, an additional evaluation criterion with two factors shall be applied to evaluate proposals submitted to the ECIP program and must be specifically addressed in the proposal:

- The potential of the PI for scientific leadership. Scientific leadership includes both direct research contributions and service to the Heliophysics community. Evaluators will be asked to assess the extent to which the proposal demonstrated the PI's potential for scientific leadership and creative vision. Examples of information of

interest include but are not limited to: educating graduate students, participation in public outreach, involvement in policy-related committees, invited and/or public lectures, awards received, 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 or endeavors that might demonstrate scientific leadership.

- The degree to which innovation affects the scientific and technical quality of the proposed work. The extent to which the scientific and/or technical innovation of proposed research might impact the direction, progress, and thinking in relevant scientific fields of research in addition to increasing the likelihood of achieving influential results.

4. 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 five years, subject to satisfactory progress and availability of funds. We anticipate receiving 60-100 Step-1 proposals and making ~8-12 awards in response to invited Step-2 proposals, but the actual number may vary from this estimate based on number of proposals and budget.

5. 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. Please also see the *ROSES Summary of Solicitation,* Section II (a).

6. Summary of Key Information

Expected annual program budget for new awards	~ $1.5M
Number of investigator awards pending adequate proposals of merit	See Section 4.
Maximum duration of awards	5 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	Step-1: 3 pages, see 3.1.1 above. Step-2: 15 pp; see also Table 1 of ROSES and the *NASA Guidebook for Proposers*.
Relevance to NASA	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*.
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 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	NNH18ZDA001N-ECIP
NASA point of contact concerning this program	Elizabeth MacDonald Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: 202-358-0991 Email: e.a.macdonald@nasa.gov

B.11 HELIOPHYSICS U.S. PARTICIPATING INVESTIGATOR

NOTICE: Amended on December 10, 2018. This program element will not be solicited in ROSES-2018. It is anticipated that it will be solicited in ROSES-2019.

1. Introduction

This program element for Heliophysics Explorer U.S. Participating Investigator (H-USPI) will be released in connection with a Stand Alone Mission of Opportunity Notice (SALMON) Announcement of Opportunity (AO) Program Element Appendix for the Heliophysics Explorer Mission of Opportunity. The purpose is to solicit potential Heliophysics Explorer Mission of Opportunity (MO) 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.

Proposals submitted in response to the SALMON solicitation will be reviewed at the same time as proposals submitted in response to this ROSES program element for Heliophysics Explorer U.S. Participating Investigators.

A single selection meeting will select proposals, and all Explorer selections will be funded from the same Explorer future mission budget; there is no separate budget for Explorer USPIs.

These studies are carried out in support of NASA's Heliophysics strategic objective "to understand the Sun and its interactions with Earth and the solar system, including space weather." from the *Science Mission Directorate Science Plan for 2014* (http://science.nasa.gov/about-us/science-strategy). The recommended priorities of the Heliophysics community are also discussed in the National Research Council Decadal Strategy for Solar and Space Physics report, *Solar and Space Physics: A Science for a Technological Society* (http://www.nap.edu/catalog.php?record_id=13060).

2. Relevance Criteria

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 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. 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 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.

Investigations requiring the provision of flight hardware are not solicited through this USPI solicitation. Investigations requiring the provision of flight hardware may be proposed to the Stand Alone Mission of Opportunity Notice (SALMON) Announcement of Opportunity (AO) Program Element Appendix for the Heliophysics Explorer Mission of Opportunity, when it is released.

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, benefits the U.S. scientific community, and enables the U.S. heliophysics 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.

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.

3. Point of Contact

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B.12 SPACE WEATHER OPERATIONS-TO-RESEARCH

NOTICE: Amended May 10, 2018. This amendment presents final text for this program element. Unlike other program elements in Appendix B of ROSES, submission to this program element does not involve a Step-1 proposal. Although not required, a Notice of Intent (NOI) is strongly encouraged. NOIs are requested by June 22, 2018, and 10-page proposals are due by August 3, 2018.

Proposers to this program element are not required to provide a data management plan via the NSPIRES cover page question.

1. Introduction

In October 2015, the National Science and Technology Council (NSTC) in the Executive Office of the President released the National Space Weather Strategy (http://sworm.gov/publications/2015/nsws_final_20151028.pdf) and the National Space Weather Action Plan (Action Plan) (http://sworm.gov/publications/2015/swap_final__20151028.pdf). The objectives of the actions described in the Action Plan are to improve the understanding of, forecasting of, and preparedness for space weather events, recognizing the need for close cooperation among the federal agencies.

Action 5.5.2 in the Action Plan directs NASA, National Science Foundation (NSF), and Department of Defense (DOD) to identify and support basic research on space weather. Action 5.5.3 directs NASA, Department of Commerce (DOC), and DOD to identify and support research opportunities that address targeted operational space-weather needs. Actions 5.6.1 and 5.6.2 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 has established the Heliophysics Space Weather Operations-to-Research (H-SWO2R) program. NASA is supporting this funding opportunity in coordination with DOC/National Oceanic and Atmospheric Administration (NOAA) to promote space weather operations-to-research (O2R) activities.

- For this opportunity, the objective of O2R is broadly defined as the joint pursuit of improvements of operational capabilities and advancements in related fundamental research.

NASA's role 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, instrument capabilities, and models; and support the transition of space weather models and technology from research to operations and from operations to research. Proposers interested in this

program element are encouraged to see the overview of the Heliophysics Research Program in B.1 of this ROSES NRA.

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.

The work carried out for this program should be in support of one or more NASA and/or NOAA goals and objectives described above.

2. Heliophysics Space Weather Operations-to-Research (H-SWO2R)

For this opportunity, NASA and NOAA have identified the following focus area for research and development to advance specification and/or forecast models of energetic particles and plasma in Earth's magnetosphere:

- Improve specifications and/or forecasts of the energetic particle and plasma conditions encountered by spacecraft within Earth's magnetosphere.

The primary goal of this funding is to support research by the grant recipient 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. Effective utilization of available data is encouraged. Employing data assimilation and/or machine-learning techniques is also encouraged. Improved specification capabilities could include real-time and/or retrospective estimates of particle fluxes at any spacecraft location within the magnetosphere, with retrospective estimates potentially being more accurate due to the utilization of additional data that may be unavailable in real time. Specification and/or forecasting capabilities could include electrons, protons, and/or heavy ions.

Proposals for this opportunity must define the products that will be developed and the timetable for producing them. Proposals must also define the metrics and validation methods that will be employed to evaluate the products. The products must have clear relevance to the focus area indicated above, and if possible, be directly related to decisions that are made and/or actions that are taken in anticipation of or in response to space weather. Proposers are strongly encouraged to include industry participants on their teams.

Proposals involving software development must describe the software license for distribution of the software to be developed by the proposing institution(s). It is strongly encouraged that the software license allow the software to be made available free of charge for non-commercial use and that it permit modification and redistribution of the software free of charge for non-commercial use.

2.1 Programmatic Considerations

Given the unique nature of this opportunity to support operations to research (O2R), 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, and specifically to the focus area detailed above.

The total funding available in fiscal year (FY) 2018 for new proposals submitted in response to this solicitation is expected to be about $2.0M. This funding is expected to support at least eight awards depending upon funds available. Proposals for more than two years will not be considered.

NASA and NOAA will jointly manage the review process, the selection process, and the administration of the program. NASA (on behalf of NASA and NOAA) will review the proposals in accordance with their own review processes/criteria connected to a unified O2R objective. The final award selections will be made in consultation with both agencies' program officers. An annual report and a final report will be submitted by each selected PI detailing the scientific results and an assessment of the value of the products developed based on the proposed metrics and, if possible, industry feedback. PIs are also encouraged to include recommendations for further research needed to improve product quality in the final reports.

3. Submission and Evaluation Process

3.1 Proposal Process

Unlike other program elements in Appendix B of ROSES, proposers may submit a proposal without any prerequisite Step-1 proposal. In order to facilitate the review process, proposers are strongly encouraged but not required to submit an NOI via NSPIRES. No PDF attachment will be requested for the NOI; proposers need only complete the online "proposal summary", answer any "program specific" questions, and provide a team member list that is as complete as possible. NOIs must be submitted by the deadline indicated in Section 5 below.

A proposal is required to be submitted electronically by the due date (see below and Tables 2 and 3 in the *ROSES Summary of Solicitation*). Proposers should refer to the Tutorials and User Guides on the NSPIRES tutorial page at https://nspires.nasaprs.com/tutorials/. The proposal must be submitted by the organization Authorized Organizational Representative (AOR). In addition to all of the elements listed in Table 1 of ROSES, a full proposal must contain a coherent correlation to Space Weather O2R goals, as described in Section 1 above. The expected format and compliance evaluation criteria are described below.

3.2 Proposal Content

Proposals should include a section titled Scientific/Technical/Management which includes clear descriptions of the following:

(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

(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 methodology, resources needed, and the technical approach to providing the proposed O2R-enabling enhancement;
(4) Plans to provide public access to the models, tools, and value-added products developed;
(5) The products that will be developed, the timetable for producing them, the metrics that will be used to evaluate them, and a description of the industry/government decisions that would benefit from the availability of these products.

For additional submission guidance, proposers are encouraged to reference the *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation* for further insights on preparation and submission of ROSES proposals. Otherwise, please contact the POC listed in the Section 5 below.

3.3 Proposal Format

Proposals that are not complaint with format requirements below may be rejected without review. See also Section IV(b)ii of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers* for further details.

- The Scientific/Technical/Management section must not exceed ten pages.
- Margins: no less than 1 inch on all sides, with a page size of 8.5 × 11 inches.
- Font: Times New Roman, 12-point or larger. If an alternate font is used, it must meet the requirement of having, on average, no more than 15 characters per inch.
- 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, on average, 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 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%. Expository text necessary for the proposal may not be located solely in figures or tables, or their captions.

Where they conflict, the requirements above supersede those found in the Guidebook.

3.4 Evaluation Criteria

Compliant proposals will be evaluated according to the scientific and technical merit, the relevance, and the cost reasonableness. 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.

In addition to the evaluation of Merit given in Appendix D of the *NASA Guidebook for Proposers*, the evaluation of the scientific and technical merit will include:

- The potential for improving specifications and/or forecasts of the energetic particle and plasma conditions encountered by spacecraft within Earth's magnetosphere, and;
- The potential value of the proposed metrics to establishing the state-of-the-art and to measuring progress in specifying/forecasting the spacecraft environment.

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), as well as whether or not industry participation is included in the team. 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. Only necessary Co-Investigators and Collaborators should be included, and their specific roles in the investigation must be clearly described. Use of Collaborators whose only role is advisory is discouraged. Including relevant industry/government participants is encouraged.

3.5 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 via the SARA web page at http://science.nasa.gov/researchers/suggested-reviewers/.

4. Available Funds

It is anticipated that approximately $2.0M will be available in both Fiscal Year (FY) 2018 and FY 2019 to support this O2R opportunity. It is expected that combined 2-year budgets of most proposals will not exceed $500K.

5. Summary of Key Information

Expected program budget	See Section 4
Number of new awards pending adequate proposals of merit	Approximately eight
Maximum duration of awards	2 years
NOI requested by	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 proposal due date
Page limit for the central Science-Technical-Management section of proposal	10 pages

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*
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 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	NNH18ZDA001N-HSWO2R
Point of contact concerning this program element	Terrance Onsager Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1615 Email: terrance.g.onsager@nasa.gov

B.13 HELIOPHYSICS PHASE I DRIVE SCIENCE CENTERS

NOTICE: Amended March 11, 2019. To permit NASA adequate time to carefully review the larger than expected number (44) of Step-1 proposals, the Step-2 due date for this program has been delayed to June 20, 2019.

Amended January 30, 2019. The proposal due dates for this program element were previously temporarily changed to "TBD" as a result of the partial government shutdown. This amendment releases new due dates for the effected program elements in Appendix B. ~~For this program element the new Step-1 due date is March 1, 2019 and the new Step-2 due date is May 2, 2019~~.

~~Amended December 18, 2018. This amendment delays the due dates for this program element. Step-1 proposals are now due February 1, 2019, and Step-2 proposals are due April 5, 2019~~

Amended November 30, 2018. This amendment presents final text for this program element, which was previously released as a draft for community comment. ~~Step-1 proposals are due January 15, 2019, and Step-2 proposals are due March 5, 2019~~. A FAQ will posted on the NSPIRES page for this program element under "Other Documents".

This program element will take proposals for Phase I Drive Science Centers by a two-step process, in which a Step-1 proposal submitted by an Authorized Organizational Representative (AOR) is required. Only proposers who submit a Step-1 proposal are eligible to submit a Step-2 proposal. Step-1 proposals will be checked for compliance and proposers encouraged or discouraged from submitting Step-2 full proposals based on internal review. Step-2 proposals will be evaluated by a review panel with input where appropriate from external reviewers, along with a uniform limited "request for clarification" step to all PIs as part of the review process. See Section 9.1 for details.

1. Introduction

DRIVE Science Centers (DSCs) are part of an integrated multi-agency initiative, DRIVE (Diversify, Realize, Integrate, Venture, Educate), put forward as a high priority recommendation of the 2013 Solar and Space Physics Decadal Survey. DSCs, which fall under the "Venture" aspect of the DRIVE initiative, address grand challenge goals that are both ambitious and focused enough to be achievable within the lifetime of the center - in other words, problems poised and ready for major advances. This program is intended to support science that cannot be effectively done by individual investigators or small teams, but requires the synergistic, coordinated efforts of a research center. In order to maximize the potential for these science centers to deliver on innovative and breakthrough science, they are expected to include aspects in their design that support collaboration and deep knowledge integration across the full range of expertise (scientific, computational, educational) within them, as recommended in a recent report

by the National Academy of Sciences, *Enhancing the Effectiveness of Team Science*. With this motivation, NASA and NSF joined forces to design a DSC program implemented in this ROSES-18 program element by NASA, that takes advantage of lessons learned from ongoing and past science centers and the growing body of information on team science.

The DSC Program is two-phase. This program element solicits only Phase I DSCs proposals. Solicitation for Phase II DSCs proposals will be seperate. 2-year grants that result from Phase I proposals funded in FY 2019 may seek funding in FY 2021 by the submission of a proposal to the anticipated follow-on Phase II DSC solicitation. Some examples of appropriate Phase I DSC activities are given in Section 4.

2. Scope of the Program

2.1 Challenges and Goals

Exciting discoveries in Solar and Space Physics over the past decade have produced spectacular insights and provide a base upon which to pursue transformative advances in the next decade. A selection of recent major advances is presented in the 2013 Solar and Space Physics Decadal Survey. As described in this survey, the emerging view of the interactions within and between elements in the solar and space physics domains (Sun, Heliosphere, Geospace, the Earth's upper atmosphere, and other planetary space environments) is that of a complex and nonlinear pattern of multiple causes feeding into large-scale responses. Some of the most challenging problems are centered on aspects of these interconnections. Progress requires "a deep understanding of multiple connected physical systems" motivating "a sea change in the way breakthrough science is done".

2.2 Operating Principles

The program described in this Program Element combines inputs from a variety of sources, including: (1) the NASA Heliophysics Advisory Committee, (2) the Committee on Solar and Space Physics (CSSP) of the National Academy of Sciences, (3) the Heliophysics community through a previously released RFI NNH17ZDA008L, and (4) documents describing the practices and structure of six other NASA and NSF Center programs augmented by discussion with a variety of center directors. Much of the information from sources (1)-(3) is contained in the following reports:

Solar and Space Physics: A Science for a Technological Society,
Enhancing the Effectiveness of Team Science,
Committee on Solar and Space Physics: Heliophysics Science Centers,
Portfolio Review of the NSF Geospace Section,
Advanced Computational Capabilities for Exploration in Heliophysical Science (ACCEHS) ,
AAAS Review of the NSF Science and Technology Centers Integrative Partnerships (STC) Program 2000-2009, and
NASA Heliophysics Science and Technology Roadmap 2014-2033.

The following basic principles underlying the design of the DSCs, derived from these sources, are:

- Transformative results are best pursued by:
    - Openly competing science objectives
    - Giving proposers as much freedom as possible to define tools, methods, team composition and management
    - Requiring metrics and making their evaluation part of the proposal selection process
    - Limiting renewals, expecting significant progress or solutions in the DSC primary lifetime. This enables DSCs to be used as agile tools for addressing pressing strategic research problems as they emerge.
- Centers play a major role in enabling interdisciplinary science and innovative approaches
- Centers create a rich environment that provides valuable research and educational experiences for the broader community (visiting scientist programs, workshops, summer schools, etc.)
- Research in centers has a strong potential for positive societal impacts
- The unique capabilities presented by DSCs augment and do not replace, existing research programs in Solar and Space Physics
- The existence of multiple simultaneous centers introduces opportunities for enriching scientific discovery through cross-center interactions

2.3 Features of a Successful DSC

The characteristics of a successful DSC, include:

- the potential for breakthrough science within its 5-year lifetime
- a talented, diverse, multi/inter/trans-disciplinary, and fully integrated team to execute the research program
- empowered leadership that will define and manage all research tasks to realize the research center's vision,
- a supportive infrastructure and management system; adequate personnel commitments to manage the research program and interact with outside entities
- creative, substantive activities aimed at enhancing education, diversity, and public outreach
- potential for impacts on other field(s) and/or benefits to society
- a synergy or value-added rationale that justifies a center- or institute-like approach.

Successful centers tackle challenges of large scope and impact, producing transformative research leading to innovation and enhanced scientific returns. DSC awards bring researchers with shared and complementary interests into productive contact to foster synergy, potentially transformative research, and innovation.

3. Foundational Elements of a DSC

DSC awards support the formation and development (Phase I) or the sustained funding (Phase II) of research centers that can address major research challenges in Solar and Space Physics. Some detailed examples of Phase I activities are provided in Section 4. The most important elements to consider in the planning and extended operation of a DSC (Phases I and II) are described below:

3.1 Synergistic Research

DSCs are built around a compelling research challenge. The proposed research must be ambitious and potentially transformative. Research topics are selected through open competition based on their significance and alignment with NAS Decadal Survey goals. Many of the most exciting questions at the very edge of current understanding are strongly interdisciplinary in scope and require the merging of perspectives from different parts of the heliophysics community and possibly other discipline areas. The DSC Program is intended to support science that cannot be effectively done by individual investigators or small teams, but requires the synergistic, coordinated efforts of a research center. The potential for synergy is explicitly evaluated during the review process. A lesson learned from existing center programs at NSF and NASA is that "Major advances occur when scientists who would not normally work together are brought together."

Developing a distinct and distinctive science portfolio is essential for any DSC. However, members of the team requesting DSC funding may already have, or choose to apply for, funding outside the context of the DSC funds. Overlap in focus of existing grants with the DSC overarching science goals can provide leveraged benefits as long as the research is synergistic and not duplicative. If an existing grant is related to the objectives of the proposed DSC, it is critical to demonstrate in the proposal that the research for which DSC funds are requested is connected to the collaborative grant activity (both center and individual grants) in such a way as to foster progress that would not be realized in the absence of the synergy provided by the DSC effort. If members of the science team apply for additional support from other programs after the DSC is operative, these proposals are required to demonstrate that this new work is unique and not already funded as part of the DSC grant.

3.2 Data Availability

If the proposed methodology involves the use of anticipated data sets not yet available, a contingency plan must be presented to address how the research will be carried out in the event these data sources do not materialize or are significantly delayed. Proposed research must be achievable with currently available data sets alone.

With respect to data not publicly available at the time of the proposal submission, NASA data policy (*NASA Plan: Increasing Access to the Results of Scientific Research)* requires data sharing and preservation in order to enable validation of results, or a plan for how results could be validated if data are not shared or preserved. This plan must be included as part of the Data Management Plan (see Section 7.2.5).

3.3 Formation of High-Functioning Science Teams

High functioning teams for this call include multi/inter/trans-disciplinary teams that require a center environment to effectively address the science goals of the proposed DSC.

3.3.1 *The Need for Science Teams*

Research efforts that span a broad range in size and scope contribute significantly to pushing forward frontiers in Solar and Space Physics. Individual investigators and small

research groups have always provided a large component of this progress and continue to do so. However, as knowledge of the space environment grows so does appreciation of its complexity. Progress on some of the most compelling questions draws on the perspectives of multiple discipline areas and requires the close interaction between team members, which may include modelers, theoreticians, laboratory experimentalists, computer scientists, and observers. Coherent attacks on these scientific frontiers require multi/inter/trans-disciplinary teams and more resources than are normally available to individual investigators or small groups. Such activities may take new research directions and involve considerable risk. They combine research tools such as models, observational techniques, high performance computing, and others in synergistic ways to achieve the desired outcome. DSCs will facilitate the formation of the needed diverse teams, supporting multi/inter/trans-disciplinary science in a way that is uniquely cross-cutting.

Note: Proposals that have as their primary objective instrument development, CubeSat and balloon flights, or sounding rockets are out of scope. Proposals for those investigations are better suited for ROSES element Heliophysics Technology and Instrument Development for Science.

3.3.2 *Team Formation Risk Factors*

Team formation is the process by which all necessary disciplines, skills, perspectives, and capabilities are brought together. Successful teams are interdependent, multidisciplinary, and diverse and can work and communicate effectively even when geographically dispersed. Team formation includes strategies to overcome barriers to effective, dynamic teaming, including the integration of members with different areas of expertise, different vocabularies and ways of approaching problems, different understanding of the problems to be addressed, and different working styles. DSCs may partner with researchers from academia, commercial entities, government laboratories, and international organizations forming broader teams with more diverse viewpoints.

Following experiences from more than 40 Science and Technology Centers and the availability of a burgeoning amount of information on the "science of team science", the National Research Council undertook a study of the factors associated with successful and effective center experiences. As described in the report *Enhancing the Effectiveness of Team Science*, the science of team science is "concerned with understanding and managing circumstances that facilitate or hinder the effectiveness of collaborative research, including translational research." Although DSCs will potentially bring increased scientific expertise, advances in computing, and the latest data integration and analysis technologies to a critical research question, as pointed out by the NRC report, the synthesis and deep knowledge integration that is an essential part of this process increases the time needed for communication and coordination among team members. The structure and/or environment within the center can actually enhance this integration or throw up roadblocks that decrease the "hoped-for" science impact. If these aspects are not addressed adequately, risk is introduced that may affect the Center’s abilities to fully achieve its stated goals. A major recommendation is that solicitations "[r]equire authors of proposals for team-based research to include collaboration plans and, for interdisciplinary or transdisciplinary projects, specify how they will foster deep knowledge integration over the life of the research project." In

addition, the NRC report provides a series of recommendations aimed at researchers, center managers, and funding agencies that address "human-centered" challenges associated with team science centers.

3.4 Center Communication Challenges

For the most part, science questions that are complex enough to justify a value-added center approach involve a set of multidisciplinary skills that may not be available at a single institution, requiring collaboration across distance. In fact, evidence suggests that even people on the same campus but in different buildings or on different floors of the same building are likely to be communicating using virtual technologies. Interactions between multi-institutional geographically-dispersed teams are of necessity both physical and virtual. A major challenge, among others, in managing a virtual interaction is "members being blind and invisible to one another" when they do not work in the same location (*Enhancing the Effectiveness of Team Science)*. Due to the complexity and interdependency of the work, keeping track of what needs to be done, in what order, and by whom is challenging. Equally concerning, there is evidence to suggest that geographic dispersion has a negative impact on innovation.

The size of the team is also a critical factor in communication challenges. While there is no upper limit on the number of investigators in a given DSC, proposers are cautioned to avoid teams that are too large to collaborate effectively. The purpose of teams is to enhance communication and take advantage of their collective intelligence to solve problems. As the team size increases, research indicates that members find it more difficult to contribute to their full potentials hindering balanced contributions from the carefully assembled range of expertise. This is especially a problem for interdisciplinary teams in which full contributions from all members are needed. Resources devoted to maintaining good communications increase rapidly with team size.

Proposals are expected to address plans for establishing robust and effective communication channels among science team members with both face-to-face and virtual elements if needed for their proposed center structure

3.5 High-Performance Computing Needs

In the dynamically complex, nonlinearly coupled domains of heliophysics, computer simulations provide the third leg of discovery (in addition to observations and theory) and are "as important as access to state-of-the-art *in situ* and remote-sensing instrumentation" (ACCEHS report). Rapid advancements in computational capabilities are a potentially important resource for the DSCs if NASA can take advantage of the developments in synergistic communities to develop further and modernize the heliophysics computing frontier. To this end, experts in computer science, algorithm development, visualization and data analytics may contribute important capabilities to multi/inter/trans-disciplinary teams.

HEC computational resources enable research at scientific frontiers that would otherwise be impossible. Because this is a limited resource, proposals must discuss access to time on HEC machines and expertise to optimize its usage if this is a needed resource.

NASA maintains two major computing facilities – the NASA Center for Climate Simulation (NCCS) at the Goddard Space Flight Center, and the NASA Advanced Supercomputing (NAS) facility at the Ames Research Center. If the program specific data question on the use of NASA-provided HEC is answered in the affirmative, an appendix document must be provided which is discussed in Section 1(d) of the *ROSES Summary of Solicitation*.

NSF supports Blue Waters, one of the most powerful supercomputers in the world, located in the National Center for Supercomputing Applications at the University of Illinois, Urbana-Champaign. NSF controls roughly 80% of the available time on Blue Waters. This time is allocated through NSF's PRAC program and must be pursued independent of the current DSC funding opportunity. The PRAC program does not provide direct funding support for research but instead provides indirect support for projects requiring peta-scale computing resources on the Blue Waters system. The core research, which may be funded by NSF or other agencies (NASA, NOAA, DOE, etc.), must show compelling science or engineering challenges that require, and can effectively exploit, the petascale computing capabilities offered by Blue Waters.

3.6 Researcher Time and Commitment

Serving as the Principal Investigator of a center award requires scientific leadership and vision. It is also a significant commitment of time and will be a primary professional focus for the duration of the DSC. For this reason, the evaluation will include a careful examination of the time commitment of Principal Investigators (nominally ~30%). Furthermore, it is required that a DSC Project Manager (PM) be identified on the proposal cover page and assigned the role "Project Manager" in NSPIRES. The role of the PM is to help the PI (Director) manage and administer the DSC. All Co-Is must have an identified substantial role in the proposed effort. Team members committing a significant part of their professional effort should take this into account if participating as Co-Is in more than one DSC submission. Reviewers will evaluate the qualifications of the team and the resources available to the project (including researcher time and commitment).

3.7 Center Management Plans

Center Management Plans address leadership of the center, how decisions will be made, including the roles of any internal committees, and how synergy among projects and activities will be actively promoted in service of the DSC's vision. These plans include mechanisms for the ongoing assessment of research outcomes and impact broadening activities; implementation and periodic modification of strategic plans; allocation of resources; the ability to initiate new lines of research and terminate support for lower priority efforts; and approaches to encourage and promote effective use of the center's communication capabilities to optimize science team interactions. Organization of such activities will vary widely, depending on the particular needs of the research. It follows that maximum flexibility in the design of units funded through the program is essential, so the specific organization of the unit is left to the creativity of the Principal Investigators.

Since the DSC program is designed to foster research at the intellectual frontiers, new types of joint efforts may be needed to address the most promising problems. In all

cases, however, a center must demonstrate that the whole is substantially greater than the sum of the parts. The center must have a PI who takes overall responsibility for the effort and a Project Manager to aid the PI in managing the DSC.

3.8 Effective Leadership/Management

Effective Leadership/Management describes the skills needed by DSC leaders including intellectual vision and leadership, effective management of center activities, successful entrepreneurial experience, a track record of delivering results, and the ability to communicate clearly and effectively with diverse audiences, such as team members, sponsors, partners, host institutions, stakeholders, press and media, and the public. Effective DSC leadership and management teams may, for example:

- Empower all team members to contribute regardless of status and power differences;
- Establish a culture of deep collaboration and inclusion;
- Build consensus around goals and problem definition;
- Facilitate communication to ensure a common understanding; and
- Resolve conflicts and build trust.

It is rare that a single person will have all of these attributes; thus, a strong leader will need to assemble an executive team that covers this broad spectrum of skills. The Center PI should understand his/her strengths and limitations and be effective in assembling an executive leadership team that fills in any leadership/management gaps. A Project Manager is required.

3.9 Impact Broadening Activities

DSCs are expected to integrate their research with activities that broaden the impact of their research. For this program activities for broadening impacts refers to STEM engagement and future workforce development, higher education & professional learning, diversity and inclusion, and/or outreach and informal science communication. Phase I DSCs plan and may pilot Impact Broadening Activities in some or all of these areas that would be fully implemented in Phase II.

3.9.1 *Heliophysics Workforce Development*

Science centers can be major attractors for faculty at research-based institutions as well as undergraduate and graduate students. DSCs are expected to provide an exceptionally stimulating environment so that students and/or other team members will benefit from interactions with a large, often multi/inter/trans-disciplinary, group of scientists at all career levels. This workforce development is a challenge confronting Solar and Space Physics encompassing all four pillars of discovery: theory, observations, data analysis, and computer simulations.

3.9.2 *Increasing Diversity and Inclusion*

Science centers also create an environment conducive to addressing diversity issues. The 2010 *AAAS Review of the NSF Science and Technology Centers Integrative Partnerships (STC) Program 2000-2009* found that science centers "harbor the potential to cultivate cohorts of students who look more like America than the current U.S. science workforce." Diversity Plans outline the context, goals and specific actions for

promoting diversity within the center's supported researchers (faculty, postdoctoral researchers, graduate students), partners, and advisers. These plans are developed as part of the strategic planning activities of a Phase I DSC. Phase II DSCs are expected to implement these plans, building capacity while creating an inclusive culture to support research, discovery, education, and innovation, producing significant outcomes within their 5-year timeframe.

3.9.3 *Informal Science Communication*

DSCs are expected to develop a web presence. The internet can be used both to enable communication of science results and center opportunities to researchers in the community as well as to report new discoveries to younger students and the public to increase science interest and literacy.

3.10 Collaboration

DSCs are encouraged to take advantage of the opportunity to collaborate broadly with academia, commercial entities, government laboratories, and international organizations. There are no requirements on the number of collaborations. However, for any collaborators that contribute significantly to research objectives in the DSC, the proposal must provide sufficient evidence of a viable collaboration.

4. Phase I DRIVE Science Centers

4.1 Examples of Appropriate Center Formation and Development Activities

Phase I DSCs will engage in research, broader impact activities, and center development activities over the two-year duration of this award. The research activities may build on pre-existing efforts, and new, collaborative results attributed to the DSC award may result but are not required. The Phase-I award will also develop activities that broaden its impact, including developing and piloting center-scale activities that ultimately would be commensurate with a Phase II DSC. Phase-I activities include the development of a strategic plan covering all aspects of a DSC.

Proposers funded through this program element may use the Phase I DSC funding to organize catalytic activities (e.g., workshops and conferences) that can help crystallize the interdisciplinary research theme, develop the approach and strengthen the following areas:

- Overarching goals that engage and excite all discipline areas in the DSC
- Team formation/roles & responsibilities
- Deep knowledge integration, and communication plans
- Effective leadership/management
- Diversity/culture of inclusion
- Relationships with stakeholder communities
- Website and public outreach planning

Taking risks and innovative approaches are encouraged. The complexity of the problem argues for a deliberate, early-stage process for the development and formation of a highly effective research team. Potential challenges to be addressed for team science arise from seven key features (*Enhancing the Effectiveness of Team Science*): (1)

highly diverse team membership, (2) deep knowledge integration across disparate disciplines, (3) the large size of the team, (4) alignment of goals across all members of the team, (5) wide geographic dispersion, (6) permeability of team boundaries, and (7) high task interdependence.

For these types of challenges, Phase I DSC grants can be used to support team formation activities (e.g., filling expertise gaps, developing team charters, roles and responsibilities, aligning individual goals with overarching team goals). As described in *Enhancing the Effectiveness of Team Science*, studies have found that, "the quality of team charters is related to the quality of the team's performance."

Phase I funding can also be used to develop and nurture relationships with the stakeholder community, or to access specialized frameworks (i.e., virtual communication, shared data, etc.) or resources (i.e., HEC allocations, postdoc mentoring, graduate/undergraduate training programs, team training, etc.) needed to address the proposal challenges

5. Award Information

It is expected that there will be approximately $4.0 M available in Fiscal Year (FY) 2019 to support ~6 Phase I DSCs selected through this solicitation. Annual funding is unlikely to exceed $650K per investigation. This is subject to receipt of meritorious proposals and the availability of funds. The actual number of awards will depend on the quality of the proposals received; NASA reserves the right to make no awards, or more than 6 awards.

Awards made in response to proposals to this program element are planned to be grants 2 years in duration after which time DSCs will be eligible to submit a proposal for Phase II funding. The intent is to construct a DSC that "solves or makes significant progress in solving a problem and then diminishes in intensity of effort" to enable a subsequent DSC with different team composition and center features to be created and focused toward investigation of another of the most pressing research frontiers [*Committee on Solar and Space Physics: Heliophysics Science Centers*].

It is anticipated that $6 M will be available for Phase II awards in 2021 with the expectation that we will select at least 1-2 Phase II DSCs.

6. Eligibility Information

6.1 What Types of Organizations May Submit Proposals?

To be eligible the proposal must be submitted by a U.S. organization excluding NASA field centers. JPL is eligible to submit. Collaborations between institutions of different types are encouraged, keeping in mind that NASA is seeking diversity of thinking and new approaches that could lead to exciting new solutions and advances. Collaboration by non-U.S. organizations in proposed efforts is permitted. However, please refer to Section III.c of the *ROSES 2018 Summary of Solicitation* and/or the FAQ regarding restrictions.

Only organizations that previously submitted a Step-1 proposal can submit Step-2 proposals. See Section 9.1. There are no restrictions or limits on the number of proposals per organization.

While more than one institution may participate in a Step-1 or Step-2 proposal, a single institution must accept overall management responsibility for the DSC. The proposal can be submitted by only one institution with funding provided to non-governmental institutions through subawards (see Section IV(d) of the *ROSES Summary of Solicitation*); use of separately submitted collaborative proposals is not permitted.

6.2 Who May Serve as PI/Co-I?

Researchers may serve as the Principal Investigator for Phase I DSCs, provided they are affiliated with an eligible organization (see above). The PI becomes the Center Director. Because of the direct funding available to the NASA field centers, NASA Civil servants may serve as Co-investigators, but not as PI or PM. Co-Is are required in the institutions with subawards on the Phase I DSC proposal, if they are responsible for leading and managing major elements of the research. Co-Is are also permitted from the lead institution.

An investigator may participate as PI in only one Step-1 and one Step-2 proposal submitted in response to this program element. See also Section 3.6 regarding time commitment. A Co-I on one proposal may also participate in other proposals.

7. Proposal Preparation and Submission

The submission of proposals in response to this program element is a two-step process. Proposers not already familiar with the two-step process are strongly encouraged to read Section IV(b)vii of the *ROSES 2018 Summary of Solicitation* and Section 1.3 of the Heliophysics Division Overview. For this Program Element, the Step-1 proposal is a 8-page white paper plus references and citations (as needed), with 6 pages of this devoted to the Technical and Management section (see Table 1, below).

Step-1 proposals will be checked for compliance. Those that are non-compliant may be returned without review. The PIs of Step-1 proposals will be encouraged to, or discouraged from, submitting Step-2 proposals based on internal review.

7.1 Step-1 Proposal Preparation

The Step-1 proposal includes a Proposal Cover Page and proposal attachment. The Step-1 Proposal pdf uploaded must include the components listed in Table 1 in the order specified.

Note the following:

- The title given to the Step-1 proposal must be descriptive of the proposed research.
- Letters of commitment are not required for Step-1 proposals.
- Step-1 proposals are likely to be evaluated internally by NASA civil servants who are solar and space physics reviewers with broad knowledge but not necessarily domain expertise on the topic of the DSC. It is, therefore, important that they be written to be comprehensible to these reviewers and that proposals emphasize

impact on Heliophysics in a broad context.

Table 1 Step-1 Proposal Contents and Page Limits

Section Number	Proposal Section	Maximum Page Length
S1	Executive Summary	1
S2	Summary Chart	1
S3	Technical and Management Section	6
S4	References and Citations	as needed

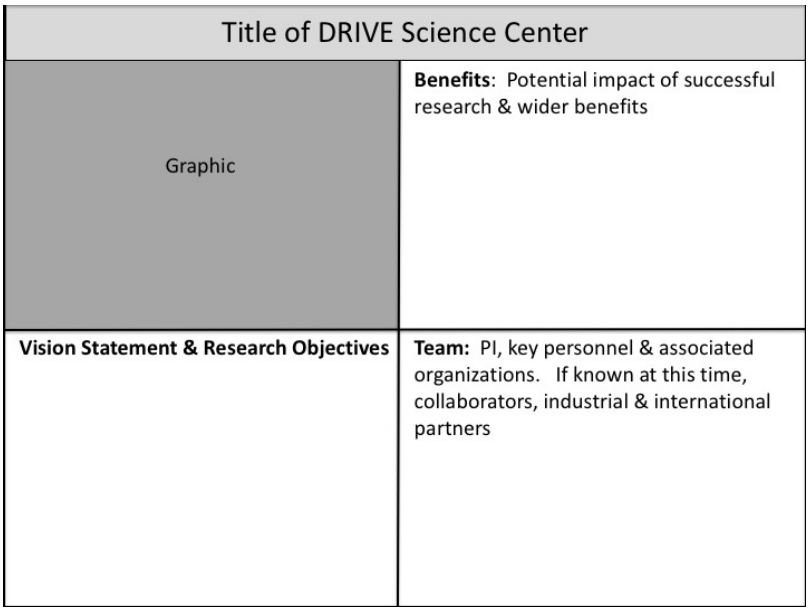
7.1.1 *Executive Summary (S1)*

The Executive Summary is limited to one page and should include: Vision, research objectives, impact, relevance, and impact broadening activities.

7.1.2 *Summary Chart (S2)*

The Summary Chart [link to page to download pptx template] shown in Figure 1 is intended to provide a quick sense of the proposed DSC and should stand alone (i.e., not require the Step-1 or Step-2 proposal to be understood). It should not include any proprietary or sensitive data as NASA may use all or some of the information on the summary chart, including images, for communications about the selections (e.g., press releases). Note: Step-2 proposals are permitted to make minor changes to the summary chart submitted in Step-1.

Figure 1 - Format for Required Summary Chart (S2)



7.1.3 *Technical and Management Section (S3)*

Proposers are encouraged to read the Technical and Management Section requirements for the Step-2 proposal (below) when preparing this section for the Step-1 proposal. The project description should address the following points:

Technical and Management Section (6 pages):

- Center Overview including the center vision, potential for transformative impact in Heliophysics, potential for synergy, key personnel and organizations, and, if known at this time, collaborators, international and industrial partners.
- Phase-I Research Plan including the group of initiating investigators, an outline of the research goals.
- Summaries of plans for center management
- Brief summaries of plans for innovation, higher education and/or professional development, broadening participation, and informal science communication

7.1.4 *References and Citations (S4)*

All references and citations given in the *Technical and Management Section* must be provided using easily understood, standard abbreviations for journals and complete names for books. It is highly preferred but not required that these references include the full title of the cited paper or report. Only the most relevant and impactful references should be referenced in the *Technical and Management Section* and provided in this section of the Step-1 proposal.

7.2 Step-2 Proposal Preparation

Step-2 proposals submitted in response to this program must originate from Principal Investigators who submitted a Step-1 proposal. Any proposals not meeting this requirement may be returned without review. Proposals are likely to be read and evaluated by solar and space physics reviewers with broad knowledge but not necessarily domain expertise on the topic of the DSC at some stage of the review process. It is therefore particularly important that they be written to emphasize their impact on Heliophysics in a broad context. Proposers are strongly encouraged to consult the proposal preparation and submission instructions in the *ROSES 2018 Summary of Solicitation*. Proposals not compliant with the proposal preparation guidelines, as supplemented by the following instructions, may be returned without review. To aid in the preparation of Step-2 Phase I proposals, examples of some activities appropriate for a selected Phase-I center are given in Section 4.

Note the following:

- Between Step-1 to Step-2:
    - Change in PI is not permitted.
    - Change in science topic is not permitted.

Table 2 shows the proposal content and page limits. Note that additional documents are required to be uploaded separately such as (optional) High-End Computing request or Total budget file.

Table 2 Step-2 Proposal Contents and Page Limits

Section	Proposal Section	Maximum Length
S1	Executive Summary	1
S2	Table of Contents	1

S3	Summary Chart	1
S4	Technical and Management Section	25
S5	Data Management Plan	2
S6	References and Citations	As needed
S7	Biographical Sketches for PI and Co-Is	2 pages for each
S8	Current and Pending Support	As needed
S9	Supplemental Documents	As needed
S10	Facilities, Equipment and Other Resources	As needed
S11	Budget Justification Plan/Cost Proposal	As needed

7.2.1 *Executive Summary (S1)*

The Executive Summary is limited to one page and should include: Vision, research objectives, impact, relevance, and impact broadening activities.

7.2.2 *Table of Contents (S2)*

A brief table of contents provides a guide to the organization and contents of the proposal.

7.2.3 *Summary Chart (S3)*

The Summary Chart [link to page to download pptx template] should be the same as that submitted as part of the Step-1 proposal, although it is permitted to make minor updates or clarifications that do not substantively change the proposed DSC.

7.2.4 *Technical and Management Section (S4)*

The *Technical and Management Section* must be 25 pages or fewer in total with standard ROSES formatting rules. This page limit includes illustrations, tables, figures, and all sub-sections and must contain the following elements:

- Center Overview: DSC vision, potential for transformative impact in Solar and Space Physics, and potential for synergy within the science team
- Center Research Plan: Narrative consisting of the following:
  - A description of the research proposed in Phase I
  - The relevance of the proposed research to solar and space physics and the anticipated outcome.
  - A brief description of the contribution to be made to each Phase I DSC by the PI, PM, and each Co-I.
  - A justification for why the DSC mode of research is appropriate (compared with individual or collaborative awards)
  - A discussion of how the Phase I research efforts can lead to a much larger Phase II effort. A discussion of the needed expertise or skills for Phase II is appropriate, but it is not necessary to name specific individuals or institutions.
- Center Development and Management Plan: Narrative consisting of the

following:

- Description of how decisions will be made regarding the project
- The roles of internal leadership
- How individual research efforts will be integrated synergistically to achieve the Center's vision
- The coordination of the DSC effort and partnerships, including how new members of the center will be identified and integrated into the Phase II effort
- How the research and broadening impact programs will be monitored, evaluated and altered as needed
- The approaches to be used during the Phase I period to develop a strategic plan for the potential Phase II Center, including the development of center-wide data management, team communication, knowledge integration, and diversity plans.
- An external advisory board is optional during Phase I. Please do not name prospective members of the external advisory board and do not include letters of commitment from prospective members in the Phase I proposal.

- Broadening Impacts: For this Proposal broadening impacts refers to the components listed below. Since broadening impacts activities are part of the evaluation of merit (Section 8.2), proposers are strongly encouraged to include at least some of the activities listed below. This section should include a discussion of how selected activities will be integrated with the research and other activities of the DSC. The following integrative components include:
  - STEM engagement and future workforce development
  - Higher Education and/or Professional Development, including training of researchers in the terminology and challenges associated with discipline areas in the DSC outside their own, interdisciplinary mentorship of undergraduate, graduate, and postdoctoral students, and any other education activities.
    - Note: Each proposal that requests funding to support postdoctoral researchers should also include, as a supplementary document, a description of the professional development and mentoring activities that will be provided for such individuals.
    - Examples of postdoctoral mentoring activities include, but are not limited to: providing career counseling, training in proposal preparation, training in responsible professional practices, developing publications and presentations, providing guidance on techniques to improve teaching and mentoring skills, and providing counseling on how to effectively collaborate with researchers from diverse backgrounds and disciplinary areas.
  - Diversity and Inclusion: NASA is invested in attracting, developing, and leveraging the full spectrum of intellectual talent in the country. Diversity is defined as the similarities and differences in individuals representing more than one national origin, color, religion, socioeconomic stratum, and sexual orientation, etc. The strengths afforded by diversity in styles, ideas, and organizational contributions drive innovation, creativity and engagement. An important mechanism for enabling diversity is ensuring that the pipeline

leading to science and engineering careers affords equal opportunities to a diverse population of students.

- Outreach and Informal Science Communication, describing the DSC approach to communicating Solar and Space Physics research to public audiences and possible ways to evaluate the impact of these outreach efforts. Partnerships with informal science education organizations are encouraged.

7.2.5 *Data Management Plan (S5)*

NASA ROSES requires that most solicitations collect Data Management Plans (DMPs) with proposals. The DSC program element treats DMPs differently. Rather than collect DMPs in a plan text box on the NSPIRES cover page, the DMP is included in the proposal document in a special two-page section, entitled "Data Management Plan" immediately following the references and citations for the Scientific/Technical/ Management (S/T/M) portion of the proposal. A template is provided for the DMP as a downloadable docx file [link to page to download template].

The Data Management Plans (DMPs) describes how all center researchers will store, access, share and archive data, with emphasis on data- sharing across collaborative teams. This is a particularly challenging prospect as the center expands, so proposals should address features such as how each team member will gain access to data in real time, how data will be archived and validated and how, as the team expands, new members will be integrated into the data management plan in ways that enhance collaboration and synergy. New approaches to, and pilot activities, in data management are encouraged during Phase I. Note: Data management at the DSCs does not replace or supplant mission data archives that are in place or planned.

7.2.6 *References and Citations (S6)*

All references and citations given in the *Technical and Management Section* must be provided using easily understood, standard abbreviations for journals and complete names for books. It is highly preferred but not required that these references include the full title of the cited paper or report (Section 3.14 of the *NASA Guidebook*). Indicate with an asterisk (*) references co-authored by two or more proposal investigators.

7.2.7 *Biographical Sketches for PI, PM, and Co-Is (S7)*

The PI – the Director of the research institute – must include a biographical sketch (not to exceed two pages) that includes his/her professional experiences and positions and a bibliography of recent publications, especially those relevant to the proposed investigation. The PI's and PM's biographical sketch must clearly show how he/she meets the requirements for Center Director and Project Manager, respectively. A one- to two-page sketch for each Co-I must also be included. For the PI, PM, and any Co-Is who are required to provide Current and Pending Support information, the biographical sketch must include a description of scientific, technical, and management performance on relevant prior research efforts. Those participants who will play critical management or technical roles in the proposed investigation must demonstrate that their qualifications, capabilities, and experience are appropriate to provide confidence that the proposed objectives will be achieved. (see Section 3.15 of the *NASA Guidebook*).

7.2.8 *Current and Pending Support (S8)*

Proposers must follow the current and pending requirements provided in Table 1 of the *ROSES 2018 Summary of Solicitation*. Intellectual and materials overlap between any Federally funded projects or projects submitted for Federal funding and the proposed research must be clarified by discussing the relationship between this proposed project and each of the these other potentially overlapping Federal awards. For pending research proposals involving substantially the same kind of research as that being proposed to NASA in this proposal, the proposing PI must notify the NASA Program Officer identified in Section 11 of this program element immediately of any successful proposals that are awarded any time between the proposal due date and the date that NASA's selections are announced.

7.2.9 *Supplemental Documents (S9)*

Letters of Support from the owner of any necessary facility or resource that is not under the direct control of the PI or a Co-I may be included as needed.

7.2.10 *Facilities, Equipment and Other Resources (S10)*

This section catalogs the resources and facilities (including laboratories, computational facilities, data infrastructure and other tools that support collaboration) that will be made available to the project, including resources and facilities accessed through collaboration (Section 3.18 and Appendix C in the *NASA Guidebook*).

7.2.11 *Budget Justification Plan/Cost Proposal (S11)*

The maximum aggregate two-year budget for a Phase I DSC should not exceed $1.3M. The budget should include funding for center development activities (website, strategic planning, travel etc.) in addition to research and broader impact activities. The annual budgets can vary in amount. A detailed budget justification from the lead and each Co-I institution must document proposed expenses. Proposers must follow the budget format requirements from Section IV(b)(iii) and Table 1 of the *ROSES Summary of Solicitation (SoS)* and examples on the SARA website. Proposal funding restrictions are detailed in Section IV(d) of the SoS. Because NASA field centers receive direct funding, a maximum of 30% of the proposal budget is allowed to fund the NASA field centers.

8. DSC Proposal Evaluation Criteria

8.1 Phase I Step 1 - Evaluation Criteria

Step-1 proposals are required in this ROSES program element in order to make an initial assessment of relevance and feasibility. The evaluation focuses on the case made for the (1) vision for the center, (2) the science merit of the questions addressed, (3) the potential for significant progress in answering these questions, and (3) the reason that a center environment is needed for success.

8.2 Phase I Step 2 - Evaluation Criteria

The primary evaluation criteria for this program element are described in Section IV.(a) of the *ROSES Summary of Solicitation*. However, additional factors that will be included in the evaluation of Merit of proposals submitted in response to this program element are grouped below under each of the aspects of the definition of Merit found in

Appendix D of The *2018 NRA and CAN Proposers' Guidebook*.

The evaluation of the Scientific Quality of the proposed project will include:

- The extent to which the scientific vision commensurate with a center investment.
- The extent to which there the potential for transformative impact or innovation in solar and space physics.
- The extent to which the science question is poised for near-term significant advances.
- The extent ot which the the research plan is comprehensive in laying out interdependent research objectives with clear research goals, and the likelihood it will lead to significant progress in overcoming well-defined critical gaps or barriers to existing understanding, and lead to anticipated breakthroughs.

The evaluation of the Overall Technical Quality of the proposed project will include:

- The extent to which the proposal demonstrates a clear understanding of the state of the art, including appropriate leveraging of available knowledge and technologies outside of the DSC, and make a case for significant advances.
- The extent to which the proposal demonstrates a clear understanding of the primary risks, and the mitigation strategies to address them.
- The extent to which the center leadership and the management plan foster sound decisions regarding the project, including:
  - The roles of internal leadership and any external advisory groups
  - The ability to carry out careful internal evaluations of research and broadening impacts activities
  - Promotion and evaluation of synergy in center activities
  - Development and implementation of strategic plans (described in Section 10.1)
  - Allocation of resources; the ability to initiate new lines of research and terminate support for lower priority efforts
  - Communication throughout the center and with partners?
- The extent to which the milestones are realistic and illustrate the critical paths, contributions from research projects, interdependence of research activities, and research objectives consistent with the DSC vision.
- The extent to which there is a reasonable plan to develop clear (specific, measurable and attainable) metrics for milestones associated with critical path activities.

The evaluation of the Qualifications, Capabilities, and Experience of Personnel includes:

- The extent to which the PI demonstrated qualifications to lead a major research center and the PM qualifications to manage one.
- The extent to which the proposed team assembles the broad, deep and diverse mix of expertise and talent needed to best advance the DSC's vision and research objectives.
- The extent to which the levels of effort ascribed to the PI, PM, and Co-Is are realistic and reasonable for the scope of the proposed program.

The evaluation of Facilities, instruments, equipment and other resources or support systems includes:

- The extent to which the proposal demonstrates access to, or plans for, adequate facilities, computational resources, and data to conduct the proposed research.
- The extent to which there is evidence of the institutional commitment of the lead and partner organizations to the goals of the proposed Center.

In addition to these factors, the evaluation of DSC proposals will include mentoring and broadening impact activities (see Section 7.2.4 for more details). If reasonable plans for broadening impact activities are included in the proposal, the panel will evaluate this as a major or minor strength but not as a weakness if these plans are inadequate or absent. Since relevance to the NASA strategic plans is already described in this ROSES-18 funding opportunity, it is not necessary for proposals to show relevance to NASA's broader goals and objectives but, rather only to demonstrate relevance to the DSC program.

9. Review and Selection Processes

9.1 Proposal Review Process

Step-1 proposals will be checked for compliance. Those that are non-compliant may be returned without review. The PIs of Step-1 proposals will be encouraged to, or discouraged from, submitting Step-2 proposals based on internal review. NASA will notify the proposers of the results after the evaluation process is completed.

Submission of a Step-2 proposal is open only to those who have submitted a Step-1 proposal, but even proposals that have been discouraged may be submitted. Step-2 proposals will be evaluated by a review panel with input where appropriate from external reviewers based on the review criteria specified in Section 8.2. These reviewers will be asked to specifically address the innovative and frontier aspects of the science proposed as well as the DSC-appropriate nature of the project. Panelists and external reviewers will be scientific experts across the broad range of physics covered by the Step-2 proposals.

Proposers should be aware that, during the evaluation, NASA may request clarification of specific points in a proposal; if so, such a request from NASA and the proposer's response must be in writing. In particular, before finalizing the evaluation, NASA may request clarification on specific, potential major weaknesses that have been identified in the proposal. NASA will not enter into discussions with proposers. If NASA requests clarification it will do so in a uniform manner from all proposers. The ability of proposers to provide clarification to NASA is limited to a few types of responses:

- Identification of the locations in the proposal (page(s), section(s), line(s)) where the potential major weakness is addressed.
- Noting that the potential major weakness is not addressed in the proposal.
- Stating that the potential major weakness is invalidated by information that is common knowledge and is therefore not included in the proposal.
- Stating that the analysis leading to the potential major weakness is incorrect and identifying a placed in the proposal where data supporting a correct analysis

may be found.

- Stating that a typographical error appears in the proposal and that the correct data is available elsewhere inside or outside of the proposal.

The PI will be given time to respond to the request for clarification, which is nominally 48 hours. Any response that goes beyond a clarification in the above forms will be deleted and will not be shown to the evaluation panel.

9.2 Selection Procedure

The NASA program officer will recommend for selection proposals to the NASA Selection Official who will make the final decisions. NSF Program Officers will provide input during the preparation of the NASA selection recommendation documentation. As stated in the *ROSES Summary of Solicitation* (SoS), page SoS-39, the selection recommendation should generally be consistent with the peer review findings, unless there are programmatic and/or other considerations.

Notifications about funding decisions (both awards and declines) will be sent to each lead PI and submitting institution Authorized Organizational Representative via NSPIRES. Debriefs offering feedback to proposing teams will be provided consistent with the SMD Reconsideration Policy.

10. Award Administration

10.1 Award Reporting Requirements

The reporting requirements will be consistent with 2 CFR 1800.902 "Technical Publications and Reports" and Exhibit E - Required Publications and Reports of the NASA Grant and Cooperative Agreement Manual. Grants require annual and final technical reports, financial reports, and final patent/new technology reports. The following additional requirements will be incorporated into the DSC awards:

10.2 Strategic Plan and Program Evaluation Plan

10.2.1 *Strategic Planning Activities*

A major activity of a Phase I center is the development of a strategic plan. This plan cover all aspects of a DSC including research, team communication, deep knowledge integration, center management, center-wide data management, postdoc mentoring, and diversity. The complete strategic plan will be submitted to NASA as part of the first annual report. Developing a strong strategic plan may include consultation with strategic planning experts at the discretion of the PI. Phase I proposals will discuss their approach and timeline for strategic planning in their management plan section.

10.2.2 *Program Evaluation Plan*

NASA will provide instructions to PIs regarding how to develop a Program Evaluation Plan for the Phase II DSC by the end of Phase I that will mutually benefit the Agency and program participants. As part of developing this plan, DSCs should design metrics best suited to demonstrate progress in achieving broadly defined science goals and specific objectives. Metrics for DSC success would provide evidence of scientific impact. In addition to scientific publications and communications, other appropriate

types of metrics, include providing: high-value community resources, including models or model frameworks, model outputs, and value-added datasets; support of innovation, patents, and inventions; evidence of team formation and integration; community impacts such as student and postdoc involvement, degrees awarded, workshops, and opportunities for guest investigators and early career investigators represent appropriate types of metrics. Evaluation throughout the DSC lifetime by an external science center advisory group could be built into the process to ensure quality and give objective perspectives.

10.3 Kick-Off Meeting

The PI is required to organize a kick-off meeting to bring together the members of his/her Phase I DSC just after funding is awarded. The kick-off is meant to set the course and tone for the rest of the project. It is an opportunity to communicate the vision for the center, establish common goals and purpose throughout the team; to introduce the team members to each other; to provide information on each member's expertise, roles and responsibilities, and to create an understanding of the project background along with what success looks like, and what needs to be accomplished. It is also the opportunity to review, and possibly refine, the timeline and initial statement of work with the entire team, create a center-wide understanding of the flow of the project, the activities and their level of interconnectedness, define the outputs and deliverables that are anticipated, and possibly begin a discussion of potential risks and mitigation strategies. Lastly, this is the opportunity to introduce NASA and NSF representatives to the team and create a dialogue with them about, for example, the agencies' perspectives on what success means, on expectations, the scope of the project, details of reporting requirements, and any other issues the team would like to address. Another advantage of a well-designed kick-off meeting is that the free exchange of information establishes an atmosphere of openness that initiates and supports the process of forming a high-functioning team.

10.4 Web Presence

The DSC is expected to establish and maintain a web presence to communicate technical and programmatic results down to the project level, new discoveries and opportunities to the research community, and new discoveries to the public.

10.5 Data Accessibility and Public Disclosure of Results

As a Federal Agency, NASA requires prompt public disclosure of the results of its sponsored research to generate knowledge that benefits the Nation. It is NASA's intent that all knowledge developed under awards resulting from this Program Element be shared broadly. DSC award recipients will be expected to publish their work in peer-reviewed, open literature publications to the greatest extent practical. In keeping with the *NASA Plan: Increasing Access to the Results of Scientific Research*, terms and conditions about making manuscripts and data publicly accessible will be attached to awards that result from this Program Element.

11. Summary of Key Information

Expected total program budget for new awards	$4M
Number of new awards	~6
Maximum duration of awards	2 years
Due date for Step-1 proposal	See Tables 2 and 3 of this ROSES NRA
Due date for Step-2 proposals	See Tables 2 and 3 of this ROSES NRA
Start Date for new Awards	~6 months after Step-2 proposal due date
Page length for the Science-Technical-Management section of Step-1 proposals	6 pages, see Table 1 in Section 7.1
Page length for the Science-Technical-Management section of Step-2 proposal	25 pages, see Table 2 in Section 7.2
Relevance to NASA	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*.
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* at https://www.hq.nasa.gov/office/procurement/nraguidebook/
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
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	NNH18ZDA001N-DRIVE

Points of contact concerning this program	Janet Kozyra and James Spann Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Kozyra Telephone: (202) 875-3278 Kozyra Email: janet.kozyra@nasa.gov Spann Telephone: (202) 358-0574 Spann Email: jim.spann@nasa.gov

B.14 SECOND SPACE WEATHER OPERATIONS-TO-RESEARCH

NOTICE: Amended January 30, 2019. The proposal due dates for this program element were previously temporarily changed to "TBD" as a result of the partial government shutdown. This amendment releases new due dates for the effected program elements in Appendix B. For this program element the new Step-1 due date is March 12, 2019 and the new Step-2 due date is May 16, 2019.

Amended November 1, 2018. This amendment presents a second opportunity in Space Weather Operations-to-Research in ROSES-2018.

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 Authorized Organizational Representative (AOR), see Section 3.

Proposers to this program element will not provide a data management plan via the NSPIRES cover page question because it is part of the proposal content.

1. Introduction

In October 2015, the National Science and Technology Council (NSTC) in the Executive Office of the President released the National Space Weather Strategy (http://sworm.gov/publications/2015/nsws_final_20151028.pdf) and the National Space Weather Action Plan (Action Plan) (http://sworm.gov/publications/2015/swap_final__20151028.pdf). The objectives of the actions described in the Action Plan are to improve the understanding of, forecasting of, and preparedness for space weather events, recognizing the need for close cooperation among the federal agencies.

Action 5.5.2 in the Action Plan directs NASA, National Science Foundation (NSF), and Department of Defense (DOD) to identify and support basic research on space weather. Action 5.5.3 directs NASA, Department of Commerce (DOC), and DOD to identify and support research opportunities that address targeted operational space-weather needs. Actions 5.6.1 and 5.6.2 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 has established the Heliophysics Space Weather Science Applications program under which this second incarnation of the Operations-to-Research (H-SWO2R) program element resides. NASA is supporting this funding opportunity in coordination with DOC/National Oceanic and Atmospheric Administration (NOAA) and the National Science Foundation (NSF) to promote space weather operations-to-research (O2R) activities.

- For this opportunity, the objective of O2R is broadly defined as the joint pursuit of improvements of operational capabilities and advancements in related fundamental research.

NASA's role 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, instrument capabilities, and models; and support the transition of space weather models and technology from research to operations and from operations to research. Proposers interested in this program element are encouraged to see the overview of the Heliophysics Research Program in B.1 of this ROSES NRA.

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.

NSF's primary role in developing space weather readiness for the nation is in the support of basic research that advances fundamental understanding of space weather and related processes, specifically, the generation of solar storms, their propagation through the interplanetary medium, and the generation of disturbances in the near-Earth space environment and atmosphere. NSF-supported community members use that fundamental understanding in the development of models for these space weather processes, which draw on observations from NSF's persistent ground-based observational platforms, among others, to test and further refine our community's understanding. The goals of these NSF funded research activities are to benefit society and contribute to the achievement of specific, desired societal outcomes, such as improving space weather predictive capability.

The work carried out for this program should be in support of one or more NASA, NOAA, and/or NSF goals and objectives described above.

2. <u>Heliophysics Space Weather Operations-to-Research (H-SWO2R)</u>

For this opportunity, NASA, NOAA, and NSF have identified the following focus area for research and development to advance forecast models of energetic particles in the heliosphere:

- Improve forecasts of the energetic proton and/or heavy ion conditions in the heliosphere due to solar eruptions.

The primary goal of this funding is to support research by the grant recipient to improve numerical models and/or data utilization techniques that could advance forecasting capabilities and which could also lead to improved scientific understanding. Effective utilization of available data is encouraged. Employing data assimilation, ensemble, and/or machine-learning techniques is also encouraged.

Improved forecast capabilities could include, for example, forecasts of solar event probabilities and enhanced energetic particle levels one or more days prior to a solar eruption, as well as probabilities of event duration, peak flux levels, and integrated event fluence following the initiation of a solar eruption. Improved forecasts of solar energetic particles can support numerous applications, including human and robotic exploration beyond low-Earth orbit, satellite launch and on-orbit operations, aviation operations, and radio communication.

Proposals for this opportunity must define the products that will be developed and specify the product details, such as the forecast leadtime, cadence, flux thresholds, etc. Proposals must also define the metrics and validation methods that will be employed to evaluate the products. The products must have clear relevance to the focus area indicated above, and if possible, be directly related to decisions that are made and/or actions that are taken in anticipation of or in response to space weather. Proposers are strongly encouraged to include participants on their teams who are involved in industry or government-agency decisions based on the occurrence of solar energetic particle events.

Proposals involving software development must describe the software license for distribution of the software to be developed by the proposing institution(s). It is strongly encouraged that the software license allow the software to be made available free of charge for non-commercial use and that it permit modification and redistribution of the software free of charge for non-commercial use.

2.1 Programmatic Considerations

Given the unique nature of this opportunity to support operations to research (O2R), 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, and specifically to the focus area detailed above.

The total funding available in fiscal year (FY) 2019 for new proposals submitted in response to this solicitation is expected to be about $1.0M. This funding is expected to support at least five awards depending upon funds available. Proposals for more than two years will not be considered.

NASA will carry out the review process and the administration of the program. The final award selections will be made in consultation with the three agencies' program officers. An annual report and a final report will be submitted by each selected PI detailing the scientific results and an assessment of the value of the products developed based on the proposed metrics and, if possible, industry feedback. PIs are also encouraged to include recommendations for further research needed to improve product quality in the final reports.

3. Submission and Evaluation Guidelines

To streamline the proposal process (submission, evaluation, and administration), 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*.

A Step-1 proposal is required and must be submitted electronically by the Step-1 due date (see below and Tables 2 and 3 of *ROSES*). The Step-1 proposal must be submitted by the organization 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 Step-1 proposal title, science goals, and investigators (Principal Investigator, Co- Investigators, Collaborators, Consultants, and Other Professionals) cannot be changed between the Step-1 and Step-2 proposals. 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.

3.1 Step-1 Proposal Content

Proposers should refer to the "Instructions for Submitting a Step-1 Proposal" under "Other Documents" on the NSPIRES page for this program. 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:

- The science goals and objectives to be addressed by the proposal;
- The expected forecast products 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 H-SWO2R announcement.

The NSPIRES system for proposal submission requires that Step-1 proposals include a summary (i.e., abstract) describing the proposed work as outlined above. The proposal summary is entered directly into a text field in NSPIRES. 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 by responding to questions on the NSPIRES cover pages when creating the Step-1 proposal.

3.2 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 below and Tables 2 and 3 in the *ROSES Summary of Solicitation*). 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. The Step-2 proposal title, science goals, and investigators (Principal Investigator, Co-Investigators, Collaborators, Consultants, and Other Professionals) must be the same as those in the Step-1 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.

3.3 Step-2 Proposal Content

Step-2 Proposals should include a section titled Scientific/Technical/Management which includes clear descriptions of the following:

(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 (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 methodology, resources needed, and the technical approach to providing the proposed O2R-enabling enhancement;
(4) Plans to provide public access to the models, tools, and value-added products developed;
(5) The products that will be developed, the timetable for producing them, the metrics that will be used to evaluate them, and a description of the industry/government decisions that would benefit from the availability of these products.

For additional submission guidance, proposers are encouraged to reference the *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation* for further insights on preparation and submission of ROSES proposals. Otherwise, please contact the POC listed in Section 5 below.

3.4 Step-2 Proposal Formatting Requirements

Proposals that are not complaint with format requirements below may be rejected without review. See also Section IV(b)ii of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers* for further details.

- The Scientific/Technical/Management section must not exceed ten pages.
- Margins: no less than 1 inch on all sides, with a page size of 8.5 × 11 inches.
- Font: Times New Roman, 12-point or larger. If an alternate font is used, it must meet the requirement of having, on average, no more than 15 characters per inch.
- 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, on average, 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 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%. Expository text necessary for the proposal may not be located solely in figures or tables, or their captions.

Guidelines for submitting Step-2 full proposals, other than those listed above, are specified in the *NASA Guidebook for Proposers*. Where they conflict, the requirements above supersede those found in the Guidebook.

3.5 Evaluation Criteria

Compliant proposals will be evaluated according to the scientific and technical merit, the relevance, and the cost reasonableness. The assessment of relevance will be based on the proposed products, the metrics and validation methods to evaluate the products, the applicability of the products to the HSWO2R focus area, and the alignment of the research with the goals and objectives of the agencies and the O2R objective, as summarized in this program element.

In addition to the evaluation of Merit given in Appendix D of the *NASA Guidebook for Proposers*, the evaluation of the scientific and technical merit will include:

- The potential for improving forecasts of the energetic particle conditions in the heliosphere, and;
- The potential value of the proposed metrics to establishing the state-of-the-art and to measuring progress in specifying/forecasting the spacecraft environment.

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), as well as whether or not industry participation is included in the team. 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. Only necessary Co-Investigators and Collaborators should be included, and their specific roles in the investigation must be clearly described. Including relevant industry/government participants is encouraged.

4. Available Funds

It is anticipated that approximately $1.0M will be available in both Fiscal Year (FY) 2019 and FY 2020 to support this O2R opportunity. It is expected that combined 2-year budgets of most proposals will not exceed $400K.

5. Summary of Key Information

Expected program budget	See Section 4
Number of new awards pending adequate proposals of merit	Approximately five
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
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*
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 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	NNH18ZDA001N-2HSWO2R
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

APPENDIX C. PLANETARY SCIENCE RESEARCH PROGRAM

C.1 PLANETARY SCIENCE RESEARCH PROGRAM OVERVIEW

Table of Contents

1. Introduction 1
   1.1 CHANGES FROM RECENT YEARS 2
   1.2 PROGRAM ELEMENTS COVERED BY THIS OVERVIEW 2
2. Proposal Submission Processes 2
   2.1 NOI SUBMISSION PROCESS 2
   2.2 TWO-STEP SUBMISSION PROCESS 2
   2.3 FULL OR STEP-2 PROPOSAL SUBMISSION PROCESS 3
3. Requirements for Full Proposals 4
   3.1 PROHIBITION ON DUPLICATE PROPOSALS 4
   3.2 RESTRICTION ON FUNDING FOR MISSION-RELATED ACTIVITIES 5
   3.3 AWARD DURATIONS AND TYPES 5
   3.4 USE OF MISSION DATA 6
   3.5 DISCUSSION OF RELEVANCE 6
   3.6 DATA MANAGEMENT PLANS AND ARCHIVING 6
      3.6.1 Data Management Plans 6
      3.6.2 Data Archiving in the Planetary Data System (PDS) 8
   3.7 TABLE OF PERSONNEL AND WORK EFFORT 9
   3.8 PUBLICATION OF GEOLOGIC MAPS 9
      3.8.1 Program Elements Supporting Geologic Mapping 9
      3.8.2 Maps Published by the U.S. Geological Survey 10
   3.9 ACCESS TO THE ANTARCTIC 10
   3.10 ADDITIONAL FUNDING FOR RELEVANT INSTRUMENTATION CONSTRUCTION OR UPGRADE 11
   3.11 PLANETARY SCIENCE DIVISION EARLY CAREER FELLOWSHIP PROGRAM 11
   3.12 TOPICAL WORKSHOPS 11
4. Resources Available to Proposers 11
   4.1 DATA AND INFORMATION RESOURCES 11
   4.2 ASTROMATERIALS 13
   4.3 RESEARCH FACILITIES 13

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

NASA ROSES (Research Opportunities in Space and Earth Sciences) program element C.1 (Planetary Science Research Overview), this document, was substantially revised last year. Proposers are encouraged to read C.1 in its entirety. Several changes to program element C.1 are highlighted here:

- Section 3.1 includes a revised description regarding the prohibition of duplicate proposals.
- Updated information regarding Data Management Plans (DMPs) is provided in Section 3.6.1. Note the addition of: 1) the inclusion of astromaterials planned to be collected or purchased over the course of the research in the DMP and 2) software/code for possible inclusion in the DMP and a revised method for submitting DMPs as part of the main proposal.
- Program elements supporting the publication of geologic maps have been clarified (Section 3.8).
- Information pertaining to Planetary Major Equipment and Facilities (C.17), Early Career Fellowships (C.16 and C.21), and Topical Workshops, Symposia, and Conferences (E.2) has been added to program element C.1.
- The Habitable Worlds program is now a Cross-Divisional program with the Astrophysics Division (see program element E.4).
- 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.

1.2 Program Elements Covered by this Overview

This document pertains to all of the program elements in Appendix C of ROSES, as well as to the cross-divisional research program element E.4 Habitable Worlds, but not E.3 the Exoplanet Research Program.

2. Proposal Submission Processes

2.1 NOI submission process

Some program elements covered by program element C.1 request a Notice of Intent (NOI), which may or may not be mandatory. See Section IV(b)vi of the ROSES *Summary of Solicitation*.

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, most 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. No budget is required. Only proposers who submit a Step-1 proposal are eligible to submit a full, or 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 explicit 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 section of a Step-1 proposal is restricted to the 4000-character text box on the NSPIRES web interface cover pages. PDF attachments will not be accepted through NSPIRES for Step-1 proposals submitted to program elements covered by program element C.1.

A Step-1 proposal must cover the following topics:

- The goals and objectives to be addressed
- The approach and methodology to be used to address the goals and/or objectives
- 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 whether 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 relevance evaluation is independent of the Step-1 evaluation.

In rare cases, including the cases where the Step-1 proposal was not compliant with the requirements outlined above or the proposed work could not be funded due to NASA, SMD, or Planetary Science Division (PSD) policy, a Step-1 proposal may be declined. In these cases, a Step-2 proposal may not be submitted.

2.3 Full or Step-2 Proposal submission process

Full and Step-2 proposals are synonymous, with the term Step-2 mainly used in program elements that use the two-step submission process.

Table 1 within the NASA ROSES solicitation provides a checklist of required information to be included in full proposals. Proposers should also refer to the PDF entitled "Instructions for Submitting 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 the order of precedence guidelines described in Section I(g) of the ROSES *Summary of Solicitation*: *Guidebook* and ROSES instructions may be superseded or modified by this document (program element C.1) for all covered program elements,

and 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 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%. Expository text necessary for the proposal may not be located solely in figures or tables, or their captions.

3. Requirements for Full Proposals

3.1 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-2017 proposal may not be submitted in response to ROSES-2018).

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, then it is not considered to be a duplicate proposal. Such areas include:

- The proposing institution
- Funded investigators and unfunded Co-Investigators (Co-Is) who would perform a significant portion of the work
- Concepts, ideas, goals, and objectives
- Implementation (methods, approaches, instrumentation)

Changes to a proposed project or investigation that would not be considered substantive include aspects of the proposal that are not covered by the merit evaluation. Two proposals that differ only in these sections may be considered duplicates:

- Current and pending support section
- Relevance statement
- Budget section
- 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 whether changes to a proposal are substantial enough that is should 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.

3.2 Restriction on Funding for Mission-Related Activities

Unless otherwise specified in the program element, proposals containing work for a mission team member, or for a worker who will directly collaborate with a mission team, may not request funding that is intended to help the mission meet its science requirements or achieve mission success. These proposals may also not request funding for work that is close in scope to a mission's funded activities.

This restriction applies regardless of the mission team-member's or collaborator's role on the proposal (e.g., PI, Co-I, collaborator, postdoc, student) or role on the mission. It applies when the mission is in phases A through F, unless otherwise specified in the program element.

If a proposal includes workers on, or collaborating with, a mission team and contains work that is relevant to that mission, it must demonstrate how the tasks to be funded by the proposal do not violate this restriction. This demonstration should be included in the proposal's Budget Justification section and does not count against the page limit of the Scientific/Technical/Management section.

3.3 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.

3.4 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 submission deadline, unless otherwise specified in the program call.

3.5 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 program element C.1 require an explicit relevance statement be placed into a mandatory (4000-character) text box on the cover pages via the NSPIRES web interface. For those program elements that require it, this required relevance text 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 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.

Regardless of whether an explicit statement of relevance is required, all proposals will be evaluated for their relevance to the program element to which they have been submitted. Proposers are urged to consult the appropriate program element to which they are proposing for detailed information on whether an explicit relevance statement is required and/or how relevance will be evaluated.

3.6 Data Management Plans and Archiving

3.6.1 *Data Management Plans*

In order to broaden access to the results of NASA-funded research, proposals submitted to ROSES are required to 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, through a stable and long-term supported data repository.

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.7) program element includes the data management discussion in the body of the proposal. The instrument development, Early Career Fellowship and Planetary Major Equipment calls (Appendices C.12, C.13, C.16, C.17, C.21, and C.22) do not require DMPs.

Proposers requiring a Data Management Plan (DMP) are strongly encouraged to use the PSD DMP template, which may be downloaded as a word doc, 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 should immediately follow 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. 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 3.6.2 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 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 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 the code's use, 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 including plans to post code in GitHub will contain a Rights in Data clause reflecting this expectation.

New in ROSES 2018, the DMP should also cover any astromaterials planned to be collected or purchased over the course of the research. These include meteorites, micrometeorites, and cosmic dust. The DMP should demonstrate that any such astromaterials with scientific value 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. These might include analog materials collected or synthesized or analytical standards developed.

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 should 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.)

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 more information on DMPs, please see the Planetary Science Division Frequently Asked Questions (FAQs) on data management plans in ROSES, which will appear under "Other Documents" on the NSPIRES webpage for the Planetary Science Division program elements.

3.6.2 *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:

Document	Hyperlink
Proposer's Archive Guide	http://pds.nasa.gov/pds4/propose/proposing.shtml
Standards Reference	http://pds.nasa.gov/pds4/doc/sr/

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).

3.7 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 doc, 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 should distinguish between the effort to be funded by NASA and non-funded efforts. 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.

3.8 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.

3.8.1 *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) and uses data from planetary missions identified in a Data Analysis Program (DAP), then the proposal should be submitted to the appropriate DAP. Examples:

- MESSENGER-based Mercury maps: Discovery DAP (program element C.11)
- Lunar maps: Lunar DAP (program element C.8)
- Mars maps: Mars DAP (program element C.9)
- Dawn-based Vesta or Ceres maps: Discovery DAP (program element C.11)
- Cassini-based Saturnian satellite maps: Cassini DAP (program element C.10)
- Pluto and Charon maps: New Frontiers DAP (program element C.19)

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.7).

3.8.2 *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 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 in their Step-2 (full) proposal a Confirmation of Technical Specification document obtained from the USGS Map Coordinator. This document will identify (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. For the USGS Map Coordinator's contact information, please refer to http://planetarymapping.wr.usgs.gov/Page/view/Contacts.

3.9 Access to the Antarctic

Unless otherwise stated in a program element, Appendix C is no longer accepting proposals for work in Antarctica.

3.10 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 programs 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. Programs elements eligible for PMEF are listed in C.17:

3.11 Planetary Science Division Early Career Fellowship Program

The purpose of the Planetary Science Division (PSD) Early Career Fellowships (ECF) program (described in program elements C.16 and C.21) is to support the development of the individual research programs of outstanding scientists early in their careers and to stimulate research careers in the areas supported by PSD. 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, methods, and more.

Those seeking to be named fellows should see C.21, The New Early Career Fellowship Program, for information on the new fellowship application process and the criteria for evaluating candidates. Those who have already been named fellows (i.e., received an award letter for the proposal to which the ECF was appended) based on prior applications who are seeking start-up funds should refer to program element C.16 the Early Career Fellowship Start-up Program for Named Fellows.

3.12 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, of this NRA. 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

- 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 at 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 serves data from NASA's planetary missions and documentation sufficient 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.

- The National Space Science Data Center (NSSDC)

NSSDC archives digital and other data from historic and completed flight missions, and its archives are complementary to those of the PDS. Such 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, while 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.

- 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 at http://www.lpi.usra.edu.

- Regional Planetary Image Facilities (RPIFs)

RPIFs contain nearly half a million images of the planets and their satellites taken both from Earth and manned and unmanned spacecraft, as well as 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 listing of RPIF locations worldwide, can be found on the RPIF home page at http://www.lpi.usra.edu/library/RPIF.

- 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/, and Map-A-Planet, http://www.mapaplanet.org/);
- 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);
- Training in the generation of topographic data from stereo images (Photogrammetry Guest Facility, http://astrogeology.usgs.gov/facilities/photogrammetry-guest-facility);

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 E-mail laz@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 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.

- 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 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/.

- Planetary Aeolian Facility (PAL)

The Planetary Aeolian Facility at the NASA Ames Research Center consists of wind tunnels to simulate atmosphere-surface interactions on Earth, Mars and Titan. For more information, contact David Williams at David.Williams@asu.edu or find the PAL Guidebook for Proposers at:
http://rpif.asu.edu/documents/PAL_Proposers_Guidebook_2015_v6.pdf.

- 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).

- 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 in order 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).

- NASA Venus In-situ Chamber (VICI)

The Venus In-situ Chamber Investigations (VICI) is a NASA 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).

- NASA Glenn Extreme Environment Rig (GEER)

The Glenn Extreme Environment Rig (GEER) is a simulation rig designed to provide the scientific and engineering communities an asset to perform laboratory experiments and/or technology developments or instrument/hardware qualification in extreme 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 of cylindrical shape with interior dimensions of three feet in diameter and four feet long. The chamber is rated for pressures up to 100 bar at 500°C and eight individually controllable gas streams are available. Interested parties should contact Dan Vento (Daniel.M.Vento@nasa.gov) or 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 http://microgravity.grc.nasa.gov/SSPO/SS/Extreme/.

C.2 EMERGING WORLDS

NOTICE: June 6, 2018. The main point of contact for this Program Element is now Melissa Morris, see Section 5 Summary of Key Information.

March 13, 2018. This year the Planetary Science Division is particularly soliciting proposals that focus on the Moon, either directly or in comparison with other bodies. Pending the result of the FY 2019 federal budget and appropriations process, significant additional funds may be available for selections in this and other program elements through the Lunar Discovery and Exploration Program to fund relevant, lunar-focused science.

Since this may result in new proposals, the Step-1 due date for this program element has been delayed to April 12, 2018. The Step-2 due date remains unchanged at June 1, 2018.

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. Major interdisciplinary efforts to solve key questions are particularly valued. 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 and processes occurring in and affecting the protoplanetary disk, including those occurring on bodies of any size that may have formed at this stage of Solar System evolution.
- Studies related to the accretion of Solar System bodies after dissipation of the protoplanetary disk.

In addition, general studies of the formation of planetary systems are within the scope of Emerging Worlds, as long as a clear and cogent case is made that the research will result in increased understanding of the formation of our own Solar System.

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.

2.3 Programmatic priorities

Emerging Worlds prioritizes proposals 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.

Proposals that seek to acquire data or otherwise characterize Solar System objects, materials, or processes with the goal of enabling future work not detailed in the proposal will be considered low priority for selection.

The Emerging Worlds program values the potential of interdisciplinary efforts to solve key scientific questions. The extent to which the interdisciplinarity of the proposed project enhances the scientific impact, or the likelihood of success, will be taken into account by the selection official as programmatic factor.

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 to continue the work past the initial award period.

2.5 Demonstration of relevance

As stated in program element C.1, Section 3.5, 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 and to contact the appropriate Points of Contact with any questions.

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 a clear and cogent case that understanding the formation of such systems would 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 to determine potential relevance to that program element.

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 E.4).

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 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 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, since 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.18), 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*

Emerging Worlds does not fund ground- or space-based surveys. Proposals with an observational component must focus on the analysis and interpretation of the observations in order to understand the formation and early evolution of our Solar System. 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).

3.1.7 *Solar System Workings*

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).

3.1.8 *Planetary Data, Archiving, Restoration, and Tools (PDART)*

Some proposals that seek to acquire data or otherwise characterize Solar System objects, materials, or processes with the goal of enabling future work in Emerging Worlds or simply expanding knowledge of the early Solar System, but which do not directly address key problems of Solar System formation and early evolution, may be relevant to PDART (program element C.7).

3.1.9 *Studies of the Sun*

Emerging Worlds does not solicit proposals that focus 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 3.3, 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 four years of its existence (selections made from ROSES-2014 though ROSES-2017) averaged ~$160,000 per year, but with a wide range, depending on the nature of the work proposed. The 2014-2017 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 Fiscal Year (FY) 2019 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 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.

3.6. 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.

3.7 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.

3.8 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.

3.9 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.

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 and content requirements described in program element C.1 and in the *NASA Guidebook for Proposers*. See section 2.3 of 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*. In Emerging Worlds, the extent to which proposals directly address key problems in the origin and evolution of our Solar System, and the anticipated impact and significance of the proposed work on the field will be considered major components of the Intrinsic Merit score.

5. Summary of Key Information

Expected program budget for first year of new awards	~$4.6M
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 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*.
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 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	NNH18ZDA001N-EW
NASA points of contact concerning this program	**Melissa Morris [Added June 6, 2018]** Jeff Grossman Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1218 Email: HQ-EMERGINGWORLDS@mail.nasa.gov

C.3 SOLAR SYSTEM WORKINGS

NOTICE: Amended February 1, 2019. The proposal due date for this program element was previously temporarily changed to "TBD" as a result of the partial government shutdown. This amendment releases new due dates for the effected program elements in Planetary Science. For this program element the new proposal due date is April 2, 2019.

March 13, 2018. This year the Planetary Science Division is particularly soliciting proposals that focus on the Moon, either directly or in comparison with other bodies. Pending the result of the FY 2019 federal budget and appropriations process, significant additional funds may be available for selections in this and other program elements through the Lunar Discovery and Exploration Program to fund relevant, lunar-focused science.

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 2.5 of this program element. Proposals that do not fulfill these requirements 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

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).

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 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.7, 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).

Conferences, workshops, and symposia. Proposals for topical conferences, workshops, or symposia related to the Solar System Workings program may not be proposed through this program element. Proposers are encouraged to pursue such submissions through ROSES program element E.2, Topical Workshops, Symposia, and Conferences. Proposers should specifically identify the Solar System Workings program as the relevant SMD program element and refer to the goals and objectives of the Solar System Workings program in demonstrating relevance.

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 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.

2.5 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 NRA. An NOI is not required to submit a full proposal. Proposals are due by the date given in Tables 2 and 3 of this NRA.

Proposals must follow all formatting requirements 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.

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

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.

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 no longer accepting proposals for work in Antarctica.

5. Summary of Key Information

Expected program budget for first year of new awards	$9-10M
Number of new awards pending adequate proposals of merit	50-70
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 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. 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*.
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 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	NNH18ZDA001N-SSW
NASA points of contacts 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. Jennifer Heldmann Email: jennifer.heldmann@nasa.gov Mary Voytek Email: mvoytek@hq.nasa.gov Mitchell Schulte Email: mitchell.d.schulte@nasa.gov Jennifer Stern Email: jennifer.c.stern@nasa.gov Adrian Brown Email: adrian.j.brown@nasa.gov

C.4 HABITABLE WORLDS

NOTICE: The Habitable Worlds program is now a cross division program between Planetary Science and Astrophysics and may be found in program element E.4.

The Planetary Science Division point of contact concerning this program is:

Mitch Schulte
Planetary Science Division
NASA Headquarters
Washington, DC 20546
Telephone: (202) 358-2127
Email: mitchell.d.schulte@nasa.gov

C.5 EXOBIOLOGY

NOTICE: July 5, 2018. The point of contact (POC) for this program element has changed. The new POC is Lindsay Hays.

This program element no longer uses the two-step proposal submission process common in Appendix C. Instead, a Notice of Intent (NOI) is requested in place of a Step-1 proposal. NOI and proposal due dates are given in Tables 2 and 3 of ROSES.

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** ~~Roadmap~~, **[Corrected February 15, 2018]** 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 understand the planetary and molecular processes that set the physical and chemical conditions within which living systems may have arisen. A major objective is 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. 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 identification and characterization of signals and/or properties of extrasolar planets that may harbor intelligent life 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 understanding or characterizing nonradio "techno-signatures" from extrasolar planets that may harbor intelligent life are included in this area.

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 Astrobiology 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 Astrobiology program, but whose periods of performance expired in the last year or are expiring in the first half of this year.

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 (E.4).

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).

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 3.3 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 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 no longer accepting proposals for work in Antarctica.

2.12 Nexus of Exoplanet System Science

Although Exobiology does not solicit proposals specifically aimed at habitability, 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 (for example, conditions for the emergence of life) are eligible to be part of 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/.

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 3.6). 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 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 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 organization's AOR. Proposals 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 in the *NASA Guidebook for Proposers*. 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*.
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 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	NNH18ZDA001N-EXO
NASA point of contact concerning this program	**Lindsay Hays [Updated July 5, 2018]** Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 **Telephone: 650-604-3668** **Email: lindsay.hays@nasa.gov**

C.6 SOLAR SYSTEM OBSERVATIONS

NOTICE: March 13, 2018. This year the Planetary Science Division is particularly soliciting proposals that focus on the Moon, either directly or in comparison with other bodies. Pending the result of the FY 2019 federal budget and appropriations process, significant additional funds may be available for selections in this and other program elements through the Lunar Discovery and Exploration Program to fund relevant, lunar-focused science.

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

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. Additionally, SSO supports NASA's commitment to discover and inventory potentially hazardous near-Earth objects with sizes down to at least ~100 meters and to characterize that population through determination of their orbital elements. This program element will also consider proposals that characterize a representative sample of these objects by measuring their sizes, shapes, and compositions.

Suborbital investigations involving balloons, sounding rockets, or aircraft are not being solicited until further notice.

SSO contains two primary components: Planetary Astronomy and Near-Earth Object Observations.

1.1 Planetary Astronomy (PAST)

Planetary Astronomy proposals must contain as a primary element new observation of Solar System objects (excluding Earth and Sun) during the period of performance. They must also support NASA Solar System exploration objectives that are not being met by current spacecraft missions, or that would directly support specific flight missions, either in development or operations, but have not been planned by those missions. The proposals also must include scientific analysis and publication plans. Ground-based observations that complement NASA missions returning significant amounts of data within the next three years are especially encouraged. Such observations may be made at any currently operating ground-based facility, public or private, including those supported by NASA. Investigations proposing to use existing airborne or space-based assets are only permitted if those missions do not already 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 an element of new observation.

1.2 Near-Earth Object Observations (NEOO)

1.2.1 *NEO Survey and Characterization Proposals*

Near-Earth Objects (NEOs) are defined as asteroids or comet nuclei whose perihelia are less than 1.3 AU. The NEOO Program has as a goal to discover all potentially hazardous NEOs with sizes down to at least ~100 meters and to characterize that population through determination of their orbital elements, with the goal of detecting more than 90 percent of this population, as soon as is feasible. In support of NASA's commitment and goal, this program supports NEO investigations whose primary objective is to complete the inventory of the population of NEOs with sizes greater than 100 meters.

In order to help achieve this inventory of NEOs, NASA seeks investigations that promise a sustained, productive search for NEOs and/or obtain follow-up observations of sufficient astrometric precision to allow the accurate prediction of the trajectories of all discovered objects. NASA will also consider within this program proposals that characterize a representative sample of these objects by measuring their sizes, shapes, body dynamics, and compositions.

In addition to this goal, the NASA Human Exploration and Operations Mission Directorate and Planetary Science Division have established an interest for the NEOO Program to search for Near-Earth Asteroid (NEA) targets that provide Human Spaceflight accessible and/or robotic mission destinations. Therefore, investigations that provide capability to detect and more fully characterize the NEAs that are in low delta velocity orbits relative to Earth are of particular interest.

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. In particular, the internationally recognized archive for these data is the International Astronomical Union (IAU) sanctioned Minor Planet Center, currently located at the Harvard Smithsonian Astrophysical Observatory (see http://minorplanetcenter.net/).

1.2.2 *Proposals for Impactor Characterization and 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.

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

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 using the Goldstone radar, which must be included in the proposal.

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

2.3 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.

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

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.

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 in the *NASA Guidebook for Proposers*. 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 (PAST) ~$2.5M (NEOO)
Number of new awards pending adequate proposals of merit	~8-10 (PAST) ~10-12 (NEOO)
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*.
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 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	NNH18ZDA001N-SSO
NASA point of contact concerning this program	Kelly E. Fast Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0768 Email: kelly.e.fast@nasa.gov

C.7 PLANETARY DATA ARCHIVING, RESTORATION, AND TOOLS

NOTICE: March 13, 2018. This year the Planetary Science Division is particularly soliciting proposals that focus on the Moon, either directly or in comparison with other bodies. Pending the result of the FY 2019 federal budget and appropriations process, significant additional funds may be available for selections in this and other program elements through the Lunar Discovery and Exploration Program to fund relevant, lunar-focused science.

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.

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 2.1 of this program element. Proposals that do not fulfill these requirements 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 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 publically 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). 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 theoretical 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 whose work effort is 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 solicitation 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 solicitation. 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.7 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 2017 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.

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 in the *NASA Guidebook for Proposers*. 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 data or otherwise use such mission 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

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 the *NASA Guidebook for Proposers*, a letter of support may be required from any facility required for the proposed effort that is not under the direct control of the proposal's PI or Co-I's.

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.

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' information on and requirements for map production and publication.

5. Summary of Key Information

Expected program budget for first year of new awards	~$2-2.4M
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 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. See Section 2.1
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 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	NNH18ZDA001N-PDART
Points of contact concerning this program all of whom share the following postal address: Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001	Sarah Noble – Lead Discipline Scientist Telephone: (202) 358-2492 Email: sarah.noble-1@nasa.gov Adrian Brown – Discipline Scientist Telephone: (650) 604-0297 Email: adrian.j.brown@nasa.gov Meagan Thompson – Discipline Scientist Telephone: (202) 358-1733 Email: meagan.thompson@nasa.gov

C.8 LUNAR DATA ANALYSIS PROGRAM

NOTICE: Amended February 1, 2019. The proposal due date for this program element was previously temporarily changed to "TBD" as a result of the partial government shutdown. This amendment releases new due dates for the effected program elements in Planetary Science. For this program element the new Step-2 proposal due date is now March 29, 2019.

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

1.1 Program Overview

The Lunar Data Analysis Program (LDAP) program funds research on the analysis of recent lunar missions in order to enhance their scientific return. LDAP broadens scientific participation in the analysis of mission data sets and funds high-priority areas of research that support planning for future lunar missions.

LDAP supports scientific investigations of the Moon using publicly available (released) data. These include the following missions:

Lunar Crater Observation and Sensing Satellite (LCROSS),
Moon Mineralogy Mapper (M3),
Lunar Reconnaissance Orbiter (LRO),
Gravity Recovery and Interior Laboratory (GRAIL),
Acceleration, Reconnection, Turbulence, and Electrodynamics of the Moon's Interaction with the Sun (ARTEMIS),
Lunar Atmosphere and Dust Environment Explorer (LADEE),
Lunar Prospector (LP),
Deep Impact Lunar Flyby,
Non-U.S. missions: Kaguya, Chang'e 1, Chang'e 2, Chandrayaan-1, Chang'e 3.

Any proposal may incorporate the investigation of data from more than one mission.

An investigator may propose a study (e.g., scientific, landing site science, cartographic, topographic, geodetic research, etc.) based on analysis of lunar data collected by spacecraft at the Moon (listed above). Proposals may incorporate the analysis of data from more than one mission. Moreover, data analyses that require the use of older mission data sets (e.g., Apollo, Clementine) are allowable in the context of enhancing the analysis and understanding of the data from the missions listed above. The use of older data sets as complementary/supplementary data sets to the missions listed above for the purpose of creating a needed data product (e.g., maps) for analysis is allowable. 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.

LDAP solicits proposals that enhance the scientific return of lunar missions through the use of mission data. Tasks responsive to this call include 1) data analysis tasks, 2) non

data-analysis tasks 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 studies, correlative analyses, and/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. All proposals must include a complete science investigation. 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. Proposals whose principle objective is the production of data products for use by other researchers are appropriate for submission to program element C.7 Planetary Data Archiving, Restoration, and Tools (PDART).

Investigations are welcome in the following high priority areas of lunar research:

- Identification and/or characterization of potential landing sites of high lunar science return (e.g., geomorphology, regolith, radiation, and compositional properties);
- Modeling of the lunar gravitational field, global topography, and global lunar figure;
- Enhancement of the lunar geodetic network to enable precision lunar landing;
- Identification, distribution, transport, and characterization of volatiles in and on the Moon;
- Determination of the size and state of the lunar core;
- Determination of lunar lithospheric thickness;
- Lunar "change detection" (i.e., detection of surface or atmospheric changes as a function of time);
- Characterization of the global variability and structure of the lunar exosphere and/or dust environment;
- Identification/characterization of lunar mineralogy as a function of location and depth.

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.

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.

Investigators interested in proposing mostly theoretical, modeling, laboratory, or field studies that do not directly use spacecraft data are advised that such studies are not appropriate for LDAP, but may be suitable for submission to the C.2 Emerging Worlds or C.3 Solar System Workings Programs.

1.2 Sources of Information and Data

The LDAP program supports research investigations relevant to the scientific interpretation of lunar mission data that are now in the public domain. LDAP supports investigations that use only publicly available and released data. Data to be used in proposed 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 submission due date for LDAP Step-2 proposals. Spacecraft data that have not been placed in the public domain 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 publically available archive) subsequent to 30 days prior to the LDAP submission date.)

Whether from the PDS or another source, if the data to be analyzed are not certified or otherwise have issues that might represent an obstacle to analysis, the obligation is on the proposer to clearly demonstrate that such potential difficulties can be overcome. Likewise, this requirement applies to proposals that make use of planetary data from international missions that do not have their data deposited in the PDS.

In all cases, it is the responsibility of the LDAP investigator to acquire any necessary data; therefore, before submitting a proposal, proposers must demonstrate in their proposal that the necessary data are available. Proposers who wish to use photographic and cartographic materials may access such data through the nearest Regional Planetary Image Facility (RPIF). RPIF locations are listed on the RPIF home page at http://www.lpi.usra.edu/library/RPIF.

1.2.1 Flight Team Member Requirements

Members of current spacecraft flight teams who wish to apply to the LDAP program 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 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 within their respective mission. This requirement applies to all members of the proposal team.

1.3 Data Products and Data Archiving and Map Publication

Investigators may propose to produce data products (e.g., cartographic products, such as geologic, topographic, or mineral maps, and/or calibration data). Such investigations must have associated scientific tasks. Proposers interested in producing data products that do not have associated scientific tasks are directed to the Planetary Data Archiving Restoration and Tools Program (program element C.7 PDART). 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.

A plan for archiving and making products readily available must be included in any proposed investigation that will result in the production of data products. NASA reserves

the option to require the archiving in the Planetary Data System (http://pds.nasa.gov/) of any data products resulting from LDAP selected proposals.

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 of the Scientific/Technical/ Management portion of the proposal.

Proposers should refer to the most recent versions of the following documents for information on PDS compliance:

Document	Hyperlink
Proposer's Archive Guide	http://pds.nasa.gov/documents/pag/index.html
Standards Reference	http://pds.nasa.gov/pds4/doc/sr/

Additional information on the PDS may be obtained from the following individuals:

Contact	Title	Email
William Knopf	Program Executive	william.knopf-1@nasa.gov
Thomas Morgan	Project Manager	thomas.h.morgan@nasa.gov

2. Programmatic Information

2.1 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.

2.2 NASA Provided High-End Computational (HEC) Facilities

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 this program 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.

2.3 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.

2.4 Duration and Size of Awards

The maximum duration of awards from C.8 is four years (not including no cost extensions). It is anticipated that most proposals will seek funding for up to three years. Proposals seeking funding for 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. Please refer to program element C.1, section 3.3, for instructions on submitting requests for more than three years.

Since this is a new program with a new scope, the budget and expected number of new awards is somewhat uncertain, as it may depend on the distribution of topics proposed and the number of proposals submitted. As always, the number of new awards will also depend on the available budget for next Fiscal Year.

The average award size from this program in ROSES-2014 through 2016 was $100K-120K per year, but with a wide range, depending on the nature of the work proposed. When the 2017 LDAP selections are made, that data will be contained on a spreadsheet on the SARA grant stats web page. Proposers are encouraged to request specifically what is needed to conduct the proposed research.

2.5 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. Summary of Key Information

Expected program budget for first year of new awards	~$1.3M
Number of new awards pending adequate proposals of merit	See Section 2.4
Maximum duration of awards	Four years, but see also 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	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 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*.
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 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	NNH18ZDA001N-LDAP
NASA points of contact concerning this program	Robert A. Fogel Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-2289 Email: rfogel@nasa.gov

C.9 MARS DATA ANALYSIS

NOTICE: This program element takes proposals via a two-step proposal submission process described in Section 2 of C.1 The Planetary Science Division Research Program Overview.

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 these requirements 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: 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) nondata-analysis tasks that are necessary to analyze or interpret the data, and 3) nondata-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. 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).
- Improved models for the Mars gravity field and global topography and planetary figure.
- Improvement of the geodetic network of Mars for precision landing.
- Analysis and comparison of Mars orbital and surface data to increase the predictive accuracy of surface characteristics of Mars from orbit.

The Mars Data Analysis Program is particularly interested in receiving proposals to analyze the extensive, but underutilized, gamma ray and neutron datasets from the Mars Odyssey mission. Many years worth of data from the neutron detector and the neutron and gamma ray spectrometers are available on the Geosciences Node of the Planetary Data System (PDS).

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-submission rule (above). 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.7 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).

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 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.

2.4 Data Management Plans (DMPs)

Program element C.1, section 3.6, 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 what 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 submission 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 publically available archive) subsequent to 30 days prior to the MDAP 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. 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

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 the *NASA Guidebook for Proposers*, 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 3.8, 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 in the *NASA Guidebook for Proposers*. 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	~ 20-25
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 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. See 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* 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	NNH18ZDA001N-MDAP
NASA points of contact concerning this program	Mitch Schulte Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-2127 Email: mitchell.d.schulte@nasa.gov Adrian Brown Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Email: adrian.j.brown@nasa.gov

C.10 CASSINI DATA ANALYSIS PROGRAM

NOTICE: Amended July 13, 2018. The use of data from the Planetary Data System's Cassini Data Release 54 has been excluded from use in this program element. Due to inconsistencies in the posted and communicated scheduled release date(s) for these data that were not recognized until after the Step-1 due date, the use of Data Release 54 is excluded from this program element. However, this amendment also creates a second Cassini Data Analysis Program Element in C.26 for proposals that require the use of those data. The due date for Step-2 proposals to this program element has been delayed to August 14, 2018 to allow proposers extra time to ascertain to whether it is more appropriate to submit to this program element or C.26. New text is in bold 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.

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 these requirements may be returned without review.

The scope of this program was clarified and slightly modified in ROSES-2016. Proposers are expected to carefully read the solicitation and should email the program point of contact with any questions sufficiently ahead of the Step-1 proposal deadline.

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 nonmission 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 utilizing 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. Science investigations may include the use of data from any spacecraft not supported by a separate Planetary Science Division Data Analysis Program and may contain outer solar system comparative planetology studies that require the use of Cassini data for at least one of the bodies of focus.

All proposals to CDAP must identify and address a clear objective with science research that would be a significant, not incremental, advance in the state of knowledge of the

research topic. Tasks responsive to this call include 1) data analysis tasks, 2) nondata-analysis tasks that are necessary to analyze or interpret the data, and 3) nondata-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. 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.

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 3.6 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 http://pds.nasa.gov/documents/pag/index.html. 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. Each research proposal must constitute a stand-alone scientific investigation, with stated lines of inquiry, and result in one or more peer-reviewed publications.

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.7. Planetary Data Archiving, Restoration, and Tools (PDART) program.

Proposals that use non-Cassini mission data that is supported by another Data Analysis Program will be evaluated as not being responsive to this solicitation and must rather be submitted to a more appropriate program element. Proposers are encouraged to read the other program elements in Appendix C.

Proposals that use Cassini mission data from the PDS Cassini Data Release 54 are not responsive to this solicitation and must rather be submitted to C.26, Cassini Data Analysis Program: PDS Cassini Data Release 54. This exclusion affects all data products in Release 54, regardless of when the data were publicly available via the PDS. Proposers are referred the relevant PDS Node to determine whether their proposal is affected by this exclusion. Any proposal submitted to this solicitation that uses data from Release 54 is non-compliant and will be declined for funding. [Added July 13, 2018]

2.2 Relevance Statement Requirement

Proposals to this program element must discuss relevance 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.

2.3 Expected Budget and Number of New Awards

On release of ROSES-2018 the expected program budget for new awards for C.10 Cassini Data Analysis Program was given as $2.5 M/Year, and 12-20 new awards were anticipated. The split of the ROSES-18 Cassini Data Analysis Program into two program elements means that the available budget will be split as well. The allocation of funds between these two program elements is expected to be proportional to the number of highly rated proposals submitted to each. Due to flexibility in the fiscal year phasing of the CDAP budget, the total amount available for new starts for both program elements may exceed $2.5 M/Year, if warranted by the number of highly meritorious proposals. [Added July 13, 2018]

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 3.4.

- 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

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).

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 Archiving and Map Publication

Proposals submitted to this program element must include a Data Management Plan (see C.1, Section 3.6). This 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.

Selected investigations may result in data products and software tools that are of broad use to the science community, including maps, data with improved calibrations, etc. NASA strongly encourages that such data be archived in the Planetary Data System (http://pds.nasa.gov/), or equivalent public archive, by the end of the award period. Proposers are advised to read C.1 The Planetary Science Division Research Program Overview, for information on including an archiving plan in the proposal.

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 3.8, for the USGS information on and requirements for map production and publication.

4. The Two-Step Submission Process

This program element uses the two-step proposal submission process outlined 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 in the *NASA Guidebook for Proposers*. Violation of these rules is sufficient grounds for a proposal to be rejected.

5. 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 that tied to the submission of a parent science proposal.

6. Summary of Key Information

Expected program budget for first year of new awards	**See Section 2.3 [Changed July 13, 2018]** ~~~$2.5 M/Year~~

Number of new awards pending adequate proposals of merit	**See Section 2.3 [Changed July 13, 2018]** ~~~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 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. See 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* 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	NNH18ZDA001N-CDAP
NASA point of contact concerning this program	Max Bernstein Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Email: HQ-CDAP@mail.nasa.gov Telephone: (202) 256-0879

C.11 DISCOVERY DATA ANALYSIS

NOTICE: 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

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 submission deadline 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. Datasets to be used in the proposed work must be clearly and specifically identified in the proposal. NASA puts no other restriction on the status or condition of the data. However, regardless of the archive(s) used, if the data to be analyzed have known issues that might represent an obstacle to analysis, the proposers must demonstrate clearly and satisfactorily how such potential difficulties will be overcome. In other words, it is the proposer's responsibility to demonstrate clearly that the public data are of sufficient quantity and quality to achieve the project's science goals.

The Discovery Missions for which archived data are available are:

- NEAR
- Stardust
- Genesis
- Deep Impact
- MESSENGER
- Dawn
- Kepler/K2

The Discovery Missions of Opportunity for which archived data are available are:

- EPOXI
- Stardust-NExT

Proposals focusing on data returned from Mars Pathfinder and ASPERA-3 should be submitted to the Mars Data Analysis Program (MDAP, program element C.9). Proposals focusing on data from GRAIL, Lunar Prospector, and the Moon Mineralogy Mapper (M3) should be submitted to the Lunar Data Analysis Program (LDAP, program element C.8). Proposals concerning Kepler/K2 observations of objects outside the Solar System

should be submitted to the Astrophysics Data Analysis Program (ADAP, program element D.2). The proposals described in this paragraph are not responsive to the DDAP solicitation.

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.7. 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.

It is the responsibility of the proposers to DDAP to specifically identify any needed data and to ascertain that these data are available. Proposals should provide convincing evidence that the data have sufficient quality and are available in sufficient quantity to achieve the goals set forth in the proposal. The proposer should demonstrate a familiarity with the data and an understanding of the work required to refine the data for the purposes of the analysis.

1.2. Archiving of Data Products

Data products produced by funded DDAP 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 http://pds.nasa.gov/documents/pag/index.html. 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.

1.3 Program Exclusions

The Discovery Data Analysis Program is not intended to overlap other active program elements. Therefore, as noted above, the 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.19);
- Data from Rosetta (see RDAP, C.20);
- Data from Kepler/K2 on objects outside the Solar System (see ADAP, D.2).

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 (which are supported by other NASA programs); 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 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 (i.e., Solar System Workings or Emerging Worlds), it should be submitted to that Core Program.

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 Discovery Program 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-submission 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.

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 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.

3.2 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.

3.3 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.

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 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.

4.3 Facilities and Data Sources Available to Proposers

Proposers are 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 the *NASA Guidebook for Proposers*, a letter of support may be required from any facility required for the proposed effort.

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.

5. 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	~10-13
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 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*.
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 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	NNH18ZDA001N-DDAP
NASA 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: 202-358-0272

C.12 PLANETARY INSTRUMENT CONCEPTS FOR THE ADVANCEMENT OF SOLAR SYSTEM OBSERVATIONS

NOTICE: August 24, 2018. The main planetary science point of contact for this program element is now Stephen Rinehart, see Section 5 Summary of Key Information.

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. 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 to develop instruments that can function in icy moon environments are particularly encouraged. See Section 1 for more details.

Proposals shall include an entry Summary Chart submitted as a separately uploaded appendix to the Step-2 proposal. See Section 2.1 for more details.

Progress reports are due Semi-Annually. See Section 2.4 for more detail.

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 show promise for use in future planetary missions in support of 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 Discovery, New Frontiers, Mars Exploration, and other planetary programs, including those flown on commercial spacecraft). The objective of the program is to develop low TRL instruments 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. As such, the entry technology readiness level (TRL) that PICASSO supports is 1-3. Proposals where the entry TRL is 4 or higher are not appropriate for the PICASSO, but should be submitted to program element C.13. MatISSE. In most cases that will mean demonstrating that meeting key performance targets is feasible. 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. 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.

Proposals to develop instruments that can function in icy moon environments are particularly encouraged. Needs have been identified to:

- Detect regions of concentrated potential biological materials from orbit
- Extract samples from plumes and cryogenic ices
- Process samples from their native solid and liquid matrices
- Characterize potential biopolymers
- Detect ultralow concentrations of microorganisms
- Detect chemical processes indicative of potential life

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 Earth orbital instruments for astronomical or astrophysics space observations. Instrument systems that have already demonstrated key performance targets can be proposed to the MatISSE program (C.13) 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.

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), Planetary Instrument Definition and Development Program (PIDDP), Astrobiology Science and Technology for Instrument Development (ASTID), and 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 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 will be given priority.
- The science objectives of the proposed instrument or component technology. The relationship between the science objectives and the instrumental 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 Technology Readiness Level and a detailed plan for raising the instrument system to the proposed exit Technology Readiness Level. The plan must include a description of milestones, as well as discussions of how the proposed research will advance the Technology Readiness Level 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.

- An entry level Summary Chart, not counted in the page limit, shall be submitted as an appendix to the Step-2 Proposal. A template will be sent to each Step-1 proposer. The Summary Chart shall contain 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 major objectives of proposed work
  - Co-Investigators (Co-Is)/Institutions
  - A figure illustrating and clarifying the proposed concept
  - Top level Milestones
  - Entry and exit technology readiness levels (TRL)

2.2 Additional Selection Considerations

In addition to the criteria specified in Section C.2 of 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;

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 Research and Technology Operating Plans (RTOP) to NASA centers, including JPL, or grants to other institutions.

2.4 Technical Reporting Requirements

Once awarded, all Progress Reporting deliverables applicable to this PICASSO solicitation shall be submitted to the web-based Planetary Science (PS) Award Administration eBook. A user account on the PS eBook 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 eBook will be established. To create an IdMAX account, some personal information will be required. All submissions shall be made in PDF format, except that the quad chart shall be submitted in Power Point.

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 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 at the end of the first six-month calendar period commencing from the date of award and at six-month intervals

thereafter. Grant recipients will have additional progress reporting requirements from 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. 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-Investigators (Co-Is)/Institutions
- A figure illustrating and clarifying the proposed concept
- Exit technology readiness level (TRL)

The written Final Report, Accomplishments Chart, and updated TRL assessment shall be E-mailed to the NASA Program Officer on or before the designated anniversary date. An Accomplishment Quad Chart template can be obtained from the NASA Program Officer for this program.

2.5 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.

2.6 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 award but may extend beyond it. Proposals from potential Fellows must be submitted through the standard NPP process. The PICASSO Program expects to select no more than two Fellows associated with Planetary Science or Astrobiology Instrument Development each year. More information about the NASA Postdoctoral Program may be found at http://npp.usra.edu/.

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 eBooks is highly encouraged.

3.1 Facilities Available to Proposers

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 the *NASA Guidebook for Proposers*, 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 in the *NASA Guidebook for Proposers*. 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 at the end of the Step-2 Proposal. 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	~$3.5M
Number of new awards pending adequate proposals of merit	~12 awards
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 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*.
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.
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	NNH18ZDA001N-PICASSO

Main NASA point of contact concerning this program **[updated August 24, 2018]**	**Stephen Rinehart** **Planetary Science Division** **Science Mission Directorate** **National Aeronautics and Space Administration** **Washington DC 20526-0001** **Telephone: 301-286-4591** **Email: stephen.a.rinehart@nasa.gov**
Other NASA 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 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: Added February 27, 2018. Instruments advancing lunar science suitable for small landers, including those of commercial providers, should be submitted to the DALI program, whereas those with a broader scope should be proposed to MatISSE. Proposers considering submissions to both programs are strongly encouraged review the prohibition on duplicate proposals guidance in Section 3.1 of C.1 Planetary Science Research Program Overview.

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 shall include an entry Summary Chart placed at the end of the 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 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 Science Plan for NASA's Science Mission Directorate 2007-2016 (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. 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, 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), Planetary Instrument Definition and Development Program (PIDDP), Astrobiology Science and Technology for Instrument Development (ASTID), and 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 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 will be given priority.
- 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. Proposers must identify potential mechanisms that could facilitate transfer of these technologies to other users, including the private sector, for possible application beyond the immediate one of meeting mission science objectives.
- 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.
- 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 an appendix on the last page of the Step-2 Proposal. A template will be sent to each Step-1 proposer. The Summary Chart shall contain the following information:
  - Title, Principal Investigator (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 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 (TRLs)

2.2 Additional Evaluation Considerations

In addition to the criteria specified in Section C.2 of the *NASA Guidebook for Proposers,* the following will also be considered when evaluating the relevance, merit, and cost reasonableness, and when formulating MatISSE selection recommendations.

- The extent to which the proposed instrument is applicable to multiple Planetary Science missions;
- 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;

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. While in most cases awards will be in the form of grants, when appropriate fixed price contracts will be issued.

2.4 Technical Reporting Requirements

Once awarded, all Progress Reporting deliverables applicable to this MatISSE solicitation shall be submitted to the web-based Planetary Science (PS) Award Administration eBook. A user account on the PS e-Book 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 e-Book 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*

Within 15 days of award, the PI shall provide an updated project plan and budget. The updated project plan and budget is only required if the selected proposal has been de-scoped. The project plan (if applicable) shall be emailed to the NASA Program Officer for this program.

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 Planetary Science (PS) eBook starting on the third-month anniversary date of the signing of the award vehicle. All awardees will receive a PS eBook 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 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 PS eBook 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 PS eBook and 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 investigators 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 PS eBook 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

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.

2.6 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 award but may extend beyond it. Proposals from potential Fellows must be submitted through the standard NPP process. The MatISSE Program expects to select no more than two Fellows associated with Planetary Science or Astrobiology Instrument Development. 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 Appendix C.1, Section 3.3. 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

Proposers are advised to read Section 4 of Appendix 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 2.3 of the *NASA Guidebook for Proposers*, 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 Appendix C.1 and the *NASA Guidebook for Proposers*. 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 Chapter 2 of 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*.
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 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	NNH18ZDA001N-MATISSE

NASA point of contact concerning this program	Rainee Simons MatISSE Program Officer Planetary Science Division Science Mission Directorate National Aeronautics and Space Administration Washington DC 20526-0001 Telephone: 216-789-0237 Email: rainee.n.simons@nasa.gov
NASA 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 Program may be addressed to: Michael H. New Lead Discovery Program Scientist Telephone: 202-358-1766 Email: michael.n.new@nasa.gov Questions concerning 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 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 on August 16, 2018. This amendment announces that this program element will not be solicited this year. It is anticipated that PSTAR will be solicited in ROSES-2019.

March 13, 2018. This year the Planetary Science Division is particularly soliciting proposals that focus on the Moon, either directly or in comparison with other bodies. Pending the result of the FY 2019 federal budget and appropriations process, significant additional funds may be available for selections in this and other program elements through the Lunar Discovery and Exploration Program to fund relevant, lunar-focused science.

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) or C.13 The Maturation of Instruments for Solar System Exploration (MatISSE) 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. Points of Contact

NASA 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: February 28, 2019. This year this program element is especially soliciting proposals that focus on advancing planetary protection research and technology development for planetary missions to icy satellite surfaces, in particular in support of a Europa Lander mission. Up to three additional projects in support of icy satellite surface technology development and/or a Europa Lander mission may be selected. The expected program budget and estimated number of new awards in Section 5 have been updated. New text is in bold.

Amended on February 8, 2019. This amendment solicits proposals to program element C.15 Planetary Protection Research, which had previously been listed as "not solicited this year". Notices of Intent are requested by April 12, 2019 and proposals are due by May 10, 2019.

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 submission of an NOI. NOI and proposal due dates are given in Tables 2 and 3 of ROSES.

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 2.5 of this program element. Proposals that do not fulfill these requirements may be returned without review.

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. Programmatic Information

2.1 General Information

Proposers are strongly advised to read C.1 The Planetary Science Division Research Program Overview, for information on the new mandatory data management plans.

2.2 Program Exclusions

Proposals are sought for new projects in planetary protection that are not within the scope of the Exobiology (see C.5), Planetary Data Archiving, Restoration, and Tools (see C.7), Planetary Instrument Concepts for the Advancement of Solar System

Observations (see C.12), Maturation of Instruments for Solar System Exploration (see C.13), Planetary Science and Technology Through Analog Research (see C.14), Laboratory Analysis of Returned Samples (see C.16), or Habitable Worlds (see E.4) programs. Proposals submitted in response to this program element should be for new work that is not currently supported by NASA or for successor proposals that seek to extend to their next logical phase those tasks performing research in PPR program that are currently funded, but whose periods of performance will expire this year.

2.3 Pilot Studies

Proposals for one to two-year pilot studies to demonstrate or develop a new method, design, technology, technique, or procedure or a new application of an established method, design, technology, technique, or procedure are encouraged.

2.4 Additional Funding for Relevant Instrumentation Construction or Upgrade

Proposers to PPR 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 PPR proposal or submit a stand-alone PMEF proposal to supplement an existing PPR award.

2.5 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.

2.6 Duration of Awards

Typical proposals to PPR seek three years of funding or fewer. Periods of performance from one to four years may be proposed, as appropriate, to the nature of the contemplated research. Please refer to section 3.3 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.

2.7 Topical Workshops, Symposia, and Conferences

The PPR 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 PPR program as the relevant SMD program element and refer to the goals and objectives of the PPR program in demonstrating relevance.

2.8 Early Career Award

The PPR program is an Early Career Award (ECA)-participating program element. Details about the ECA will be announced with the ROSES-19 solicitation. For now, proposers may refer to the draft text released for community comment. Interested proposers should check the early career box on the NSPIRES cover page when preparing their proposal.

2.9 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. 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.

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 3.6), and since samples are an important component of planetary protection 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. The two-page DMP section does not count against the 15-page limit of the S/T/M section.

3.4 Geologic Maps

Proposers who plan investigations involving geologic mapping should consult 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 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 organization's AOR. Proposals 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 in the *NASA Guidebook for Proposers*. Violation of these rules is sufficient grounds for a proposal to be rejected.

5. Summary of Key Information **[Updated February 28, 2019]**

Expected program budget for first year of new awards	~ $500K **+ $500K for activities to support icy satellite surface technology development and/or a Europa Lander mission**
Number of new awards pending adequate proposals of merit	~ 3 **+ 3 activities to support icy satellite surface technology development and/or a Europa Lander mission**
Maximum duration of awards	4 years; shorter-term proposals are encouraged.
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*.
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. See also Section IV of 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	NNH18ZDA001N-PPR
NASA 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 EARLY CAREER FELLOWSHIP START-UP PROGRAM FOR NAMED FELLOWS

NOTICE: This program element is only for those who have already been named Early Career Fellows to submit proposals for start-up funds. For information on how to apply to be named an early career fellow see program element C.21, The New Early Career Fellowship 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 $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. See Section 2 for eligibility to apply for start-up funds.

Please also refer to the Frequently Asked Questions PDF, which may be downloaded from the NSPIRES web page for this program element.

2. Fellowship Start-up Funds

The application for start-up funds is the second component of this program (those who respond to this program element must have been already named an "Early Career Fellow" in response to proposal previously submitted 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.

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). However, see also Section 3.2.

To be eligible for 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 definition of "permanent" position is provided at the end of this program element in Section 3.3.

Fellows (or organizations) applying for 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. Receive 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, 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 peer review.

The proposal must clearly describe how the funds will be used to establish their 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, and this program element in particular. For example, the technical management section of a proposal to this program element is limited to seven pages.

2.3 Evaluation Criteria for Start-Up Proposals

Proposals for start-up funds will be evaluated vs. the three standard criteria given in ROSES: merit, relevance, and cost reasonableness. The evaluation of start-up proposals vs. these criteria 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., not tenure track) to independently apply for NASA grants, which might prevent potential PIs from proposing to this program. However, the proposal may 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 (AOR).

3.2 Time Since Degree

Potential proposers who took a leave of absence for family leave, military service, or serious health problems may request a waiver to the chronological eligibility restrictions outlined in Sections 2.1. These applicants should write to the ECF point of contact given in Section 5 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

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 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.
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, 2019.
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 ROSES 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	See the Frequently Asked Questions.
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	NNH18ZDA001N-ECF (only for current Fellow applications for start-up funds; otherwise please see C.21.)
NASA point of contact concerning this program	Mary Voytek Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Email: mvoytek@hq.nasa.gov

C.17 PLANETARY MAJOR EQUIPMENT AND FACILITIES

Amended March 15, 2018. This amendment presents final text for this program element. The text has changed significantly from prior years. Appended proposals are submitted along with a Step-2 proposal using the normal submission process of an eligible program element by the due date given for that program element in Tables 2 and 3 of ROSES. Stand-alone proposals are submitted in response to this program element. Stand-alone Step-1 proposals are due July 17, 2018 and Step-2 proposals are due September 17, 2018.

Stand-alone proposals submitted to this program element will follow a two-step process, beginning with a required Step-1 proposal. The proposal title, category of instrument (investigator or facility), and the nature of the instrument to be purchased cannot be changed between the Step-1 and Step-2 proposals. Only proposers who are "invited" in response to the Step-1 proposal can submit a Step-2. See Section 3 for details.

Table of Contents

1.1 Scope of Program 2
1.2 Instrument Categories 2
1.3 Submission methods and eligibility 3
1.3.1 *PMEF requests appended to research proposals* 3
1.3.2 Stand-Alone PMEF proposals 3
1.4 Allowable PMEF requests 4
1.5 Allowable Costs 4
2. APPENDED PMEF REQUESTS FOR INVESTIGATOR INSTRUMENTS 5
2.1 Content of a PMEF Appendix 5
2.2. Evaluation of a proposal with a PMEF Appendix 6
3. STAND-ALONE PMEF PROPOSALS 6
3.1 Step-1 proposal process for Stand-alone PMEF requests 7
3.2 Content of Stand-alone Step-2 PMEF proposals for Investigator Instruments 7
3.3 Content of Stand-alone Step-2 PMEF proposals for Facility Instruments 8
3.4 Evaluation of Stand-alone Step-2 PMEF proposals. 10
3.4.1 *Investigator Instruments* 10
3.4.2 *Facility Instruments* 10
4. FUNDING FOR PMEF AWARDS 10
5. SUMMARY OF KEY INFORMATION 10

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.18	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

[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 will 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 sections 3.2 for Investigator Instruments and section 3.2 for Facility Instruments are given in section 3.3.

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 Science PI of the stand-alone PMEF proposal must either be the PI or 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 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.

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. 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 Content of 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.

The main research proposal must contain an appendix entitled, "Planetary Major Equipment and Facilities Request," which should be the last item in the proposal (subsequent to all of the required sections in the main 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
    - 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 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.

In constructing a full research proposal 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. Proposers are strongly encouraged to present a contingency plan (if one is possible) for the non-selection of the PMEF request. Such a plan should be part of the Scientific/Technical/ Management section of the main proposal not the PMEF appendix. 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 descoped from the proposal if the instrument were not available.

Appended PMEF requests will be funded only if the main science proposal itself is selected for funding. Conversely, if there is no meritorious descope plan for the PMEF request, 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 should 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:

1) to 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;
2) for Facility Instruments, to 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 Content 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 provided 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 Content 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 team members.

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 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 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	~ $2M, 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. See also Section IV of 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	Appended PMEF requests: Please refer to the specific science research program element. It will be of the form NNH18ZDA001N-AAA where AAA is the abbreviation for that program. Stand-alone PMEF requests: NNH18ZDA001N-PMEF

NASA 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 LABORATORY ANALYSIS OF RETURNED SAMPLES

NOTICE: Amended April 10 2018. The proposal due dates for this program element have been changed. The Step-1 due date is now May 24, 2018 and the Step-2 due date is now July 26, 2018. In addition, Section 2.2.3 has been updated. New text is in bold and deleted text is struckthrough.

This program element uses a two-step proposal submission process described in Section 2 of program element C.1.

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.

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 of interest 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.

1.2 Proposals to Analyze Returned Samples

Proposals are solicited to conduct analytical studies of astromaterials already returned by planetary missions. 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 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 interpretation of sample-return mission data.

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 (program element C.12 PICASSO, and program element C.13 MatISSE).

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 *Hayabusa1*

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 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 will encounter 101955 Bennu, a 500-m diameter, B-type Apollo asteroid, in 2018. 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 will encounter asteroid 162173 Ryugu, a ~1-km diameter, C-type, Apollo asteroid, in 2018. Small samples of fine-grained regolith (<1 mm particles) will be collected from up to three locations on Ryugu, and 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://global.jaxa.jp/projects/sat/hayabusa2/ for more information.

2.2.3 *Other missions and potential missions*

Below is a list of some of the ~~types of~~ missions that may return samples to Earth in the ~~distant~~ future. ~~In general,~~ Proposals addressing these missions are expected to **demonstrate the timeliness of the development effort** ~~have low priority for LARS funding.~~

- 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**
- ~~New Frontiers lunar sample-return missions~~
- ~~Asteroid Redirect Mission~~

3. Programmatic information

3.1. 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.

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. 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. 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 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.

3.2 Topical Workshops

The LARS 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 LARS program as the relevant SMD program element and refer to the goals and objectives of the LARS program in demonstrating relevance.

3.3 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.

3.4. Mission data, facilities, and resources

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.

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 3.4.

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 3.5, 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 3.6, 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 program element C.1 and in the *NASA Guidebook for Proposers*. 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 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*.
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 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	NNH18ZDA001N-LARS
NASA 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.19 NEW FRONTIERS DATA ANALYSIS PROGRAM

NOTICE: 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 Authorized Organizational Representative. Only proposers who submit a Step-1 proposal are eligible to submit a Step-2 (full) proposal.

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 these requirements may be returned without review.

The scope of this program element also differs slightly from the other Planetary Science Division Data Analysis Programs. Proposers are expected to carefully read the solicitation and should email the program point of contact with any questions sufficiently ahead of the Step-1 proposal deadline. In addition, the NSPIRES page has an FAQ that holds answers to common questions about this program.

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 require the use of data from at least one New Frontiers mission.

This program solicits research proposals to conduct scientific investigations utilizing 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. Science investigations may include the use of spacecraft data not supported by a separate Planetary Science Division Data Analysis Program, specifically those datasets archived at the Planetary Data System and certified at least 30 days prior to the Step 2 deadline.

Investigations using the New Horizons and/or Juno data may also use mission data supported by a separate Data Analysis program for outer Solar System single-body or comparative-planetology studies that require the use of those New Frontiers mission data for at least one of the bodies of focus.

All proposals to NFDAP must identify and address a clear objective with science research that would be a significant, not incremental, advance in the state of knowledge of the research topic. Tasks responsive to this call include 1) data analysis tasks, 2) nondata analysis tasks that are necessary to analyze or interpret the data, and 3) nondata 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. 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.

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 3.6 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 http://pds.nasa.gov/documents/pag/index.html. Data products, including maps, improved calibrations, etc., must be submitted to the PDS or the 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. Each research proposal must constitute a stand-alone scientific investigation, with stated lines of inquiry, and result in one or more peer-reviewed publications.

2. Programmatic Information

2.1 Exclusions

Proposals to this program 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 Planetary Data Archiving, Restoration, and Tools (PDART) Program, C.7.

2.2 Relevance Statement Requirement

Proposals to this program must discuss relevance 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.

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 3.4.

- Mission information can be accessed via the NASA website(s).
  - Juno: https://www.nasa.gov/mission_pages/juno/main/index.html
  - New Horizons: https://www.nasa.gov/mission_pages/newhorizons/main/index.html
- Mission data information can be accessed via the PDS webpage(s).
  - 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

3.2 Facilities and Data Sources Available to Proposers

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). 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 Archiving and Map Publication

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, immediately following the References and Citations section for the Scientific/Technical/Management portion of the proposal.

Selected investigations may result in data products and software tools that are of broad use to the science community, including maps, data with improved calibrations, etc. NASA strongly encourages that such data be archived in the Planetary Data System (http://pds.nasa.gov/), or equivalent public archive, by the end of the award period. Proposers are advised to read program element C.1, The Planetary Science Division Research Program Overview, for information on including an archiving plan in the proposal.

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 program element C.1, Section 3.8, for the USGS' information on and requirements for map production and publication.

4. The Two-Step Submission Process

This program element uses the two-step proposal submission process outlined 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 program element C.1 and in the *NASA Guidebook for Proposers*. Violation of these rules is sufficient grounds for a proposal to be rejected.

5. 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 that tied to the submission of a parent science proposal.

6. Summary of Key Information

Expected program budget for first year of new awards	~ $1.5 M/Year
Number of new awards pending adequate proposals of merit	~ 8-12 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 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*.
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	NNH18ZDA001N-NFDAP
NASA point of contact concerning this program	Michael DiSanti Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Email: HQ-NFDAP@mail.nasa.gov Telephone: (301) 286-7036

C.20 ROSETTA DATA ANALYSIS

NOTICE: This program element continues to accept proposals in a two-step proposal submission process described in Section 2 of program element C.1.

1. Scope of Program

The objective of the Rosetta Data Analysis Program (RDAP) is to enhance the scientific return of the Rosetta mission and broaden the scientific participation in the analysis of archived data collected from the Rosetta and Philae spacecraft.

1.1 Sources and Analysis of Mission Data

Spacecraft data used in RDAP investigations must be available in the Planetary Data System (PDS; http://pds.nasa.gov/), or equivalent publicly accessible archive(s), at least 30 days prior to the Step-2 submission deadline for RDAP proposals. Spacecraft data that have not been placed in such archives are not eligible for use in RDAP investigations. In all cases, it is the responsibility of the RDAP investigator to acquire any necessary data. Investigators are encouraged to contact the archive for assistance in identifying specifics of available datasets. Datasets to be used in the proposed work must be clearly and specifically identified in the proposal. NASA puts no other restriction on the status or condition of the data. However, regardless of the archive(s) used, if the data to be analyzed have known issues that might represent an obstacle to analysis, the proposers must demonstrate clearly and satisfactorily how such potential difficulties will be overcome. In other words, it is the proposer's responsibility to demonstrate clearly that the public data are of sufficient quantity and quality to achieve the project's science goals.

Proposals to RDAP must include a science investigation. Proposals to produce a higher order data product that enhances the science return from Rosetta, but does not include a science investigation, should be submitted to the Planetary Data Archiving, Restoration, and Tools (PDART) Program (program element C.7).

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 Rosetta 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 Rosetta mission data in order to be responsive to this call.

It is the responsibility of the proposers to RDAP to specifically identify any needed data and to ascertain that these data are available. Proposals should provide convincing evidence that the data have sufficient quality and are available in sufficient quantity to achieve the goals set forth in the proposal. The proposer should demonstrate a familiarity with the data and an understanding of the work required to refine the data for the purposes of the analysis.

1.2 Data Archiving into PDS

Data products produced by funded RDAP 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 http://pds.nasa.gov/documents/pag/index.html. 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.

1.3 Program Exclusions

The Rosetta Data Analysis Program is not intended to overlap other active data analysis or Core (see below) research and analysis programs. Therefore, RDAP 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 Discovery Missions, including Kepler/K2 observations of Solar System targets (see DDAP, C.11);
- Data from New Frontiers Missions (NFDAP, C.19)
- Data from Kepler/K2 on objects outside the Solar System (see ADAP, D.2).

RDAP 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 (which are supported by other NASA programs); 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 Rosetta data).

The Planetary Science Division uses RDAP and the other data analysis programs (DAPs) to solicit proposals whose work efforts are primarily analysis of planetary mission data. If a proposal seeks to analyze data in the scope of two or more DAPs in order to perform comparative studies across the Solar System, and is not appropriate to any one DAP, then submission to a Core Research Program is encouraged. If a proposal is not appropriate for one of the DAPs, but does fit within the bounds of a Core Research Program (e.g., Solar System Workings or Emerging Worlds), it should be submitted to that Core Program.

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 RDAP investigations.

Members of Rosetta mission or instrument teams who wish to apply to RDAP must clearly demonstrate that their proposed investigation will use only released and publicly available data. These team members must scrupulously comply with the 30-days-prior-to-submission rule (above). Additionally, team members must clearly demonstrate how the proposed RDAP research does not overlap and is not redundant with already funded activities.

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 program element C.1 and in the *NASA Guidebook for Proposers*.

The Planetary Science Division intends that RDAP proposals will be co-reviewed at the same time as proposals to the Discovery Data Analysis Program (DDAP; program element C.11); however, RDAP awards will be funded from a source other than the Discovery Program.

3. Programmatic Information

3.1 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.

3.2 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.

3.3 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.

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 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.

4.3 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 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.

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.

5. Summary of Key Information

Expected program budget for first year of new awards	~$1.3 M
Number of new awards pending adequate proposals of merit	~9-12
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 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*.

Detailed instructions for the preparation and submission of proposals	Please see Table 1 of the ROSES *Summary of Solicitation* Section and 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 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	NNH18ZDA001N-RDAP
NASA point of contact concerning this program	Melissa A. Morris Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Email: melissa.a.morris@nasa.gov Telephone: 202-774-8476

C.21 NASA PLANETARY SCIENCE EARLY CAREER AWARD

NOTICE: Amended February 1, 2019. The comment period for this program element was previously temporarily changed to "TBD" as a result of the partial government shutdown. This amendment releases new due dates for the effected program elements in Planetary Science. Community comments on the draft text below are now due by February 14, 2019.

Amended on December 20, 2018. This amendment releases draft text for the NASA Planetary Science Early Career Award. ~~Comments on the draft text are due by January 21, 2019~~. The final version of this program will be part of ROSES-2019. This program will not solicit proposals through ROSES-2018.

1. Scope of Program

The NASA Planetary Science Early Career Award supports the research and professional development of outstanding early-career scientists, and serves to stimulate research careers in areas supported by the Planetary Sciences Division. The support of this program will allow key individuals to play an increasing role in the community — to achieve high-impact science and to help lead the field through development of new concepts, technologies, and methods.

This program consists of a two-tiered nomination and selection process. The first tier is to check a box when a regular ROSES research proposal is submitted. Early-career Principal Investigators, whose proposals are selected via normal review processes, will be invited to enter the second tier of the application. Invitees will be asked to submit an application package to be considered for the NASA Planetary Science Early Career Award. Details of the first and second tiers of the application process are provided in Section 2 and 3, respectively. The Planetary Science Division intends to select approximately five (5) Early Career Awards per year.

2. Early Career Award

This section describes the first tier of the Early Career Award (ECA). The application for the Early Career Award does not involve a separate proposal to this program element. Rather, the ECA applicant will check the "Early Career" box when submitting their research proposal to one of the ROSES Research Program elements listed in Section 2.4. Upon selection of the regular proposal, the early-career Principal Investigator (PI), or Science PI, will be invited to submit an application package for consideration for the NASA Planetary Science Early Career Award by the lead program officer for the selecting program, as described in Section 3.

2.1 Eligibility for Early Career Award

To be eligible to apply for an ECA, the applicant must have received their Ph.D. (or equivalent degree such as D.Phil) within 10 calendar years of the year of the submission of the research proposal to the participating program element listed below (in Section 2.4). Further information regarding this time criterion is provided in Section 4.2.

Only one NASA Planetary Science Early Career Award will be given to an individual. That is, previous awardees are ineligible for application to the ECA.

2.2 Awardee Application Procedure

The process for applying to be an Awardee is as follows:

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1. Be PI (or Science PI, see Section 4.1) on a normal, full, Step-2 proposal submitted to one of the participating ROSES program elements listed in Section 2.4;
2. Check the Early Career Award checkbox on the NSPIRES Cover Pages of that proposal; and
3. Receive an award letter for that proposal, and be invited to submit an application to the NASA Planetary Science Early Career Award program.

Selection of the ROSES proposal by the participating program is a prerequisite for consideration for an Early Career Award, but does not ensure selection as an Early Career Awardee. Only a small number of funded PIs in those participating programs will also be selected for an Early Career Award.

As always, the ROSES proposal to which the ECA application is tied must adhere strictly to the deadlines and instructions for the participating ROSES program element to which it was submitted. The length of the proposal, and any other rules defined in the participating ROSES program element, must therefore be followed. The proposal will be reviewed along with all other proposals submitted to that participating program element as part of the normal peer-review process. Note that requirements and funding levels vary between the participating programs. Refer to the information in the corresponding participating program element for questions about, and specific constraints and requirements for, proposals to those program elements.

2.3 Evaluation Criteria for Selection as an Early Career Fellow

ECA applications will be evaluated separately from the tied ROSES proposal for merit and relevance. In addition, unique to this program, the ECA Applicant's community participation and leadership qualities will be evaluated on the basis of the ECA applications.

2.3.1 *ECA Merit Evaluation*

The ECA merit evaluation aligns with that generally employed in ROSES. It includes an assessment of the novelty of the proposed science ideas, viability of implementation, and impact on planetary science. All three aspects of merit are applied to past, current, and proposed future work.

2.3.2 *Relevance to ECA*

The scope and goals of the ECA differ from the parent ROSES research programs listed in Section 2.4. The evalution of relevance for the ECA may therefore differ from that of the parent research program. For example, Program Element E.3, the Exoplanet Research Program (XRP) is a cross-division program run and funded by both the Planetary Science and Astrophysics Divisions. A research proposal could be deemed relevant to XRP and selected for funding primarily because of its relevance to Astrophysics, yet the affiliated ECA proposal could be rejected because it is not relevant to this Planetary Science Division ECA program.

2.4 Participating ROSES Program Elements for Early Career Award Applications

ROSES programs that participate in the ECA program are identified in Tables 2 and 3 of the solicitation by a "[3]" after the solicitation title. For ROSES 2019, at the time this amendment was released, the program elements listed below are participating in this program and allow proposers to include an ECA application with their research proposal:

- Emerging Worlds (C.2);
- Solar System Workings (C.3);

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- Exobiology (C.5);
- Solar System Observations (C.6);
- New Frontiers Data Analysis (C.7);
- Lunar Data Analysis (C.8);
- Mars Data Analysis (C.9);
- Cassini Data Analysis (C.10);
- Discovery Data Analysis (C.11);
- Planetary Instrument Concepts for the Advancement of Solar System Observations (C.12);
- Maturation of Instruments for Solar System Exploration (C.13);
- Planetary Science and Technology from Analog Research (C.14);
- Laboratory Analysis of Returned Samples (C.18);
- Exoplanet Research (E.3); and
- Habitable Worlds (E.4, formerly C.4)

3. Application Package

Upon invitation to apply for the NASA Planetary Science Early Career Award, applicants will be required to submit the full second-tier application package. This package consists of a Personal Statement, a full Curriculum Vitae, and up to three (3) letters of support. Applications may be submitted up to three years after invitation.

The personal statement (maximum two pages) must address the following:

- How receiving this award would advance the applicant's career;
- How the applicant's past, current, and planned activities support the goals of the Planetary Science Division;
- How the applicant's past, current, and planned activities support the planetary science community (this could include service activities, dedication to diversity and inclusion, mentorship, science communication, and collaborative work); and
- Describe the broader impacts of the applicant's work in planetary science, and beyond.

The Curriculum Vitae (no page limit) should include a full publication history, as well as details of collaborative activities (e.g., involvement on large scientific teams, including mission teams), awards, service, and any other relevant information.

Up to three letters of support (maximum 3 pages each) should be included. These letters should substantiate the application and address the Award's evaluation criteria.

3.1 Evaluation Criteria for Application Packages

In addition to the standard Relevance and Merit criteria listed in Section 2.3, the applicant's potential for future leadership in their scientific community - based on their engagement in their field - will also be evaluated. Information of interest includes: 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).

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4. Programmatic Information

4.1 Role of Early Career Applicant on Proposal vs. Organizational rules

Some institutions do not allow non-tenured researchers to independently apply for NASA grants, which might prevent potential PIs from proposing to this program. At either stage of the two-tier application for the Early Career Award (i.e., either the initial ROSES research proposal or 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" or "Co-I/Institutional PI" to allow the application to be submitted by the Authorized Organizational Representative.

4.2 Time Since Degree

This program element was closed for ROSES-2017 and -2018, while the program was evaluated and reformulated. This new NASA Early Career Award program thus broadens eligibility from seven years post-PhD to ten years post-PhD. This action will allow applicants who were ineligible for the previous program to apply for the new award.

4.3 Duration of Awards

The ECA awardee is affiliated with a ROSES research proposal to a participating program element listed above in Section 2.4. The duration of that research award varies, depending on that program element, but has no effect on the duration of the ECA.

5. Summary of Key Information

Expected program budget for first year of new awards	N/A; all funds are distributed by the corresponding research program element
Number of awards	No more than five per year
Maximum duration of awards	One time, $200K award
Due date for Notice of Intent to propose (NOI)	No Notices of Intent are requested for this program element
Due date for proposals	For consideration as an Early Career Applicant (new applicants), submit a proposal to the participating program element by the deadline specified in Tables 2 and 3 of ROSES. Proposals from nominees selected in prior years for start-up funds may be submitted by the annual due date for up to three years after being nominated.
Planning date for start of investigation	Six months after proposal receipt
Page limit for the central Science-Technical-Management section of proposal	See Section 3. Personal statement: 2 pages. Letters of support: 3 pages each.
Relevance	Proposals must be relevant to the Planetary Science Division. See also Section 2.2.2.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.

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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 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	NNH19ZDA001N-ECF (only for current Fellow applications for start up funds; otherwise please see the specific science research program element.)
NASA point of contact concerning this program	Shoshana Weider Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1667 Email: shoshana.z.weider@nasa.gov

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C.22 DEVELOPMENT AND ADVANCEMENT OF LUNAR INSTRUMENTATION PROGRAM

NOTICE: Added February 27, 2018. Instruments advancing lunar science suitable for small landers, including those of commercial providers, should be submitted to the DALI program, whereas those with a broader scope should be proposed to MatISSE. Proposers considering submissions to both programs are strongly encouraged review the prohibition on duplicate proposals guidance in Section 3.1 of C.1 Planetary Science Research Program Overview. No data management plan is requested for this program element.

This program element uses a two-step proposal submission process described in Section 2 of Appendix C.1. This program element includes a special emphasis on lunar science instruments, including, but not limited to, flight hardware for small commercial lunar landers. Unlike most program elements in Appendix C, this program element may result in contracts, depending on the nature of the work.

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 special lunar funding, 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 as early as ~2021.

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 Science Plan for NASA's Science Mission Directorate 2014 (https://smd-prod.s3.amazonaws.com/science-pink/s3fs-public/atoms/files/2014_Science_Plan_PDF_Update_508_TAGGED_1.pdf) 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 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), Planetary Instrument Definition and Development Program (PIDDP), Astrobiology Science and Technology for Instrument Development (ASTID), and 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 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 will be given priority.
- 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. Proposers must identify potential mechanisms that could facilitate transfer of these technologies to other users, including the private sector, for possible application beyond the immediate one of meeting mission science objectives.
- 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 an appendix on the last page of the Step-2 Proposal. A template will be sent to each Step-1 proposer. The Summary Chart shall contain the following information:
  - Title, Principal Investigator (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 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)

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 following will also be considered when evaluating the relevance, merit, and cost reasonableness, and when formulating DALI selection recommendations.

The extent to which the proposed instrument is applicable to multiple Planetary Science missions;

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.

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. While in most cases awards will be in the form of grants, when appropriate fixed price contracts will be issued.

2.4 Technical Reporting Requirements

Once awarded, all Progress Reporting deliverables applicable to this DALI solicitation shall be submitted to the web-based Planetary Science (PS) Award Administration eBook. A user account on the PS e-Book 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 e-Book will be established. To create an IdMAX account, some personal information will be required. All submissions shall be made in PDF (preferred), Microsoft Word, Microsoft Excel, or 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*

Within 15 days of award, the PI shall provide an updated project plan and budget. The updated project plan and budget is only required if the selected proposal has been de-scoped. The project plan (if applicable) shall be E-mailed to the NASA Program Officer for this program.

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 Planetary Science (PS) eBook starting on the third-month anniversary date of the signing of the award vehicle. All awardees will receive a PS eBook 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, Microsoft Word, or 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 PS eBook 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 PS eBook and E-mailed 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 investigators 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 PS eBook 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

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.

2.6 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 award but may extend beyond it. Proposals from potential Fellows must be submitted through the standard NPP process. The DALI Program expects to select no more than two Fellows associated with Planetary Science or Astrobiology Instrument Development. 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 Appendix C.1, §3.3. 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

Proposers are advised to read Section 4 of Appendix 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 2.3 of the *NASA Guidebook for Proposers*, 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 Appendix C.1 and the *NASA Guidebook for Proposers*. Violation of these rules is sufficient ground 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	3-4 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* and Section 3.7 of 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*.
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 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	NNH18ZDA001N-DALI

NASA point of contact concerning this program	James R. Gaier Planetary Science Division Science Mission Directorate National Aeronautics and Space Administration Washington DC 20526-0001 Telephone: 260-579-3442 Email: james.r.gaier@nasa.gov
NASA 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.23 INSTRUMENT CONCEPTS FOR EUROPA EXPLORATION 2

NOTICE: Amended on August 23, 2018. To give more time to proposers from Hawaii affected by Hurricane Lane, the Step-2 proposal due date for this program element has been delayed to September 7, 2018.

July 18, 2018. The point of contact (POC) for this program element has changed. The new POC is Mitch Schulte.

Amended June 1, 2018. The page limit for the central Science-Technical-Management section of proposal is 15 pages. New text is in bold and deleted text is struck through. The due dates are unchanged.

May 17, 2018. This amendment presents final text for this program element, which was previously released as draft for community comment. Consolidated feedback on the draft text and NASA's responses have been posted under "Other Documents" on the NSPIRES page for this program element. Step-1 proposals are due June 22, 2018, and Step-2 proposals are due August 24, 2018.

1. Scope of Program

The Instrument Concepts for Europa Exploration (ICEE) 2 program supports the development of instruments and sample transfer mechanism(s) for Europa surface exploration. A sample transfer mechanism is defined as a lander-mounted mechanism for handling sample and/or sample containers for presentation or transfer to scientific instruments. It includes any sample processing needed by all in situ instruments. The goal of the program is to advance both the technical readiness and spacecraft accommodation of instruments and the sampling system for a potential future Europa lander mission.

The program is noteworthy in that all awardees will be required to collaborate with the pre-project NASA-JPL spacecraft team and potentially other awardees. This collaboration will provide the opportunity for co-development of potential instruments, the sample acquisition and delivery system, and the lander itself, as all of these require maturation in a compatible system. The complexity of the mission and the anticipation of very limited spacecraft resources require this collaboration and co-development to develop a solid mission formulation capable of achieving the scientific goals.

This opportunity is open to any instrument concept addressing one or more of the Science Definition Team (SDT) objectives in "*Europa Lander Study 2016 Report*" posted under "Other Documents" on the NSPIRES page for this program element. However, instrument concepts must be compatible with the Europa lander mission architecture described in the report above as well as fit within the payload resource constraints described in Section 2.1. It is a priority for NASA to invest in development of instrument concepts in the strawman science payload, but selections will not be limited to those concepts. It is expected that multiple awards for similar instrument concepts will be made.

While specific technology readiness levels (TRL) are not prescribed for the ICEE 2 program, instrument concepts must be at TRL 6 in the 2021/2022 timeframe. Proposers are encouraged to target as early as possible in this timeframe. It is the responsibility of the proposers to describe a convincing development path extending beyond the ICEE 2 period of performance that will meet this timeframe. If selected, as part of the funded effort selectees will evolve this path into a detailed technology development plan and begin executing it. Other appropriate activities during the two year period of performance include developing requirements and flowing them down to the subsystem level and across to the spacecraft; developing the instrument architecture; conducting acquisition planning; completing heritage assessment; conducting performance, cost, and risk trades; identifying and mitigating development and programmatic risks; initiating engineering development activities; creating preliminary system-level designs; and developing time-phased cost and schedule estimates. It is not expected that all of these activities will be undertaken during the period of performance, and it is the responsibility of the proposers to prioritize these efforts such that TRL 6 is achievable no later than the end of 2022.

The ICEE 2 program also seeks to mature the accommodation of instruments on the lander, especially regarding the sampling system. This accommodation will require close interaction (including face to face) between the NASA-JPL pre-project lander study team and ICEE 2 selectees. Such interactions are necessary to not only exchange technical information but also to enable collaborative discussions of issues and solutions regarding instruments, the sample acquisition and delivery system, and the landed element. It is anticipated that some of these collaborative discussions will take place in a group setting with all selectees and the NASA-JPL lander study team.

Prospective proposers are encouraged to review the documentation posted under other documents on the NSPIRES web page of this program element to learn more about the current lander mission concept, recognizing that the lander element will continue to mature as study continues

2. Programmatic Considerations

Proposers to this program are not required to provide a data management plan.

2.1 Special Requirements for Proposals

All proposals submitted to this program must specify:

- The science objectives of the proposed instrument concept. The science objectives, investigations, and measurements must be clearly stated, and the relationship among them explained.
- Relationship to SDT science objectives. The relationship between the science investigations and measurements of the proposed instrument concept must be concisely linked and contrasted to the SDT objectives provided in "*Europa Lander Study 2016 Report*."
- The capabilities of the proposed instrument concept and their relationship to proposed science objectives. The anticipated performance specifications of the instrument concept must be provided as well as the relationship between them and

the measurements necessary to support the science objectives. This relationship must be clearly explained and rationalized.

- Technology developments to mitigate risk. Proposers should describe specific technology developments or testing to be pursued if selected and how these activities will reduce risk and mature the instrument concept.
- Spacecraft accommodation. Proposals should provide an initial assessment of spacecraft accommodation of the proposed instrument concept, including a comparison to a similar instrument in the strawman science payload (if any). The resources dedicated to the entire payload are given below, and proposers should note these allocations must be shared among all instruments. As with all surface missions, the Europa lander mission concept is extremely limited in its ability to accommodate resource growth during mission development, and proposers to this program element must utilize conservative realism when estimating resource needs for instrument concepts.
    - Lifetime: 20 days on surface
    - Mass: 33 kg (26.6 kg current best estimate (CBE) with 32% margin)
    - Volume: 34,500 cm^3 (maximum expected value)
    - Energy: 1,600 W-hrs (CBE for payload for entire surface mission)
    - Data Volume: 600 Mbits (CBE for payload for entire surface mission)
- Two-year awards. Proposals are limited to a duration of two years, but standard rules for no cost extensions will be followed. NASA may choose to release an Announcement of Opportunity to solicit flight instruments before the end of this period of performance.

2.2 Additional Selection Considerations

In addition to standard evaluation definitions given in the ROSES *Summary of Solicitation* Section VI (a) and Appendix D of the *NASA Guidebook for Proposers*, the following will also be evaluated as part of merit:

- The extent to which the proposed instrument concept supports the science objectives, investigations, and measurements of the current Europa Lander mission concept described in the documents posted with the solicitation;
- The likelihood that the proposed instrument concept can be accommodated on the lander and within the operational concept described in the "addendum to the *Europa Lander Study 2016 Report*" posted under "Other documents" on the NSPIRES web page of this program element. Note that the operational concept minimizes ground in the loop and relies extensively on automation.
- The likelihood that the proposed instrument concept can reach TRL 6 no later than the 2021/2022 timeframe.

2.3 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.

- A detailed assessment of the spacecraft accommodation necessary for the proposed instrument. Awardees are required to engage the NASA-JPL pre-project Europa Lander study team to enable this assessment and share this report with the study team no later than the end of Year 1.
- Biannual and final briefings to program managers at NASA Headquarters. The biannual briefings may be conducted via teleconference, but budget should be allocated for a final briefing to take place at NASA Headquarters in Washington, DC.
- Complete final report to NASA Headquarters not to exceed 10 pages of text (excluding figures).

2.4 Participation in Other Programs

This program does not participate in the Early Career Fellowship program or the NASA Postdoctoral Program

3 Proposal Submission Process

In order to facilitate the early recruitment of a conflict-free review panel 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. The Scientific/Technical/Management section of a Step-1 proposal is restricted to the 4000-character text box on the NSPIRES web interface cover pages.

Proposals must follow all formatting requirements that are described Section IV(b)ii of the ROSES Summary of Solicitation and in Section 2.3 of C.1 The Planetary Science Research Program Overview. Violation of these rules is sufficient grounds for a proposal to be rejected.

4. Summary of Key Information

Expected program budget for first year of new awards	~ $15M/Year
Number of new awards pending adequate proposals of merit	~ 15 ICEE 2 awards
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 Step-2 proposals are due
Page limit for the central Science-Technical-Management section of proposal	~~25~~ **15** pp; see also Table 1 of the *ROSES Summary of Solicitation* and Section 3.7 of the *NASA Guidebook for Proposers*. **[Amended June 1, 2018]**

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	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 permitted.
Website 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	NNH18ZDA001N-ICEE2
NASA point of contact concerning this program	**[Changed July 18, 2018]** **Mitch Schulte** **Planetary Science Division** **Science Mission Directorate** **NASA Headquarters** **Washington, DC 20546-0001** **Telephone: (202) 358-2127** **Email: mitchell.d.schulte@nasa.gov**

C.24 APOLLO NEXT GENERATION SAMPLE ANALYSIS PROGRAM

NOTICE: Amended on May 14, 2018. This amendment creates a new opportunity in this program element: C.24 Apollo Next Generation Sample Analysis (ANGSA). This program element uses a Notice of Intent (NOI) followed by full proposal submission. It does not require or allow submission of a Step-1 proposal. Data Management Plans are required for all proposals, see Section 3.4. All Apollo Next Generation Sample Analysis proposals must be accompanied by a separately uploaded document in NSPIRES entitled "Sample Requirements" (see Section 3.5).

Proposers who submit an NOI will receive email notifications about changes to the Frequently Asked Questions (FAQ) document after the NOI deadline. The link to the FAQ appears on the NSPIRES page for this program element under "Other documents".

1. Program Overview

1.1 Scope of Program

The goal of the Apollo Next Generation Sample Analysis (ANGSA) Program is to maximize the science derived from samples returned by the Apollo Program in preparation for future lunar missions anticipated in the 2020s and beyond. To achieve this, ANGSA solicits research on specially curated materials from the Apollo 15, 16, and 17 sample collections, which were returned to Earth in 1971-72.

The ANGSA program will consider only proposals that focus on the analysis of the following list of Apollo samples, although proposers are welcome to include other lunar samples in their studies to help understand the specially curated samples.

- Unopened vacuum-sealed Apollo samples: Nine "special samples" were collected in containers that had indium knife-edge seals to maintain a lunar-like vacuum, and three such containers remain sealed: Special Environmental Sample Container (SESC) 15014 (333 g) from Apollo 15, Core Vacuum Special Container (CSVC) 69001 (558 g) from Apollo 16, and CSVC 73001 (809 g) from Apollo 17. The three sealed samples are eligible for study under ANGSA.
- Frozen Apollo Samples: Several Apollo 17 samples were initially processed under nominal laboratory conditions in an N_2 cabinet at room temperature, but placed into cold storage (-20°C) within one month of return: six subsamples of Apollo 17 drill core (70001, 70002, 70003, 70004, 70005, 70006; 18.4 g total); nine subsamples of permanently shadowed soils 72320 and 76240 (50.1 g total); a subsample of soil 70180 (20.2 g); and all of rock 71036 (118.4 g).The frozen samples are eligible for study under ANGSA.
- Apollo Samples stored in Helium: Apollo 15 SESC samples (15012 and 15013) were opened in a helium cabinet inside an organic clean room at the University of California, Berkeley. A total of 21 subsamples of 15012 (212 g total) and 16 subsamples of 15013 (198 g total) have been continuously stored in He since this initial processing. The He-stored samples are eligible for study under ANGSA.

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*.

1.2 Types of Proposals and Consortium Formation

Proposals submitted to ANGSA may be for consortium-type studies or smaller-scale, individual projects.

Because of the limited number of samples and the special requirements for curation and handling of most of the samples, NASA anticipates that all selected projects will be integrated into one or more over-arching consortia, with NASA Curation personnel coordinating the overall effort. NASA will work with all selected teams to develop the most appropriate timeline for opening, sampling, and distributing samples. The overarching consortia formed by those selected under the present program element in ROSES 2018 may be augmented in future by a participating scientist program element.

1.3 Proposals from Non-U.S. Organizations

International participation is welcome, either as team members of consortium studies submitted by U.S. institutions, or as proposals submitted directly from foreign institutions. Proposals submitted by non-U.S. institutions will be considered on a no-exchange-of-funds basis. They will be reviewed to the same standards as those from U.S. institutions and will be selected solely by NASA.

Proposers from non-U.S. institutions should refer to the "NASA Foreign PI Instructions" on the NSPIRES page for this program element. Proposals from non-U.S. institutions must include a letter of endorsement and financial commitment from the agency or institution that will be providing support for the investigation. Proposals from non-U.S. institutions must contain all of the required sections outlined Table 1 of the *ROSES-2018 Summary of Solicitation*, including the required table of work effort for all proposal team members. The required "Total Budget" attachment in NSPIRES may be empty, except for the sentence: "This is a proposal from a non-US institution, therefore this document has been left empty".

2. Programmatic information

2.1 Sample Information

All of the samples relevant to this solicitation are curated by the NASA Astromaterials Acquisition and Curation Office, Johnson Space Center (JSC), Houston, Texas.

Documentation of all of the specially curated samples from Apollo 15-17 are provided in the Programmatic Information Package, linked from the NSPIRES page for this program element under "Other documents". Additional sources of information are the NASA curation website, https://curator.jsc.nasa.gov/lunar/, and, within this site, the Lunar Sample Compendium, https://curator.jsc.nasa.gov/lunar/lsc/index.cfm.

2.2 Lunar Sample Requests

Normally, requests for the study of all Apollo samples are submitted to the JSC Curator and reviewed by the Curation Analysis and Planning Team for Extraterrestrial Materials (CAPTEM). However, CAPTEM review for Apollo samples to be used in ANGSA proposals will be integrated into the ANGSA proposal-review process itself. Proposers should not submit ANGSA sample requests directly to JSC.

Section 3.5 explains the separate, mandatory Sample Requirements section to be uploaded with each ANGSA proposal to document Apollo sample requests.

2.3 Facilities at JSC

The samples described in this call are stored in a dedicated suite of cleanrooms that comprise the Apollo Lunar Sample Laboratory (ALSL) within the Astromaterials Curation Facility at Johnson Space Center. Within the ALSL there are facilities for the storage, processing, and characterization of all types of Apollo samples, including specialized facilities for the opening and dissection of core samples, processing samples under cold conditions (-20°C), and processing samples in a He atmosphere. The facility is staffed by people experienced in the care, processing, and handling of lunar materials (the Apollo Curatorial processing staff and the Apollo Curator). There are facilities available to make thin sections suitable for optical and electron microscopy. The laboratory complex and staff also provide the capability for high resolution optical photography of samples in the glove-box environment. A description of the clean-room facilities can be accessed at https://curator.jsc.nasa.gov/lunar/laboratory_tour.cfm.

All of the facilities and personnel described above will be available to proposers for the processing and initial characterization of the samples requested.

In addition to the ALSL and associated curation facilities, science teams or individual investigators may utilize a suite of analytical facilities affiliated with the JSC Curation Office to aid in the preliminary examination and sample selection process. These instruments include: a Nikon XT H 320 X-ray computed tomography instrument; a Focused Ion-Beam system, microtome and micromanipulation systems, an optical microscopy lab, a JEOL 7600F scanning electron microscope, and a JEOL JXA-8530F electron microprobe. Additionally, the Curation Office anticipates adding a state-of-the-art confocal Raman microscope system and a scanning benchtop X-ray fluorescence system by early 2019.

2.4 Timeline for Sampling

It is anticipated that the initial processing of vacuum-sealed samples, including experimental setup and any proposed sampling of contained volatiles, will occur during the first year of awards selected by this program element. Therefore, proposed work plans should delay sampling and analysis of the encapsulated, solid material until at least year 2, beginning in calendar year 2020. This applies only to samples from the sealed containers, not to the frozen and Helium samples or any normally curated samples.

3. Proposal Preparation and Submission

3.1. Proposal Content and Formatting

Proposals to ANGSA must follow all formatting requirements that are described in C.1, the Planetary Science Research Program Overview and the *ROSES-2018 Summary of Solicitation*, except for the length of biographical sketches, described below. Proposals that violate the rules may be rejected without review, or declined following review, if violations are detected during the evaluation process.

This program element supersedes the instructions in Table 1 of the *ROSES-2018 Summary of Solicitation* and the 2018 *NASA Guidebook for Proposers* regarding biographical sketches. All biographical sketches may be up to two pages in length, regardless of the team member's role in the project.

3.2 Statement of Relevance

Proposals to this program element do not require a separate or explicit statement of relevance; although proposers are encouraged to include one within the STM section of the proposal. As stated in program element C.1, Section 3.5, 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.

3.3. Planetary Major Equipment and Facilities

Proposals from U.S. institutions are eligible to apply for instrument funding under the Planetary Major Equipment and Facilities (PMEF) program, either through a PMEF appendix to the proposal submitted to this program element, or as a stand-alone proposal submitted to PMEF after receiving an award letter from this (ANGSA) program.

3.4 Data Management Plans (DMPs)

Section 3.6 of C.1, the Planetary Science Research Program Overview, 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 (STM) portion of the proposal.

3.5. Sample Requirements Documentation

All ANGSA proposals must be accompanied by a separately uploaded document (using document type "Appendix"), entitled "Sample Requirements", explaining the anticipated sample requirements for the proposed study. The first line of this document should be the bold title, "SAMPLE REQUIREMENTS". It is recognized that, for unopened samples, it may not be possible to document a sample request with precision. Selected proposers will have the opportunity to prepare modified sample requests for CAPTEM review during their projects.

There is no page limit on the Sample Requirements document.

The Sample Requirements section is based on the guidelines for a normal written request for Apollo samples, as outlined in section B of the JSC curation website https://curator.jsc.nasa.gov/lunar/sampreq/requests.cfm, and the checklist at https://curator.jsc.nasa.gov/lunar/sampreq/checklist.cfm.

Include the following specifications for all samples needed for research:

A. General types of samples: rocks, regolith (soil), regolith cores.
B. Special requirements: for example, location, depth, orientation in parent sample.
C. Specific lunar sample numbers (if known):
    1. Five-digit "parent" number (for example, 74001) plus 1-4-digit "daughter" number (for example, 6040) to give complete proper number (in this example, 74001,6040).
    2. Sample identifications based on information published by other PIs should identify the publications (and the page numbers in those publications) in which the sample numbers appear. (Published sample numbers sometimes include unofficial designations, given by individual PIs, that may differ from the official designations maintained by the Lunar Sample Curator. The Curator must be able to unambiguously identify the sample.)
D. Mass and/or volume requested for each sample.
E. Specification of whether "returned" (previously studied) lunar samples are acceptable.

Describe, in general terms and referring to the STM section of the proposal, the analytical techniques to be applied to each sample.

1. Be specific: Do not say "probe" analysis; specify electron-, ion-, proton-, or other microbeam method.
2. Make clear the intended uses of the proposed methods (for example, elemental analyses by ICP-MS or SIMS vs. isotopic analyses by same techniques).
3. Identify which team member and facility will perform each analysis.

Do not include the following elements of a normal Apollo sample-request:

- Cover letters: No cover letters should be included from the PI or other team members; the endorsed proposal serves to provide the same information.
- Requests for non-team members: No samples may be requested for investigators who are not on the proposal team.
- Documentation of previous peer review.
- Reprints/preprints: No attachments of publications are permitted in this program element.
- Description of scientific goals and objectives: Information about the goals and objectives, details of proposed methodology and instrumentation, and project milestones/timeline belong in the STM section of the main proposal and will not be evaluated if present in the Sample Requirements section.

Also, if needed, include in the Sample Requirements section a separate heading under which are listed any Apollo samples already allocated to the proposing team for which permission is being sought to do additional work.

You may also include in the Sample Requirements section a list of samples already in

hand and available for use in the proposed project, or that will need to be requested from other collections at JSC or elsewhere.

Note that NASA curation policy controls the quantity of sample that may be allocated (https://curator.jsc.nasa.gov/lunar/sampreq/lunarallochndbk-jsc06090_revf_2012.pdf):

"As a general guideline, no lunar sample will be allocated that reduces the remaining pristine sample below 50% by weight. Exceptions are granted based on the importance of the scientific problems being studied."

Proposers expecting to need an exception to this rule should document their rationale for an exception in the Sample Requirements section, referring to the STM section of the proposal as appropriate.

3.6 Budgets and schedule

All proposals should request a starting date of February 1, 2019.

All proposers should include in their budgets sufficient funds to travel to Houston in early 2019 for a kickoff/planning meeting at Johnson Space Center. The meeting itself is expected to occupy two work days.

4. Evaluation and Selection information

The three basic evaluation criteria for this program are listed in the *ROSES Summary of Solicitation* Section VI (a) and Appendix D of the *NASA Guidebook for Proposers*. These criteria are intrinsic merit, relevance, and cost reasonableness. Clarifications specific to this program element are listed below.

Intrinsic Merit will include the appropriateness and availability of the proposed samples for addressing the research objectives. It will be considered an Intrinsic Merit weakness if the proposed use of specially curated samples is not critical to the achievement of the objectives.

Relevant and cost-reasonable proposals of high intrinsic merit will be candidates for selection. Selection criteria will also include programmatic balance, which in this case will involve maximizing the scientific return that can be derived from the specially curated samples. Selection decisions will also involve balancing immediate scientific gain with the need to conserve adequate material for future studies. Not all specially curated samples may be opened, depending on the overall response to this program element and the scientific value of the proposed work. Security of the samples may also play a role in selection decisions.

All selections in this program element will be contingent on execution of loan agreements with all institutions that are to receive Apollo samples or other materials curated at JSC.

5. Summary of Key Information

Expected program budget for first year of new awards	~$3.5M

Number of new awards pending adequate proposals of merit	~1-15, depending on sizes of proposed consortia
Maximum duration of awards	3 years
Due date for Notice of intent	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	February 1, 2019
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*.
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 permitted.
Website for submission of NOIs and full proposals via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Website for submission of NOIs and full 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	NNH18ZDA001N-ANGSA
NASA points of contact concerning this program	Jeffrey N. Grossman Sarah K. Noble Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1218 (Grossman) Telephone: (202) 358-2492 (Noble) Email (Preferred): HQ-ANGSA@mail.nasa.gov

C.25 SCIENTIFIC EXPLORATION SUBSURFACE ACCESS MECHANISM FOR EUROPA (SESAME) TECHNOLOGY DEVELOPMENT

NOTICE: June 27, 2018. This amendment creates a new opportunity in this program element. Mandatory Step-1 proposals are due July 27, 2018 and Step-2 proposals are due September 28, 2018. No data management plan is required for this program element.

1. Scope of Program

The Scientific Exploration Subsurface Access Mechanism for Europa (SESAME) technology development opportunity supports the formulation and maturation of system concepts and the associated technologies capable of penetrating ice and accessing the subsurface liquid water on ocean worlds such as Europa. The overall goal of this opportunity is to define, and ultimately validate, a realistic architecture for deep (>1 km) subsurface access under flight-like constraints. In addition, the endeavor seeks to identify, address, and reduce technical risks for the most promising ice-penetration systems so that these systems may eventually be infused into potential future flight opportunities. This program does not solicit technologies or hardware for a specific flight opportunity.

More specifically, the SESAME technology development solicitation seeks to:

a) identify promising cryogenic ice penetration systems capable of facilitating the detection of evidence of life, especially extant life, in the ocean worlds of the outer solar system by providing access to subsurface liquid water bodies that may be located hundreds of meters to tens of kilometers below the surface of the ice;
b) identify the technology component(s) that represent the greatest technical risk to the overall penetration system;
c) begin to reduce the key technology risks through an analytical and experimental technology development effort;
d) develop prototype hardware for cryogenic ice penetration system(s); and
e) assess the performance of the prototype hardware through analysis and complementary laboratory experiments.

Such system-level technologies of interest may include, but are not limited to, melt-probes, mechanical drills, and hybrid approaches combining multiple techniques. Like most hardware intended for eventual space-flight, the SESAME technologies must be low power, low mass, and low volume. Additionally, the technologies must be capable of long duration operations in the extreme Europan environment (high radiation, high vacuum, cryogenic temperatures, etc.). Proposers should assume that a NASA-provided lander will deliver the SESAME system to the surface and provide a communication relay between the SESAME system and Earth. Additionally, proposers should assume the use of one of two NASA-provided nuclear power systems carried along with the SESAME technology. The first nuclear power system is a small fission reactor that would provide 420 Watts of electrical power and 43,000 Watts of thermal waste heat. The second nuclear power system would consist of several GPHS-based radioisotope power system units that would provide up to 110 Watts of electrical power and 2,000 Watts of thermal waste heat. The SESAME concepts are encouraged to utilize the waste heat to enable efficient advancement through the ice. Selectees will

receive a more complete briefing on the potential power systems at the start of the study

The specific mission details and the associated constraints for an eventual flight mission are still being studied and codified. However, preliminary studies have identified the following salient attributes applicable to a system-level ice penetration system:

- The system-level ice penetration system must be capable of penetrating an ice sheet on an icy world and must reach a depth up to 15 km within three years of being placed on the surface.
- The total system mass, excluding the power system and the science payload, should be minimized and must be less than 200 kg.
- The ice penetration system must be capable of starting and operating for up to three years in the targeted relevant environment (cryogenic temperatures, vacuum, high radiation, etc.).
- The system must be reliable and minimize the probability of failure due to hardware malfunction or the inability to make forward progress due to the penetration system being stalled during penetration.
- The system must be able to efficiently progress through realistic ice profiles expected on Europa. The precise profile is currently not well understood but is expected to include cryogenic brittle ice near the surface and "warm" ductile ice at greater depths; "dirty" ice mixtures containing salts, sulfuric acids, and other materials; subsurface voids; and liquid water reservoirs.

Given the importance of ice shell characteristics to subsurface exploration, it is appropriate and highly encouraged for proposals to include subtask(s) for scientific investigations intended to constrain physical parameters such as temperature, ice hardness, tectonic activity, etc. with depth.

NASA's ultimate goal is to formulate a realistic architecture for deep subsurface access and to reduce the technical risk of the ice penetration system(s) so that the technology can be considered for future flight missions. This goal will be partially achieved by successfully executing a two-year development process under this opportunity. Future solicitations may offer additional funding to develop and test higher fidelity prototype hardware at Earth analog sites and/or in realistic terrestrial testbeds.

Based on the receipt of quality proposals, and the continued availability of funding, it is expected that up to four (4) awards will be made. At the conclusion of the effort, each awardee will present their results along with evidence documenting the feasibility of further advancing the Technology Readiness Level (TRL) during a subsequently solicited activity. At a minimum, the offerors shall perform the following during the initial SESAME effort:

- All necessary design, development, analysis, fabrication, assembly, testing, and evaluation, including the identification and validation of system performance metrics, necessary to mature the SESAME concept to TRL 4 or higher. The expected entry TRL is nominally TRL 3. However, lower TRL technologies will receive equal consideration provided that the proposal realistically demonstrates that the technology will achieve the targeted TRL 4 during the initial, two-year

period of performance. At a minimum, the final documentation should address the mass, power, rate of penetration, and the expected system reliability.

- Identify, develop, and present a mitigation plan for the critical remaining risks associated with the proposed technology development concept.
- Develop a presentation summarizing the results and provide a final written report. The report shall include, but not be limited to, demonstration that key technologies are at least TRL 4 and that further development can realistically achieve at least TRL 6. The presentation should also detail the offeror's proposed plans for the continued maturation of the ice-penetration system.

2. Programmatic Considerations

Proposers to this solicitation are not required to provide a data management plan. Consistent with C.1 The Planetary Science Research Program Overview, NASA does not anticipate that contracts will be an appropriate award type given the nature of the work solicited.

2.1 Special Requirements for Proposals

All proposals submitted to this solicitation must specify:

- The role of the proposed development in an ocean worlds mission concept. For example, the ability of the system to meet the performance requirements listed above.
- The technology development activities that will be completed to mitigate the known technical risks. The proposal must describe:

  a) the current maturity level of the proposed technology (including a TRL estimate),
  b) the development plan to increase the system maturity (including specific development activities, testing, etc.) and how these activities will reduce the risk and mature the technology, and
  c) justification that the technology will achieve the desired maturity level at the end of the development period.
- The potential for the technology to be infused into a flight mission as demonstrated by adherence to the salient attributes germane to a system-level ice penetration system given in Section 1.

2.2 Additional Selection Considerations

In addition to the standard evaluation definitions given in the ROSES *Summary of Solicitation* Section VI (a) and Appendix D of the *NASA Guidebook for Proposers*, the following will also be evaluated as part of the 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 infused into a flight mission as demonstrated by meeting the salient attributes germane to a system-level ice penetration system and compliance with the anticipated resource constraints. The salient attributes and the resource constraints are both documented above.

2.3 Reporting Requirements

The following reporting deliverables will be required of institutions receiving awards. In cases where subcontract arrangements exist, consolidated project reports are the responsibility of the Principal Investigator (PI). The proposed budget should provide for adherence to these reporting requirements:

- Written, semiannual reports highlighting accomplishments, technical/ programmatic issues (and associated mitigation plans), and plans for the upcoming six-month execution period. These reports shall not exceed five pages excluding figures, schematics, and photographs.
- Annual in-person briefings to program managers at NASA Headquarters.

2.4 Participation in Other Programs

This program does not participate in other programs, such as the Early Career Fellowship program and the NASA Postdoctoral Program.

3. Proposal Submission Process

In order to facilitate the early recruitment of a conflict-free review panel, this program element uses the 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. The Scientific/Technical/Management section of a Step-1 proposal is restricted to the 4000-character text box on the NSPIRES web interface cover pages.

Proposals must follow all formatting requirements that are described Section IV(b)ii of the ROSES Summary of Solicitation and in Section 2.3 of C.1 The Planetary Science Research Program Overview. Violation of these rules is sufficient grounds for a proposal to be rejected.

4. Summary of Key Information

Expected program budget for first year of awards	~$4M
Number of new awards pending receipt of adequate proposals of merit	~4 awards
Maximum total 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 Step-2 proposals are due.
Page limit for the central Science-Technical-Management section of proposal	15 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 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	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.
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	NNH18ZDA001N- SESAME
NASA point of contact concerning this program	Ryan Stephan Planetary Exploration Science Technology Office 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

C.26 CASSINI DATA ANALYSIS PROGRAM: PDS CASSINI DATA RELEASE 54

NOTICE: Amended July 13, 2018. This program element is identical in scope to C.10, Cassini Data Analysis Program, except that it requires the use of data from the Planetary Data System's Cassini Data Release 54 (see Section 2.1). Due to inconsistencies in the posted and communicated scheduled release date(s) for these data that were not recognized until after the C.10 Step-1 due date, NASA must exclude the use of Cassini Data Release 54 from C.10 and is soliciting proposals that require the use of data from Release 54 in this program element instead. For clarity, language that distinguishes this program element from C.10 is in bold.

This program element continues to use a two-step proposal submission process described in Section 2 of C.1, Planetary Science Division Research Program Overview.

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 these requirements may be returned without review.

1. Scope of Program

1.1 Programmatic Overview

This program element is identical in scope to C.10, Cassini Data Analysis Program, except for the requirement that it only solicits proposals that use and that require the use of data from the Planetary Data System's Cassini Data Release 54. Proposals that do not use and do not require the use of Cassini mission data from Cassini Data Release 54 are not responsive to this call (see Section 2.1).

The objective of the Cassini Data Analysis Program 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 nonmission 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 utilizing 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. Science investigations may include the use of data from any spacecraft not supported by a separate Planetary Science Division Data Analysis Program and may contain outer solar system comparative planetology studies that require the use of Cassini data for at least one of the bodies of focus.

All proposals to CDAP must identify and address a clear objective with science research that would be a significant, not incremental, advance in the state of knowledge of the research topic. Tasks responsive to this call include 1) data analysis tasks, 2) nondata-analysis tasks that are necessary to analyze or interpret the data, and 3) nondata-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. 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.

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 3.6 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 http://pds.nasa.gov/documents/pag/index.html. 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. Each research proposal must constitute a stand-alone scientific investigation, with stated lines of inquiry, and result in one or more peer-reviewed publications.

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.7. Planetary Data Archiving, Restoration, and Tools (PDART) program.

Proposals that use non-Cassini mission data that is supported by another Data Analysis Program will be evaluated as not being responsive to this solicitation and must rather be submitted to a more appropriate program element. Proposers are encouraged to read the other program elements in Appendix C.

Proposals that do not use and do not require the use of Cassini mission data from the PDS Cassini Data Release 54 are not responsive to this solicitation. Proposers are referred the relevant PDS Node to determine whether their proposal is affected by this exclusion. Any proposal submitted to this program element that does not use and does not require the use of data from Release 54 is non-compliant and may be returned without review.

This program element does not solicit proposals that were submitted to other ROSES-18 program elements but that add data from Release 54 or tasks that use those data. Rather, proposals must be distinct from submissions to other

ROSES-18 program elements and must require the use of data from Release 54. Any proposal that is not distinct from proposals that were submitted to other ROSES-18 program elements is non-compliant and may be returned without review.

2.2 Relevance Statement Requirement

Proposals to this program element must discuss relevance 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.

2.3 Expected Budget and Number of New Awards

On release of ROSES-2018 the expected program budget for new awards for C.10 Cassini Data Analysis Program was given as $2.5 M/Year, and 12-20 new awards were anticipated. The split of the ROSES-18 Cassini Data Analysis Program into two program elements means that the available budget will be split as well. The allocation of funds between these two program elements is expected to be proportional to the number of highly rated proposals submitted to each. Due to flexibility in the fiscal year phasing of the CDAP budget, the total amount available for new starts for both program elements may exceed $2.5 M/Year, if warranted by the number of highly meritorious proposals.

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 3.4.

- 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

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). 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 Archiving and Map Publication

Proposals submitted to this program element must include a Data Management Plan (see C.1, Section 3.6). This 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.

Selected investigations may result in data products and software tools that are of broad use to the science community, including maps, data with improved calibrations, etc. NASA strongly encourages that such data be archived in the Planetary Data System (http://pds.nasa.gov/), or equivalent public archive, by the end of the award period. Proposers are advised to read C.1 The Planetary Science Division Research Program Overview, for information on including an archiving plan in the proposal.

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 3.8, for the USGS information on and requirements for map production and publication.

4. The Two-Step Submission Process

This program element uses the two-step proposal submission process outlined 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 in the *NASA Guidebook for Proposers*. Violation of these rules is sufficient grounds for a proposal to be rejected.

5. 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 that tied to the submission of a parent science proposal.

6. Summary of Key Information

Expected program budget for first year of new awards	See Section 2.3
Number of new awards pending adequate proposals of merit	See Section 2.3
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 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. See 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* 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	NNH18ZDA001N-CDAPR54
NASA point of contact concerning this program	Max Bernstein Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Email: max.bernstein@nasa.gov Telephone: (202) 256-0879

C.27 MARS 2020 RETURNED SAMPLE SCIENCE PARTICIPATING SCIENTIST PROGRAM

NOTICE: This program requires a Notice of Intent (NOI). Proposals that are not preceded by the mandatory NOI will be returned without review. No feedback will be provided in response to the NOI. Data management plans will not be collected on the NSPIRES cover pages since data archiving is evaluated as part of merit and must be included in the body of the proposal.

1. Scope of Program

1.1 Introduction and Background

The preparation of a cache of Martian rock and regolith samples for possible return to Earth *via* a future mission is a central objective of the Mars 2020 mission.

The Returned Sample Science Participating Scientist (RSS PS) program seeks individuals whose addition to the mission's science team will enhance the value of the samples to be selected, characterized, and cached by the Mars 2020 Rover. The selected investigators should anticipate the needs of future investigators who may analyze these samples for a very diverse range of studies in Earth-based laboratories. Selected RSS PSs will become members of the Mars 2020 Science Team and are expected to contribute collaboratively to any and all aspects of the surface science mission. Specifically, RSS PSs are sought to contribute to the following Mars 2020 science team efforts:

a) Identify, articulate and prioritize the scientific questions that may potentially be addressed through analysis of returned samples cached by the Mars 2020 Rover at its selected landing site.
b) Using the rover's instruments, characterize the geology of the landing site and its past habitability and potential for preservation of biosignatures.
c) Informed by the observations in b), identify individual samples and suites of samples that can best meet the priorities identified in a).
d) Prepare detailed "field notes" that document both the geologic context and the rationale used for sample selection to a level that justifies return of samples to Earth.
e) Participate in Science Team meetings and training events.
f) Regularly contribute to daily rover operations during the surface mission, including serving in at least one operational role.

Returned Sample Science will be organized in a fashion parallel to the mission's existing investigations associated with each of the rover's seven science instruments. RSS PSs will join existing science team members in a separate Returned Sample Science investigation. Two members will represent the Returned Sample Science Investigation in the science leadership of the Mars 2020 mission, namely the Project Science Group.

The timing of this solicitation is designed to permit selection and training of RSS PSs in time to contribute fully to both pre-landing activities such as landing site analysis and to science operations immediately upon arrival at Mars. We envision a future Mars 2020

Participating Scientist solicitation covering scientific areas other than returned sample science at a later date.

1.2. Eligibility and Desired Skills

To complement the existing Mars 2020 Science Team and its expertise in orbital and *in situ* Mars exploration, this call seeks internationally-recognized sample scientists – individuals who develop or apply techniques for the analysis of rock or soil samples, or who have relevant experience in collecting such samples in the field prior to laboratory analysis.

Further information on Mars Sample Return objectives can be found in the documents *Visions and Voyages for Planetary Science in the Decade 2013-2022*, *Planning for Mars Returned Sample Science: Final report of the MSR End-to-End International Science Analysis Group (E2E-iSAG)*, *Report of the Mars 2020 Science Definition Team*, and *the recent report of iMOST* presented at the June 25, 2018 meeting of MEPAG.

Because the intention of this program is to enhance and broaden the scientific return of the Mars 2020 mission, proposals submitted by Mars 2020 Instrument PIs, Deputy PIs, and Instrument Co-Investigators (Co-Is) will not be considered. Members of the former Mars 2020 Returned Sample Science Board are eligible to apply.

NASA encourages proposals from people who have not previously participated in Mars missions or Mars research, but have expertise in the areas above.

Proposal teams are limited to only one individual, the PI, who will be named to the Science Team. No other participants are permitted.

1.3 Proposal Information Package

The Proposal Information Package (PIP) for the Mars 2020 RSS PS Program provides more details about the spacecraft, its science payload and other useful information about the Mars 2020 mission and the science team. The Mars 2020 PIP is available on the NSPIRES index page for this program element under "Other Documents". At this time, the project can provide no information about the actual capability and calibration of other mission hardware beyond what is in the Proposal Information Package. Any additional information or responses to questions will be provided by updating and/or adding documents to the NSPIRES index page for this program element.

2. Proposal Submission

A Notice of Intent (NOI) is mandatory for this program element. NOIs must be submitted by the deadline, and late NOIs will not be accepted. Any proposal that is not preceded by an NOI will be returned without review. Proposals must address the same broad scientific goals in the NOI and changes of the PI and Title are not permitted. Also, this program element will not collect a data management plan on the NSPIRES cover pages, since data archiving is evaluated as part of merit and must be included in the body of the proposal. Moreover, if peer reviewed publications result from these awards, the data behind figures and tables must be available electronically at the time of publication, ideally in supplementary material with the article. See also Section II (c) of the *ROSES Summary of Solicitation*.

2.1. Proposal Guidelines

All proposals must contain the elements described in Table 1 of the *ROSES Summary of Solicitation* and Section 3.3 of the *NASA Guidebook for Proposers*. Where ROSES differs from the Guidebook, ROSES takes precedence (see Section I(g) of the ROSES *Summary of Solicitation*).

Applicants must submit a proposal that will allow NASA to assess the qualifications and capabilities of the candidate with respect to the Mars 2020 mission objectives described above. Successful proposals will explain how the proposer can substantively contribute to objectives a, b, c, and d listed in Section 1, with specific reference to at least one of the remaining potential Mars 2020 landing sites (Columbia Hills, Jezero Crater, NE Syrtis; see https://marsnext.jpl.nasa.gov/workshops/wkshp_2017_02.cfm). Proposers to this program element should consider: What are the key returned sample science questions that the proposer's participation enables? What rocks (or rock types) are required to be sampled and returned to address these questions? What *in situ* geologic characterization is required? How can *in situ* observations best be organized and documented to support selection of samples to cache for the envisioned Earth-based investigations? Can the Mars 2020 caching system store and return samples in an appropriate condition for the anticipated Earth-based analysis?

2.2 Operational Roles

Since proposers will be participating in operations, they should be prepared to obtain the necessary training for operational positions and they should be prepared to staff operational roles on a regular basis. If selected, the Project will assist in determining the operations roles that are most suitable and recommended location(s) for training. See also Section 3.2 for additional information regarding participation in other mission activities.

2.3 Sources of Information and Data Used in the Proposal

All information and data used in the proposal pertaining to the Mars 2020 mission, the Mars 2020 science instruments (or testbeds or engineering models belonging to the Mars 2020 instrument teams), and Mars 2020 science data (from instruments, testbeds, or engineering models belonging to the Mars 2020 instrument teams) must be publicly available at least 30 days prior to the due date. If data are not available, then the proposal will not be considered for selection. By "publicly available," we mean information that can be found in the published literature, at the Mars 2020 website (http://mars.jpl.nasa.gov/m2020/), in the PDS, or through the NSPIRES web site or other established public archives and such information should be referenced in the proposal accordingly. For details on the mission and instrument capabilities, proposers should refer to the Proposal Information Package (PIP), which may be downloaded from the NSPIRES page for this program element.

2.4 Proposals from Non-U.S. institutions

Proposals from non-U.S. institutions are acceptable but will only be considered on a no-exchange-of-funds basis. The expected program budget listed in Section 4 excludes contributions from foreign organizations. Non-U.S. proposals will be reviewed to the same standards as proposals from U.S. institutions and selected solely by NASA.

Proposers from non-U.S. 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-U.S. proposals submitted via the NASA Foreign PI Support Organization must include a letter of endorsement from their government agency or funding/sponsoring institution promising financial support for all proposed activities. Even though no funds will be provided by NASA, all non-U.S. proposals must contain all of the required sections listed in Table 1 of ROSES, including complete budget information and the required table of time commitments. It is anticipated that more time will be needed to satisfy the requirements of Export Control Laws prior to making foreign persons members of the teams. Selected foreign investigators will work with JPL to secure access to JPL facilities.

2.5 Termination of Award

Any alteration of the Mars 2020 mission, or any of its instruments, that renders the Participating Scientist unable to accomplish all of the proposed science tasks (*e.g.,* spacecraft or instrument failure) may be cause for award termination. In such a case, NASA reserves the right to terminate the award after a suitable closeout period is negotiated with the PI. NASA may alternatively choose to engage the PI to conduct a modified or altered research program, for all or part of the remainder of the award period.

3. Programmatic Information

3.1 Award Duration and Funding

Participation is expected to begin in January of 2019 and extend through the end of the prime mission (currently June 2023) plus a 3-month wrap up period. For purposes of this proposal the end date should be considered September 2023.

Proposers should be prepared (and should budget for) a commitment of a minimum of 18% time through this five-year period. Because we are seeking the expertise of proposing individuals, no supporting personnel and no other team members are allowed.

A second Participating Scientist (PS) call is expected in early 2020, in which selected PSs will enhance the scientific expertise of the existing science team, with a focus on selecting proposed investigations that complement those of the Mars 2020 science team.

3.2 Budget Information

The budget must follow the guidelines described in Section IV(b)iii of the *ROSES Summary of Solicitation* and the budget must include funding for any training and data analysis to support the proposed science investigation, all page charges for publication and reprints, attendance at conferences, all travel, and all other necessary expenses.

Proposers should include adequate funds for the PI to travel to Pasadena, CA to participate in one Operations Readiness Test (ORT) during Phase D (ending at launch of the mission, January 2020-July 2020,), one ORT during Phase E (after launch but before landing on Mars, July 2020-February 2021), and science team meetings (one

week per calendar year from 2019-2023). In addition, proposers should budget travel for a 90-day period of Science Team co-location in Pasadena, CA post-landing during calendar year 2021.

The expected total program budget and number of awards are indicated in Section 4 (Summary of Key Information).

3.3 Evaluation Criteria

As stated in Section VI.(a) of the *ROSES Summary of Solicitation* and defined in Appendix D of the *NASA Guidebook for Proposers*, the evaluation criteria are intrinsic merit, relevance, and cost realism/reasonableness. In addition to the factors for each criterion given there, this program specifically includes the following two factors in the evaluation of intrinsic merit:

(a) Demonstrated understanding of the key questions that motivate Mars sample return and how they can be addressed through appropriate selection and documentation of samples on Mars and,

(b) Demonstrated experience developing and implementing state-of-the-art terrestrial laboratory methods for analyzing samples.

Relevance is defined as the extent to which the proposal meets the objectives of the Mars 2020 Return Sample Science Participating Scientist Program in Section 1.

Although left up to the proposer, it may be advantageous to call out the anticipated contributions listed in Section 1.1 in separate sections within the proposal.

Programmatic factors that may affect selection of proposals include the degree to which the proposed work broadens participation and expertise in the mission and the ability of the mission to accommodate the proposed work in light of spacecraft and instrument capabilities, schedule, and resources.

3.4 Progress Reports and Deliverables

The Participating Scientist shall provide annual reports to the Mars 2020 Project Scientist and the NASA Headquarters Mars 2020 Program Scientist that include: accomplishments over the past year, plans for the next year, issues, concerns, schedule performance, financial performance, recovery plans, and status of publications and other deliverables.

4. Summary of Key Information

Expected program budget for first year of new awards	~$1M
Number of new awards to US PIs pending adequate proposal of merit	~10
Maximum duration of awards	5 years (see text)
Due date for mandatory 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 2019

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 of 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*
Detailed instructions for the preparation and submission of proposals	See Table 1 and Section I(g) 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)
We 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	NNH18ZDA001N-RSSPSP
NASA point of contact concerning this program	Mitch Schulte Mars 2020 Program Scientist Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-2127 Email: Mitchell.D.Schulte@nasa.gov

C.28 LUNAR SURFACE INSTRUMENT AND TECHNOLOGY PAYLOADS

NOTICE: Amended February 1, 2019. The proposal due date for this program element was previously temporarily changed to "TBD" as a result of the partial government shutdown. This Amendment presents the new due date for this program element. Step-2 proposals are now due February 27, 2019.

October 18, 2018. This amendment presents final text for this program element, which was previously released as draft for community comment. This program element uses the two-step proposal submission process, as described in Section 2 of C.1 The Planetary Science Division Research Program Overview. Mandatory Step-1 proposals are due November 19, 2018, and ~~the due date for Step-2 proposals is January 17, 2019~~.

Because a data archiving plan is an integral part of the proposal and evaluated as part of the merit, no separate data management plan will be collected on the NSPIRES cover page. It is anticipated that awards will be Cost Plus Fixed Fee (CPFF) contracts and managed by PMPO at NASA MSFC.

1. Program Scope

1.1 Program Overview

This program solicits proposals for Lunar Surface Instrument and Technology Payloads (LSITP) to be integrated onto and delivered to the lunar surface by commercial lunar landers. This opportunity specifically solicits flight payloads that do not require significant additional development. Investigations are sought that address the science goals of any of the four divisions (Planetary, Earth Science, Heliophysics, Astrophysics) of the Science Mission Directorate (SMD) as well as Strategic Knowledge Gaps of the Human Exploration and Operations Mission Directorate (HEOMD) and any technology demonstration goals of the Space Technology Mission Directorate (STMD) that advance capabilities for science, exploration, or commercial development of the Moon (see Section 1.2 for a description of all of these goals).

NASA is coordinating with commercial venture(s) to land valuable scientific and technology payloads on the lunar surface, including those solicited here. NASA has issued a separate Request For Proposals (RFP) to procure lunar lander services and expects to coordinate with multiple enterprises capable of landing small payloads on the lunar surface. NASA anticipates future opportunities to integrate multiple payloads on multiple landing opportunities.

This ROSES element calls for proposals for complete, Principal Investigator led (PI-led) science instrument and technology investigations. The term "complete" encompasses all of the investigation phases including project initiation, payload preparation, payload integration, payload operations, scientific and engineering analysis of the mission data, publication of results, and final dissemination of the data including delivery to NASA's archive.

This call is specifically geared towards small payloads that can be ready quickly in order to meet the immediate need for payloads for early CLPS flights. We are interested in flight spares, engineering models, modified off-the-shelf payloads, student hardware or any other hardware that can credibly meet the aggressive timeline outlined below. Future calls for lunar payloads will occur at regular intervals for later missions. We anticipate that the next call will be released in approximately one year.

Selections for flight integration will be conducted in a two-phase process. Selections resulting from proposals to this program element will ultimately establish a catalog of eligible payloads that will be prepared for integration and flight during the initial "payload preparation phase". The second phase, the "flight phase", will be executed after a specific flight opportunity is identified. One or more of the eligible payloads from the "payload preparation phase" will be selected through an internal process for lander integration and flight based on factors including ease and cost of accommodation, hardware readiness timeline, and the suitability of the landing site for the capability of the proposed payload. Selection through the current solicitation *does not* guarantee a subsequent flight opportunity.

1.2 NASA's Relevant Strategic Goals

All proposed payloads must support NASA's goals and objectives as described below. It is the responsibility of the proposer to demonstrate how the proposed payload addresses one or more of the significant questions, goals, and objectives identified below. Only proposed payloads relevant to NASA's strategic goals and objectives will be considered for award.

To argue relevance to SMD, proposers are encouraged to refer to the Strategic Goals and Objectives of the Science Mission Directorate described in the *NASA 2018 Strategic Plan* and the Questions and Goals in the *NASA 2014 Science Plan* (both of which may be found at https://science.nasa.gov/about-us/science-strategy),in addition to other more specific documents such as decadal surveys, roadmaps, or the reports of advisory bodies or groups relevant to SMD (see for example https://science.nasa.gov/researchers/nac/science-advisory-committees).

NASA's Strategic Knowledge Gaps (SKGs) represent the knowledge that must be obtained to reduce risk, increase effectiveness, and improve the design of systems and capabilities to be used for exploration of any future human destination. NASA addresses SKGs through ground- and space-based research, targeted toward near-term mission destinations, such as the lunar surface. See https://www.nasa.gov/exploration/library/skg.html for a complete listing of the Lunar SKGs.

The technologies of primary interest are those needed to enable or enhance capabilities for future science or exploration operations, transportation, or commercial development of the Moon. Technology demonstration payloads should only be proposed if the demonstration on the lunar surface or en route to the lunar surface is critically needed and the demonstration cannot be accomplished on Earth or in any other more accessible test environment. Areas of interest for technology demonstrations include:

- *In situ* resource utilization (ISRU) for consumables production, manufacturing, and construction. Of particular interest is the acquisition and processing of lunar

volatiles or mineral oxides to produce oxygen and fuels for propulsion, power, and life support systems.

- Power generation, distribution, and energy storage
- Thermal management, including cryogenic fluid management and survival and operation of components and systems in extreme hot and cold environments including lunar night, lunar noon, and permanently shadowed areas
- Technologies to support the operation of landers, ascent vehicles, and surface mobility including navigation, autonomous precision landing, and hazard avoidance
- Technologies to support robotic and human surface operations and habitation.

1.3 Lunar Mission Description

NASA is pursuing a novel paradigm in which it will coordinate with commercial venture(s) to land valuable scientific and technology payloads on the lunar surface. Among other payloads, these missions will include the most promising payloads selected in response to this program element. Payloads to this call should be ready for delivery and integration by as early as March 2020 and must be ready no later than December 2021. It is anticipated that in most cases, payloads will be delivered in place and remain under the PI's control until they are selected for a specific flight.

NASA has not yet selected the commercial lander providers and therefore cannot predict future flight opportunities and their timing, but proposers should assume the following notional timeline for the purposes of developing their proposals. Selected payload offerors will be asked to provide updated budgets and development schedules when a specific flight opportunity is identified.

Table 1. Notional Lunar Mission Timeline

Payload Milestone	Milestone Date
Payload Delivery to Commercial Lander Provider	March, 2020-Dec, 2021
Payload Integration Complete	Delivery + 3 months
Lunar Lander Launch Date	Delivery + 5 months
Lunar Lander Achieves Lunar Orbit	Launch + 15 days
Lunar Surface Touchdown (LST)	Launch + 30 days
Lunar Surface Mission Complete	LST + 7 days
Data delivered to PDS	End of Mission + 6 months

The specific lander designs and destinations are not available at this time but NASA anticipates multiple companies will participate with a range of designs and destinations. These first missions will be to the lunar nearside and are not expected to last longer than approximately seven Earth days, as indicated in Table 1. Proposals should be clear about any landing site requirements and/or preferences to optimize science return.

1.4 Lunar Payload Technical Requirements

The payload proposed in response to this solicitation must be accommodated by commercially-provided lunar landers. Specific payload accommodations may vary by lander provider, and because these lander services are still being developed, the

payload accommodations are subject to change. To aid potential offerors in assessing the likelihood that a proposed payload can be accommodated by potential future lunar landers, Table 2 includes some of the more salient expected accommodation capabilities. These capabilities will most assuredly evolve over time, but are expected to approximately represent the initial operating capabilities of the expected lunar landers. As with most spaceflight hardware, responders should aim to minimize the resource requirements (mass, power, volume, cost, etc.) necessary to support the proposed payload.

Table 2. Engineering accommodation capabilities for a potential lunar lander

Mechanical	
Surface Delivery Mass	Although it is expected that some landers can handle significantly larger payloads, NASA is soliciting payloads for this call that are less than approximately 15 kg
Radiation	Not expected to exceed 1 krad
Surface Communication	
R/F Communication Capability	Up to 3.0 kbps per kg of payload
Wired Interface	Serial RS-422
Wireless Interface	2.4 GHz IEEE 801.11n compliant Wi-Fi
Power	
Continuous Power Level	Up to approximately 8 Watts
Peak Power Level	Potentially up to 25 Watts for one minute
Power Conditioning	Regulated and switched 28 Vdc

The preceding information represents approximate lunar lander capabilities, and its inclusion should not be interpreted as an endorsement for any specific commercial lander provider. Responses to the current solicitation should explicitly address the feasibility of integrating the proposed payload with future lunar landers.

Responders shall document expected flight payload mass and dimensions, and as many interface requirements as possible with special consideration given to the following:

- Payload launch load limits, and, if available, results of any finite element analysis or vibration testing performed.
- Payload acoustic and shock load limits and results of any acoustic testing performed, if available
- Payload thermal conditioning requirements
- Payload communication requirements (volume, bandwidth, etc…)
- Payload communication interfaces (wired, wireless, interface port(s), etc…)
- Payload power requirements (nominal, peak, power conditioning, etc…) and any grounding requirements
- Payload pointing requirements.

- Payload mechanical interface(s) (thermal isolation, bolt-hole pattern, etc…) and launch lock requirements, if any.
- Payload optical sensitivities (dust, chemicals, line-of-sight to the Sun, etc…) and keep out zones for sensor operation, if applicable
- Payload cleanliness requirements
- Payload electrical pin configuration

Responders should be aware that NASA may elect to publicly release responses to the previous interface requirement information. The purpose of releasing this information is to inform, educate, and guide the lunar lander development community. It is, therefore, not necessary to release the identity of the potential payload provider or the payload type/capability. Responders are instructed to clearly identify any information that is proprietary or not publicly releasable.

2. Programmatic Information

2.1 Eligibility to Propose

2.1.1 *Proposals from NASA centers*

Proposals from NASA centers (including JPL) will not be accepted. There is a parallel internal call for proposals from NASA centers. NASA personnel are welcome to serve as team members on proposals from other institutions.

2.1.2 *Proposals from Non-US Organizations*

Proposals from Non-US Organizations will not be accepted. However, international participation is welcome as team members or hardware providers on a no-exchange of funds basis. There is no limitation on percentage of foreign participation.

2.2 Cost Information

Proposals should clearly describe all of the investigation phases from project initiation through the archival of data acquired during the mission. Given the aggressive mission integration timeline, payloads proposed to this announcement are expected to be mature (mid to high TRL) and substantially complete at the time of proposal submission. However, NASA does anticipate that some amount of refurbishment, testing, and/or repackaging may be necessary during the payload preparation phase.

The proposal’s budget narrative must clearly, but separately, describe the "payload preparation phase" costs and the "flight phase" costs. The "payload preparation phase" costs are anticipated to be no more than $3M (RY) and the cost to execute the second phase, the "flight phase", is expected to be on the order of $1M to $3M (RY) or less. There is not a fixed cost cap and the preceding information is included only to help communicate the scope of the effort.

Although we are asking for a complete budget through data archiving, the selections made through this call are only for the "payload preparation phase". Once selected for a specific flight opportunity, a revised budget will be requested for the "flight phase”. Thus, proposers should include the best estimate for all costs for all phases in the separately

uploaded "total budget" file, but the NSPIRES (web) cover page budgets will only include the costs for the payload preparation phase.

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 appropriate question field in NSPIRES in your Step-1 proposal, or emailed to the Program Officer listed below.

2.4 Proposal Submission Process

This program element uses a two-step proposal submission process, as described in Section 2 of C.1, the Planetary Science Research Program Overview. 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 ROSES summary of solicitation. Violation of these rules is sufficient grounds for a proposal to be returned without review.

2.5 Step-2 Proposal Review and Evaluation Criteria

To accommodate the amount of information requested, no more than 25 single-spaced pages will be allowed for the science/technical/management section, including figures and tables. 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, the evaluations for this program element will also include the following factors:

Intrinsic Merit

- The maturity and technical readiness of the instrument or payload and the extent to which the proposed activity strives to minimize the hardware and/or software modifications required to deliver the payload.
- The likelihood, and ease, that the proposed payload can be readily integrated into a commercial lunar lander.
- The quality of the management plan and project timeline for carrying out the work.
- The effectiveness and resilience of the proposed experimental designs, methods, techniques, and approaches for achieving the proposed goals and/or objectives; including operational resiliency; the ability to withstand adverse circumstances, and the potential to recover from anomalies.
- The qualification, capabilities, and expertise of proposed personnel, including planning for resiliency against an unknown timeline that may extend the launch date by months to several years from the planning schedule. The role of each Co-Investigator and collaborator will be evaluated for necessary contributions to the proposed investigation; the inclusion of Co-Is or collaborators who do not have a well-defined and appropriate role may be cause for downgrading of the proposal during the evaluation.
- The extent to which the proposal convincingly demonstrates that the payload will be available in time to support the lander integration opportunities as described in

Section 1.3. While we have provided a range of dates for delivery, it is important that we have payloads ready for the earliest missions so there will be some preference for payloads that can be delivered early in the range.
- Merit of the data analysis, data availability, and data archiving plan.

Cost
- The extent to which the proposal is responsive to the specific cost information documented in Section 2.1.
- The overall approach and ability to manage the project and achieve the stated objectives.

The selecting official for this program element will be the SMD Deputy Associate Administrator for Exploration.

2.6 Data Management Plans (DMPs)

Because a data archiving plan is an integral part of LSITP 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 or allowed for this program element. This supersedes the instructions in C.1.

2.7 Award Type and Administration

Upon selection, the investigation(s) will be managed under the Lunar Program by the Planetary Missions Program Office (PMPO). The Associate Administrator for SMD has established the PMPO at the NASA Marshall Space Flight Center (MSFC) to be responsible for project oversight. There are appropriate protective firewalls between the PMPO and the rest of NASA MSFC, allowing investigators from NASA MSFC to propose as team members in response to this solicitation. The PMPO will manage the Lunar Surface Payload investigations as modified Class D under the requirements of NPR 7120.5E, *NASA Space Flight Program and Project Management Requirements,* and as modified by the NASA SMD Class-D Tailoring/Streamlining Decision Memorandum (issued December 7, 2017). Further tailoring may be applied on a case-by-case basis after selection.

It is anticipated that awards will be Cost Plus Fixed Fee (CPFF) contracts. The NASA Federal Acquisition Regulation Supplement (NFS) 48 CFR §1852.235-72 applies. Since proposals to this program element are for contracts, unlike the rest of ROSES, the table of personnel and work effort is part of the budget. Moreover, in accordance with the clause at FAR 52.219-9, a small business subcontracting plan is also required as part of the budget.

All selected investigations must comply with the technical requirements and delivery schedules provided by NASA and/or the commercial provider(s).

3. Summary of Key Information

Expected program budget for first year of new awards	$24M - $36M

Anticipated Number of Initial Awards	8 – 12
Expected duration of awards for payload preparation phase	1-3 years
Due date for Step-1 proposals	See Tables 2 and 3 of ROSES
Due date for Step-2 proposals	See Tables 2 and 3 of ROSES
Selection Date	6 months after proposal due date
Planning Date for start of investigation	June 2019
Relevance	Proposals that are relevant to this program are, by definition, relevant to NASA. See Section 1.2
General information and solicitation overview	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*.
Page limit for Science/Technical/Management section	25 pages, including figures and tables
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)
NASA point of contact concerning this program	Dr. Sarah Noble Lunar Surface Payloads Program Scientist Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-2492 Email: Sarah.Noble-1@nasa.gov

C.29 ASTRODYNAMICS IN SUPPORT OF ICY WORLDS MISSIONS

NOTICE: Amended February 1, 2019. The proposal due dates for this program element were previously temporarily changed to "TBD" as a result of the partial government shutdown. This Amendment presents new due dates for this program element. Step-1 proposals are now due March 11, 2019 and Step-2 proposals are now due April 18, 2019. Moreover, the point of contact for the Mystic and MALTO Astrodynamics Tools in Table 1 has been changed. New text is in bold and deleted text is struck through.

December 11, 2018. This amendment presents a new program element in ROSES-2018. This program element uses the two-step proposal submission process, as described in Section 2 of C.1 The Planetary Science Division Research Program Overview. ~~Step-1 proposals are due January 18, 2019 and final proposals are due March 15, 2019.~~

1. Scope of Program

This program element supports the formulation, maturation, and validation of promising, astrodynamics analysis tools. The development of these codes has the potential to uncover new mission concepts, motivate entirely new classes of missions that may not have been previously considered, improve the efficiency of missions, and/or extend mission life. The improved tools and all supporting documentation would ultimately be provided for archiving in the NASA Planetary Science Division's (PSD) Github site and will be available as open-source code for subsequent use. Science missions to icy moons orbiting the Solar System's giant planets are of particular interest to NASA for this program element.

The activities solicited in this program element can be classified into two broad categories:

1. Enhancements to Existing Astrodynamics Tools
   Activities relevant to this category of development would involve the identification of inadequacies within the currently available suite of tools and the formulation of approaches to address these identified deficiencies. This may include improvements to existing approaches or the development of complementary methods and algorithms that can be readily integrated with existing codes such as MALTO, Copernicus, GMAT, or EMTG (see Table 1).
2. Development of New Astrodynamics Tools
   This category of development is different as it involves the development and/or maturation of new standalone tools and approaches. These approaches may involve the application of nontraditional science and mathematical approaches to the field of astrodynamics and spaceflight. The development of these novel approaches may be facilitated by ongoing breakthroughs in processing speeds and computing technologies capable of efficiently solving computationally intensive problems.

The resulting open-source tools and capabilities will ultimately be available for future mission assessments performed in rapid, collaborative, mission design engineering environments. The tools will also be used for requirements development, risk assessment activities, and for analyses performed during mission operations. Given that these tools

will be open-source, they may also be used for subsequent proposal development activities.

2. Programmatic Information

2.1 Eligibility and Teaming

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. Additional information on foreign participation can be found in the *NASA Guidebook for Proposers* (https://www.hq.nasa.gov/office/procurement/nraguidebook).

Team members must confirm participation online via NSPIRES. Please note that a proposal cannot be submitted if any listed team member has not confirmed their participation via NSPIRES. In addition, if partner institution(s), would provide access to a resource or facility not under the direct control of the team member, letter(s) of resource support must be provided from the partner organization.

2.2 Existing Tools

Proposers considering enhancements to existing astrodynamics tools are encouraged to discuss their concepts with the appropriate NASA points of contact documented in Table 1, below. Distribution for some of the existing astrodynamics tools is currently limited. However, if an offeror is awarded a project through the current solicitation, NASA can provide direct access to the code upon request. Proposers should discuss their specific access requirements with the points of contact. Additionally, if appropriate, proposers should consider including a letter of feasibility from the relevant point(s) of contact. Table 1 documents the points of contact for a number of astrodynamics tools maintained at NASA.

Table 1. Astrodynamics Tools Maintained at NASA

Astrodynamics Tool	NASA Point of Contact
Mystic and Mission Analysis Low-Thrust Optimizer (MALTO)	**Ryan Stephan** **NASA Glenn Research Center** **832-289-5533** **Ryan.A.Stephan@nasa.gov**
Evolutionary Mission Trajectory Generator (EMTG)	Jacob Englander NASA Goddard Space Center jacob.a.englander@nasa.gov 301-286-4710
General Mission Analysis Tool (GMAT)	Steven Hughes NASA Goddard Space Center steven.p.hughes@nasa.gov 301-286-0145
Copernicus	Jerry Condon NASA Johnson Space Center gerald.l.condon@nasa.gov 281-483-8173

2.3 Proposal Guidelines

Proposals must contain all of the elements described in Table 1 of the *ROSES Summary of Solicitation.* However, the Scientific/Technical/Management section of the proposal is limited to seven pages rather than 15 pages as documented in the table. The Scientific/Technical/Management section should cover the topics listed in Section 3.13 of the *NASA Guidebook for Proposers*.

To facilitate the early recruitment of a conflict-free review panel, this program will use the two-step proposal submission process described in Section 2 of C.1 The Planetary Science Division Research Program Overview. 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 C.1 The Planetary Science Division Research Program Overview and in the *NASA Guidebook for Proposers*.

All salary, fringe, and overhead are to be omitted from the main peer reviewed proposal PDF but are included in the NSPIRES web page budget and in the separately uploaded "total" budget file, see the FAQ regarding budget redaction.

2.4 Evaluation Criteria

The evaluation criteria for this opportunity are given in Section VI (a) of the *ROSES Summary of Solicitation* and the *Guidebook for Proposers.* In addition to those, the evaluation of proposals submitted to this program element will also consider the following:

The evaluation of Intrinsic Merit will include:

- The ease of incorporating the proposed activity into an existing astrodynamics code, such as those referenced in Table 1 of this program element, or the extent of the work required before a broad release of an open source, stand-alone tool.
- The impact of the research or capability advancement expected from the proposed activity.

The evaluation of Relevance will include:

- The applicability of the exploration goals of NASA's Planetary Science Division, as described in the Planetary Science Decadal Survey. Of particular interest for this program element are tools relevant to the Solar System's icy worlds.

The evaluation of Cost Reasonableness will include:

- The review panel will evaluate the reasonableness of the cost of procurements and whether the person-time is appropriate for the work proposed. NASA personnel will weigh the total proposed funding request versus the funding expectations of ~$100,000 per year, per grant, for a maximum of three years.
- Cost-sharing is welcome but not required and will not be evaluated by the peer review panel. As always, any person time must be included in the table of work effort and any facilities or equipment should be mentioned in the proposal but the corresponding dollar value of any such cost sharing may be presented only in the separately uploaded "total" budget file.

2.5 Reporting

The awardee shall provide a final presentation at the awardee's site. The final report, and presentation, are due no later than six months after the completion of the awarded activity. In addition to the aforementioned reporting requirements, awardees shall provide a final

version of the software codes and all supporting documentation for archival via GitHub (https://github.com/nasa) at the conclusion of the funded activity. Awardees are also encouraged to broadly disseminate the results of their research activity at conferences and in journal publications.

3. Summary of Key Information

Expected program budget for first year of awards	Up to $500k
Number of new awards pending receipt of adequate proposals of merit	Up to 5 awards
Maximum total 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	July 2019
Page limit for the central Scientific/Technical/Management section of the proposal	7 pages, including figures and tables; 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 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 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 Notices of Intent and final proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of Notices of Intent and final 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	NNH18ZDA001N-ADYN

NASA point of contact concerning this program	Ryan Stephan Planetary Exploration Science Technology Office Planetary Science Division Science Mission Directorate NASA Glenn Research Center Telephone: 832-289-5533 Email: Ryan.A.Stephan@nasa.gov

C.30 PLANETARY MISSION CONCEPT STUDIES

NOTICE: Amended March 13, 2019. The wording regarding the evaluation of Merit and Relevance in Section 3.1 Proposal Evaluation, have been updated to remove redundancy and more clearly explain the factors for peer review. New text is in bold and deleted text is struck through. Mandatory NOIs are now due by April 1, 2019, and the due date for 15-page proposals is May 31, 2019.

Amended on February 20, 2019. This amendment creates a new opportunity in ROSES-18 in this program element, C.30 Planetary Mission Concept Studies. Any new information that comes out of or questions sent to the NASA point of contact will be posted in a FAQ on the NSPIRES web page for this program element. ~~Mandatory NOIs are due by March 22, 2019, and the due date for 15-page proposals is May 21, 2019~~.

1. Scope of Program

NASA has started preparations for the 2023 Planetary Science Decadal Survey and one of the tasks of the 2023 Decadal Survey Committee will be to recommend a portfolio of planetary science missions. The Decadal Survey Committee may choose to recommend a portfolio of missions containing a mix of prioritized large- and medium-size mission concepts, or even a program of competed medium- size missions. The Decadal Survey will not be asked to prioritize missions in the Discovery and SIMPLEx Programs. NASA and the community are interested in providing appropriate input to the 2023 Decadal Survey regarding medium/large-size mission concepts.

To this end, NASA is soliciting 15-page proposals to conduct mission concept studies in planetary science. Following review of the proposed mission concept studies, NASA will select a small number of proposals for funded studies. Results of the selected studies will be provided by NASA as input to the 2023 Decadal Survey.

These planetary missions are envisioned to have a cost greater than a Discovery mission cost cap (Discovery FY19 cap cost $500M Phases A through D) not including launch costs. Proposals for concept studies may envision missions that include contributions from other agencies (national or international), industry, and universities.

Should NASA choose to develop a mission that flows from any selected mission concept study, the responsibility for that mission will be assigned by NASA; there is no expectation that the mission concept study team or participating organizations will necessarily participate in the eventual mission development.

2. Planetary Science Investigation Goals

This program element solicits proposals for mission concept studies that address NASA's planetary science objectives, which are to ascertain the content, origin, and evolution of the Solar System and the potential for life elsewhere. These objectives are discussed in more detail in the 2014 NASA Science Plan available at https://science.nasa.gov/about-us/science-strategy/. To further identify relevant topics,

proposers should also refer to the *Vision and Voyages (V&V)* decadal survey report available at https://www.nap.edu/catalog/13117/vision-and-voyages-for-planetary-science-in-the-decade-2013-2022, the Committee on Astrobiology and Planetary Sciences (CAPS) report, *Getting Ready for the Next Planetary Science Decadal Survey* available at https://www.nap.edu/catalog/24843/report-series-committee-on-astrobiology-and-planetary-science-getting-ready ; as well as the recent Planetary Science Division Mid-Term report, *Visions into Voyages for Planetary Science in the Decade 2013-2022: A Midterm Review,* available at http://sites.nationalacademies.org/ssb/currentprojects/ssb_177619.

In order to advance the objectives outlined in the Science Plan, V&V decadal report, and the CAPS report, proposed investigations may target any body in the Solar System. Proposers are also encouraged to review the list of recent studies provided in the CAPS report. Investigations of Earth, the Sun and extrasolar planets are not solicited in this program element.

3. Programmatic Information

The goal of the Planetary Mission Concept Studies element is to develop scientific, technical, and cost information to be used as input to the 2023 Decadal Survey. The selection of mission concepts will be driven by scientific merit, as well as likely technical feasibility and cost realism of the mission concept that is studied.

Proposers are reminded that, 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. The characteristics of a successful team include a talented, diverse, multi/inter/trans-disciplinary, and fully integrated team to execute the concept study.

NASA is invested in attracting, developing, and leveraging the full spectrum of intellectual talent in the country.

3.1 Proposal Evaluation

As stated in the *ROSES Summary of Solicitation* Section VI (a) and the NASA *Guidebook for Proposers* proposals are ~~ordinarly~~ evaluated on three criteria: Intrinsic Merit, Relevance, and Cost.

The evaluation of Merit will include:

- The scientific merit of the science goals of the mission concept proposed for study,
- The scientific merit and quality of the planned study,
- The scope of the proposed concept and its justification as a mission of greater cost and complexity than can be completed within the Discovery cost cap
- The value of the proposed study given any previous or ongoing (e.g., large mission concept) mission concept studies (proposers are encouraged to review the list of recent studies provided in the CAPS report),

- ~~The relevance of~~ **How effectively** the proposed mission architecture(s), instrumentation, and technologies ~~to~~ **would address** the proposed scientific objectives. ~~as well as~~
- **T**he breadth of proposed mission architecture(s), instrumentation, and technologies to be considered as part of the study, and
- The evaluation of the Qualifications, Capabilities, and Experience of Personnel includes: the extent to which the proposed team assembles the broad, deep and diverse mix of expertise and talent needed to enable an objective approach to developing a mission design that meets the science objectives of the proposed mission concept.

The evaluation of relevance will be based on:

- The relevance of the proposed mission concept to the scientific goals of the Planetary Science Division, as described above (Section 2),
- ~~The relevance of the proposed mission architecture(s), instrumentation, and technologies to the proposed scientific objectives as well as the breadth of proposed mission architecture(s), instrumentation, and technologies to be considered as part of the study.~~

The evaluation of cost will be based on the ~~realism and~~ reasonableness of the proposed budget.

A budget for utilizing the NASA Design Laboratories will be held by NASA and will be provided by NASA directly to JPL, GSFC or APL; the cost of these studies should not be included in the proposed budget.

3.2 Proposal Guidelines

The 15-page proposals submitted in response to this solicitation must address the science objectives noted above in Section 2. If a proposed investigation can, without any additional cost or additions, address other science goals in the NASA Science Plan, they may be briefly discussed as secondary science objectives.

As a modification to the components of the Scientific/Technical/Management section of proposals given in Table 1 of the *ROSES Summary of Solicitation* and Section 3.7 of the *NASA Guidebook for Proposers*, submissions to this program element must also include the following additional items in that same section:

1. A clear description of the scientific objectives and how these are met by the proposed science investigation(s), measurements, and capabilities supported by the mission concept and how they relate to NASA's strategic objectives in planetary science. In addition, the relationship of the proposed science investigation to the present state of knowledge in the field, to the current readiness of needed technologies, and to any other relevant missions currently operating or under development, and synergies with current and future missions, should be addressed;
2. A clear description of the current readiness levels for mission critical technologies, especially those not currently under development at NASA, and the rationale supporting the stated readiness levels in the proposal, including, where possible, laboratory or field demonstrations of the technologies;

3. A sound justification for why a mission that is larger than Discovery-size is required to address the science goals;
4. Explicit description of how the mission concept science goals relate to NASA's objectives in Planetary Science.
5. For mission concepts already studied in the past or ongoing, a robust justification of the value of the proposed additional study;
6. A detailed management plan and schedule, including a statement of work to be undertaken over the proposed period of performance.

If studies include proposed contributions to the mission concept from other agencies, industry or academia, they must include at least one Co-Investigator (Co-I) from each institution or agency envisioned as making a contribution. Research conducted by team members affiliated with foreign organizations (e.g., Co-Is at foreign institutions) must be performed on a no exchange of funds basis. See section III(a) of the *ROSES Summary of Solicitation*.

In recent years, NASA has conducted detailed studies of mission concepts (e.g., refer to section 2). Proposals addressing these areas are required to state very clearly what the value of an additional study will be over those already conducted by NASA.

3.3 Proposal Format

Table 1 within the NASA ROSES solicitation provides a checklist of required information to be included in proposals. All proposals submitted to ROSES must strictly conform to the formatting rules outlined in 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.

3.4 Additional NASA-funded Services for selected concept studies

3.4.1 *NASA Design Laboratories*

During the concept study's period of performance, study teams may request the technical assistance of the design laboratories at the Jet Propulsion Laboratory (JPL), Goddard Space Flight Center (GSFC), or the Johns Hopkins University Applied Physics Laboratory (JHU APL). These laboratories will provide space system analysis and development of conceptual designs, including:

- design of spacecraft, science instrument(s), and their interface;
- full end-to-end studies of an entire mission concept, including its system/subsystem concepts, requirements, and possible trade-offs;
- focused studies of only part of a proposed mission;
- independent assessments of investigator-provided studies/concepts;
- preliminary cost estimates; and
- new technologies and risk assessments.

Any team contemplating the use of any of these design laboratories should plan for 2-3 weeks laboratory runs and must include that intent in the body of the proposal and specify their preference, for NASA planning purposes. Once the selections are finalized, NASA will work with the study laboratories and identify the final pairing between laboratories and selected proposals. A budget for utilizing these facilities will be held by

NASA and will be provided by NASA directly to JPL, GSFC or APL; the cost of these studies should not be included in the proposed budget. Please direct questions to the point of contact in Section 4, below.

3.5 Reporting to NASA

Periodic status quad charts to NASA will be required of those selected. A template and schedule for the quad chart will be provided by NASA after selections are made.

3.6 Community Workshop and Final Report

The proposal must include plans for presenting findings at a workshop to be held towards the end of the study. Assume for planning purposes that this will occur at a workshop at the March, 2020, meeting of the LPSC. The final concept study report will be made publicly available. The final report should include: science case and measurement(s) requirements, mission concept/architecture and instrument design concept, technologies involved, a technology gap and maturation roadmap that describes how enabling technologies should be developed (including estimated costs and schedules), data handling needs, implementation risks, deployment process and launch vehicle constraints, operations concept, and cost estimate. If the concept requires technology currently below TRL 5, the proposal should estimate the cost to get to TRL 5 and assume that maturation cost would be funded outside of the mission cost. (STMD, MATISSE, IRAD, or equivalent)

3.7 Award Type and Budget

The total budget available for this solicitation is ~$1M. The planetary Science Division anticipates that it will select ~10 proposals with budgets in the range of ~$100K - $150K. NASA has separately budgeted the cost of design laboratory runs and final cost assessment (see Section 3.4).

Consistent with the default guidance in the Planetary Science Research Program Overview, NASA does not anticipate contracts resulting from this program element as it would not be appropriate given the type of work solicited. Awards to non-governmental organizations will be as grants or cooperative agreements, as appropriate. Awards to government governmental organizations will be as inter- or intra- Agency transfers.

4. Summary of Key Information

Expected program budget Awards	Up to $1M
Number of new awards pending adequate proposals of merit	~10
Due date for electronic submission of Mandatory 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.
Anticipated selection date	August 15, 2019
Planning date for start of investigation	October 15, 2019
Anticipated study report due to NASA	June 30, 2020
Page limit for the central Science-Technical- Management section	15 Pages

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	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 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	NNH18ZDA001N-PMCS
NASA point of contact	Doris Daou Program Scientist Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1686 Email: Doris.Daou@nasa.gov

C.31 KOREA PATHFINDER LUNAR ORBITER PARTICIPATING SCIENTIST PROGRAM

NOTICE: Amended on March 11, 2019. This amendment makes many changes to the text of this program element including at least one significant change in scope (Section 4.2), as well as corrections, updates and clarifications of technical parameters. The due dates have been deferred to permit proposers time to adjust their proposal plans. New text is in bold and deleted text is struck through. Step-1 proposals are now due April 11, 2019 and Step-2 proposals are due June 11, 2019.

Amended on February 21, 2019. This amendment creates a new opportunity in ROSES-18 in this program element, C.31 KPLO PSP. ~~Step-1 proposals are due April 2, 2019 and proposals are due May 22, 2019~~. Any updates to the relevant information regarding the KPLO mission and its instruments will be posted on the NSPIRES page for this program element under "Other Documents".

1. Scope of Program

The objective of the Korea Pathfinder Lunar Orbiter (KPLO) Participating Scientist Program (PSP) is to enhance the scientific return during the science phase of the KPLO mission by expanding participation in the mission through new investigations that 1) broaden or complement existing mission investigations, or 2) leverage the KPLO mission data for studies outside of the original mission scope.

This program element briefly describes the KPLO mission and its science investigation. Proposers are expected to review any information posted on the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) page under "Other Documents" and embedded links within this program element, as not all relevant information about the mission is included in the text of this program element.

The KPLO Participating Scientist Program is jointly solicited by the Science Mission Directorate (SMD) Planetary Science Division (PSD) and the Human Exploration and Operations Directorate (HEOMD) Advanced Exploration Systems (AES) Division, but will be administered primarily by the Planetary Science Division. As part of Appendix C of ROSES, this program element is governed by the rules laid out in the Planetary Science Research Program Overview, except where superseded by this document.

2. Background Mission Information

2.1 Introduction

The Korea Pathfinder Lunar Orbiter (KPLO) project is the first space exploration mission of the Republic of Korea (Korea or South Korea) beyond earth orbit. Korea launched its first satellite, KITSAT-1 in 1992, and has continued its space program ever since. The commercial-level space program was initiated by Korea Aerospace Research Institute (KARI), and KARI launched its first multi-purpose satellite, called KOMPSAT-1, in 1999. KARI has successfully launched a series of KOMPSATs into low earth orbit and now is

planning to conduct a series of lunar missions, culminating in a robotic landing on the Moon by 2030.

The KPLO program started in 2016 and is expected to be launched on board a Space-X vehicle in December 2020. It will undergo a translunar injection burn to enter into its primary mission orbit, an approximately 100 km circular lunar polar orbit with an inclination of 90 ± **3**° ~~1°~~. A one-year mission duration is planned, but a longer mission may be considered and will likely be determined based on spacecraft fuel reserves.

The main goals of KPLO mission are to: 1) realize the first space exploration mission by Korea; 2) develop and verify space technologies suitable for deep space exploration; and 3) investigate physical characteristics of the lunar surface, to aid future robotic and human landing missions to the Moon.

Although KPLO is a relatively small satellite, with a total wet mass of ~550 kg, there will be five science instruments on board: LUnar Terrain Imager (LUTI), Polarimetric Camera (PolCam)**,** KPLO Magnetometer (KMAG)**,** KPLO Gamma Ray Spectrometer (KGRS)**,** and ShadowCam. There will also be one technology demonstration instrument, the Disruption Tolerant Network Payload (DTNPL). Details of the KPLO instruments are provided in the subsequent sections. Any updates to the relevant information regarding the KPLO mission and its instruments will be posted to the NSPIRES page for this program element under "Other Documents".

2.2 Planned Mission Scenario

The launch of KPLO is targeted for December 2020, to minimize spacecraft propellant needs and provide a monthly launch window for correct lunar-orbit insertion. After launch, over the course of a month, the KPLO spacecraft will perform 3.5 phasing loops around the Earth. During the subsequent lunar transfer phase, KPLO instruments will be activated for health checks, spacecraft system verifications, and Earth imaging for public outreach purposes. After the phasing loops are completed, KPLO lunar orbit insertion will place the spacecraft in a lunar polar orbit, with an expected inclination of ~90°.

After achieving polar orbit, a one-month commissioning phase will begin. During this phase, the spacecraft bus system will be checked and all the KPLO instruments will be activated for calibration and verification before the primary science phase. During the commissioning phase, the polar orbit will be maintained at 100 ± 30 km, corresponding to a two-hour orbital period. After the commissioning phase, KPLO's primary science phase will continue for 11 months. An extended mission is possible, if spacecraft resources are available.

2.3 KPLO Bus Overview

The configuration of the KPLO bus, in both its stowed and deployed configurations, is depicted in Dr. Gwanghyeok Ju's KPLO Status update presentation to LEAG (https://www.hou.usra.edu/meetings/leag2017/presentations/tuesday/ju.pdf). Some details include:

- The spacecraft bus has a height of approximately 2.3 m;

- The spacecraft has two one-axis solar panels that deploy along the spacecraft's y-axis, and its total wingspan (i.e., with deployed solar panels) is 6.5 m;
- The propulsion system is located along the spacecraft's –x axis (where +x is the spacecraft's flight direction);
- The high-gain antenna is located along the spacecraft's –z axis;
- The lunar-surface-facing KPLO instruments will either be attached on the +z panel (LUTI, PolCam, KGRS), or mounted on the +x panel looking in the +z direction (ShadowCam);
- A ~1 m boom system for KMAG will be deployed during the first phasing loop (around Earth) of the transfer phase.

To maximize the spacecraft electric power for solar illumination cases across the entire mission lifetime, KPLO will be operated with a 45° tilt around the z axis. The tilt direction will be reversed after six months (i.e., to –45°). Most of the instruments (except for KMAG and DTNPL) will be mounted so as to compensate for this tilt. During periods with a Sun beta angle of near 45°, the spacecraft power will be the most limited and operational plans may require adjustment.

2.4 KPLO Instruments

An overview of the KPLO instruments **(and their anticipated data)** is given here, and technical instrument specifications are provided in Table 1.

Lunar Terrain Imager (LUTI) will be used to obtain high-resolution images (<5 m spatial resolution) of areas on the lunar surface, specifically those that are potential landing sites for future KARI landers (i.e., during the second stage of KARI lunar exploration, planned for 2030). LUTI images will be used to:

- Investigate the technical feasibility of candidate landing sites; and
- Support other KPLO instruments by providing images of areas of special interest.

Wide-Field Polarimetric Camera (PolCam) will **have three passband filters (at wavelengths of 320, 430, and 750 nm) and will** be used to conduct polarimetric imaging (<100 m spatial resolution; 0~**135** ~~120~~° phase angles) of the whole lunar surface (except for the polar regions). **Polarimetric** measurements will be obtained at wavelengths of 430 and 750 nm. These data will allow the first polarimetric maps of the Moon to be constructed. Such maps ~~can~~ **will** be used to investigate:

- The lunar regolith (**e.g., grain size, surface roughness, composition** ~~including its electromechancial characteristics~~);
- Space weathering processes; and
- Titanium concentration of the lunar surface.

KPLO MAGnetometer (KMAG) will be used to measure **the magnetic strength of the lunar environment, i.e,** DC and low-frequency magnetic field variations ~~near the lunar surface~~. The KMAG data will be used to create a 3D map of lunar magnetic fields. The data will be used to investigate:

- The origin of the Moon's crustal magnetism (including widely scattered paleopoles) and magnetic 'swirls'; and
- The ancient lunar dynamo and the magnetic dipole axis.

KPLO Gamma-Ray Spectrometer (KGRS) will be used to map the concentration of elements (e.g., Mg, Ni, Cr, Ca, Al, Ti, Fe, Si, O, U) and other components (e.g., water and He-3) across the lunar surface (to a depth of about 50 cm). The data from KGRS will allow investigations of:

- Lunar resources**, including (i) water and volatiles in polar regions, (ii) rare earth elements and precious metals in the polar regions (X-ray range), (iii) energy resources (e.g., U, $FeTiO_3$, He-3), and (iv) prospects for *in situ* resource utilization**;
- **Lunar geology** and geochemistry**, e.g., Mg distribution, mineralogical distribution, lunar impact history, lunar evolution, surface evolution** and
- The lunar environment, ~~i.e.,~~ **e.g.,**the **global** radiation environment **(from 30 keV to 10 MeV)** and high-energy cosmic-ray flux.

ShadowCam will be used to obain optical images (<2 m spatial resolution) of permanently shadowed regions (PSRs) in areas close to the Moon's poles. With the use of these images, there are five primary science objectives (that help address some of HEOMD's Strategic Knowledge Gaps):

- Map albedo patterns in PSRs and interpret their nature;
- Determine the origin of anomalous radar signatures associated within some polar craters;
- Document and interpret the temporal changes of PSR albedo;
- Map the morphology of the PSRs, to search for and characterize landforms that may be indicative of permafrost-like processes; and
- Provide hazard and trafficability information for the PSRs.

Disruption Tolerant Network Payload (DTNPL) is a technology-demonstration instrument. It will be used to make the first test of the Disruption Tolerant Network in space, which will subsequently allow deep-space communication (further than the Moon).

Table 1 KPLO Science Instrument Specifications

Instrument	Specifications
LUTI	Optical system: • Two identical **telescopes with wide swath (8 km width at 100 km altitude)** ~~optical tubes with Cassegrain focus (D = 9 cm, F-ratio = 4.4)~~ • **Modulation transfer function (MTF) >10% at Nyquist frequency** • **Signal-to-noise-ratio (SNR) >40 (for phase angles between 30° and 60°)** • ~~Field of view (FOV): 2.934° for each tube (total swath: 10 km at 100 km altitude)~~ • Spatial resolution: 2.5 m/px at 100 km altitude Electronics: • **Two linear CCDs (each with 2048 pixels)** • ~~2 × 2,048 px push-broom type charge-coupled devices (CCDs)~~ • 12 bit analog-to-digital converter (ADC) ~~Instrument Suite System~~ • ~~Signal-to-noise-ratio (SNR) >40, Modulation transfer function (MTF) >0.1~~

PolCam	Optical system • Two tilted optical apertures (D = 14 cm, focal length = 77 mm) • **Field of view** (FOV): 9.9° (swath: 35 km with 45° tilting angle) • Spatial resolution: 80 m/px at 100 km altitude Electronics • 1,024 × 1,024 px (13 × 13 μm) CCDs • 14 bit ADC Filters • Color: 320, 430, 750 nm • Polarization: 0°, 60°, 120° (for 430 nm), 0°, 90° (for 750 nm)
KMAG	Three boom-mounted, tri-axial fluxgate magnetometers (1.2 m boom length). Two magnetometers are located at the far end of the boom, the third magnetometer is located at the spacecraft-end of the boom (to allow spacecraft interference to be subtracted from observational data). • Sampling rate: 10 Hz (32 Hz: limited option) • Resolution: ~0.2 nT • Dynamic range: ±1,000 nT • Magnetic cleanness: <700 nT at the spacecraft-end of the boom
KGRS	$LaBr_3$ main detector • Number of channels: 4,096 (high gain) and 8,192 (low gain) • Energy range: 30 keV~10 MeV • Energy resolution: <4% at 661 keV Shielding detector (5% barium fluoride plastic scintillator) • Number of channels: 1,024 • Energy range: up to 10 MeV
ShadowCam	Time-delay integration (TDI) pushbroom camera (D = 195 mm; focal length = 700 mm) • 32 TDI lines • Spatial resolution: 1.7 m/pixel at 100 km altitude • SNR >100 • FOV **(cross track): 2.86°** • **Maximum image footrpint**: 5 × 140 km

3. Solicited Investigations

NASA invites proposals that require the use of anticipated KPLO mission data to address outstanding science questions about, or related to, the Moon. In particular, NASA seeks the submission of proposed science investigations that 1) broaden or complement the scope of KPLO science objectives, or 2) leverage KPLO's anticipated mission data, but that do not fall within the scope of the mission **(as described in Section 2).**

Proposed studies may incorporate theory, modeling, laboratory studies, ground-based observations, correlative analyses (including data from other, launched, missions), or other research. The results of any such analyses (i.e., of data that is not from KPLO) must be incorporated into the analysis or interpretation of KPLO data. Proposals for studies that would only involve the analysis of data that are not derived from KPLO (i.e., that do not actively involve interpretation of KPLO data), but that would make the results available to other KPLO investigators, are not responsive to this program element.

The KPLO Joint Science Teams (JSTs) for each instrument are responsible for making recommendations on the implementation of science activities, as well as the calibration and verification of science data obtained by the KPLO instruments. Each KPLO instrument will have its own JST, which will consist of both KARI and NASA-designated scientists. For more information regarding the KPLO JSTs, please refer to the "KPLO Data Rules of the Road" document on the NSPIRES page for this program element under "Other Documents".

~~For reference, the Principle Investigators (PIs) for each of~~ The KPLO instruments are listed in Table 2, together with a brief outline of **potential Participating Scientist (PS) expertise, experience, and knowledge sought by the JSTs to augment the current KPLO teams and investigations. Please note that this list is not exhaustive, and other PS expertise may also be valuable**.

Table 2 KPLO Participating Scientist Expertise & Experience Sought
[This table has been reformatted. The names of the Instrument Principle Investigators have been removed]

Instrument	**Participating Scientist Expertise & Experience Sought**
LUTI	• Ground and in-flight calibration of images, including radiometric and geographic calibrations • Lunar and planetary geology • **Evaluation of proposals for targeted observations** • **International collaboration in lunar science**
PolCam	• Space weathering processes • Surface maturity • Surface roughness • Lunar differentiation and thermal evolution • Image processing • **International collaboration in lunar science**
KMAG	• In-flight calibration of multiple (gradient-mode) space magnetometers • Analysis and processing of lunar magnetic field data during normal operations **(including interpretation of induced fields)** • Modeling and analysis of 3D maps of lunar magnetic fields • Interpretation of geophysical processes (e.g., true polar wander, space weathering, **the extinct** lunar dynamo) from magnetic remote sensing observations • Acquisition of remnant magnetism from planetary materials • **International collaboration in lunar science**
KGRS	• Gamma-ray production of the Moon • Gamma-Ray Spectrometer (GRS) data analysis and data processing for elemental mapping • **Development of GRS mapping routines, and** PDS data processing • Lunar geology and resources

Table 2 Continued: KPLO Participating Scientist Expertise & Experience Sought

Instrument	**Participating Scientist Expertise & Experience Sought**
ShadowCam	• Modeling of regolith/ice mixtures on the Moon • Radio science, including precise orbit determination • Morphology of icy/rock landforms

3.1 Proposal Team Roles and Responsibilities

The PI of a selected proposal, and that person alone, will be added to the KPLO Science Team as a Participating Scientist and will be given all of the rights and responsibilities of KPLO Science Team members. In the case that a proposal names a Science PI, that individual (and not the named PI) will be added to the KPLO Science Team as a Participating Scientist. Similarly, any extra requirements or allowances for a PI (e.g., an extra page for the CV of the PI) will be assigned to the person named as the "Co-I/Science PI" in NSPIRES.

Although Co-Is 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 inclusion of funded Co-Is, unfunded collaborators, graduate students, and postdoctoral researchers is discouraged, although not prohibited. Proposal Co-Is, collaborators, and other team members will have no official status with the KPLO Science Team. They will only have access to KPLO mission data (i.e., that is not publicly available) for use on the selected proposal through the Participating Scientist with whom they are affiliated. The Participating Scientist takes responsibility for ensuring that their proposal team members follow the rules laid out in the "KPLO Data Rules of the Road" on the NSPIRES page for this program element under "Other Documents".

4. Participating Scientist Program (PSP) Programmatic Information

The KPLO PSP is jointly solicited by the NASA Science Mission Directorate (SMD) Planetary Science Division (PSD) and the Human Exploration and Operations Directorate (HEOMD) Advanced Exploration Systems (AES) Division. All proposals will be solicited through this program element and will be reviewed together.

The KPLO PSP will be administered primarily by the PSD. As such, this program element is governed by information contained in C.1, The Planetary Science Research Overview, except where superseded by this document.

4.1 Eligibility to Propose

PIs and Co-Is on the KPLO mission are not eligible to be named a KPLO Participating Scientist (i.e., such persons may not be the PI of a proposal to this program element).

Proposers from non-U.S. institutions should refer to the "NASA Foreign PI Instructions" under "Other Documents" on the NSPIRES page for this program element. Proposals from non-U.S. institutions must include a letter of endorsement and financial commitment from the agency or institution that will be providing support for the investigation.

Proposals from non-U.S. institutions must contain all of the required sections outlined in Table 1 of the ROSES *Summary of Solicitation*, including the required table of work

effort for all proposal team members. Proposals from non-U.S. institutions, however, need not upload the separate "Total Budget" PDF attachment.

Individuals (whether from U.S or non-U.S. institutions) who are funded to participate in the KPLO mission are eligible for funding through this PSP, but they must follow Section 3.2 (Prohibition on Duplication of Mission-Funded Activities) of the Planetary Science Research Overview. These individuals may not request funding for any work that duplicates the mission's funded activities. All proposers must address non-duplication of funding for mission-funded activities in the Science Technical Management section of the proposal. In situations where a proposal involves work within and without the scope of mission-funded activities, funding may only be requested for the work outside the scope of mission-funded activities. Although the peer-review panel may be asked to comment on this topic, the decision will be made by NASA.

4.2 Sources of Information and Data Used in the Proposal

~~Other than KPLO mission data, All information used in the description of the proposed work effort that pertains to KPLO or other missions must be in the public domain at least 30 days before the Step-2 deadline (i.e., the requirement in Section 3.4 of C.1 of the Planetary Science Research Program Overview only applies to non-KPLO mission data). Proposals for studies that will use information that is not in the public domain will not be considered for selection, and may be returned without review. Proposed studies must require the use of future KPLO mission data.~~

All information and data used in the submitted proposal, except that described in Section 4.2.1, must be in the public domain at least 30 days before the Step-2 deadline. Proposals for studies that will use information that is not in the public domain (except data described in Section 4.2.1) will not be considered for selection, and may be returned without review. Proposed studies must require the use of future KPLO mission data.

4.2.1 *Use of Mission Data*

The normal requirement (see Section 3.4 of of the Planetary Science Research Program Overview) for spacecraft mission data to be used in proposed work to be publicly accessible (e.g., in the Planetary Data System, PDS, or an equivalent archive) at least 30 days prior to the Step-2 proposal deadline ("30-day rule"), does not apply here. That is, propsals must describe work on future KPLO mission data that does not satisfy this requirement.

Moreover, proposed investigations may also make use of other planetary spacecraft flight (PSF) data. For example, proposed work may use data obtained concurrently from KPLO and other missions. Proposals that would use non-KPLO PSF data must demonstrate how the combination of data from KPLO and other spacecraft would contribute significantly to lunar or planetary science.

Non-KPLO PSF data that are acquired routinely, or on a predetermined schedule, and that do not require pre-arrangements with other flight teams, may be used as part of a PS investigation. Proposals for the use of spacecraft data that require collaborative measurements (i.e., involving pre-arrangements between mission

teams) from KPLO and other missions, however, are not permitted. Proposers should not, therefore, append letters of agreement or endorsement from other flight team members.

All PSF data to be used in proposed investigations should preferably meet the 30-day rule. Proposals that do make use of other PSF data that do not comply with the 30-day rule, however, will be evaluated in light of the risk that such data may not ultimately be collected (or otherwise become available to the proposer on the proposed timeline). It is the obligation of the proposer to clearly demonstrate that the risk of failure to acquire the other PSF data is sufficiently low and is offset by the benefit(s) of the proposed task(s). Proposers using PSF data that have not yet been acquired should include a risk mitigation plan that outlines the steps taken by the PI to continue the proposed research, should the PSF data not be collected. If no such risk mitigation strategy is feasible, this should be articulated in the risk mitigation plan.

A proposal to use future PSF data should demonstrate that there is either a publicly available aquisition plan for the PSF data, or that these data are generated according to a routine (predetermined) schedule. Suitable evidence includes: (1) reference to official NASA (or other space agency) materials; (2) reference to publicly available research papers; (3) reference to the other PSF data already in the PDS (or equivalent archive) that is routinely collected. The burden is on the proposer to demonstrate that the data required for the proposed investigation have a reasonable chance of being collected.

Members of non-KPLO spacecraft flight teams who wish to propose to this program, and use PSF data from the mission on which they are a team, must only use publicly available sources to demonstrate how the future PSF data will be acquired. Such proposals may not present internal flight team documents, data, or agreements as evidence of future spacecraft collection plans. In addition, proposals from non-KPLO PSF team members must demonstrate that the proposed KPLO PSP research does not overlap, and is not redundant, with duties or responsibilities that are already funded within their respective missions. This requirement applies to all members of the proposed KPLO PSP team.

4.3 Data Management Plan

Proposals submitted to this program element must include a Data Management Plan (DMP) consistent with the requirements outlined in the Planetary Science Research Program Overview. That is, the DMP must be presented in a special section (not to exceed two pages) that immediately follows the References and Citations section for the Scientific/Technical/Management (S/T/M) 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. The proposal DMP, however, must cover new data and software products that would be generated as part of the proposed investigation, including those derived from spacecraft data.

Any higher-order data products generated as part of a Participating Scientist award, whether from KPLO mission data or other data sets, are expected to be archived in the Planetary Data System (PDS), with rare exceptions. DMPs that do not include a

commitment to archiving mission-data-derived higher-order data products in the PDS must justify why an exception is appropriate for that data product.

In exceptional cases where the PDS is an unsuitable archive, all data produced from the proposed work—unless infeasible—must be made publicly available via an online archive, following the timelines and guidance in the KPLO PSP Roles and Data Rights on the NSPIRES page for this program element under "Other Documents". An example of a suitable archive is a long-term repository hosted by the PI's institution, or by another institution or agency that accepts external submissions.

If a proposed investigation would produce a substantial number of large files that are impractical to deposit as a complete set, the DMP must include a committment to depositing a reasonable subset (e.g., data directly used in published analyses) and to making the remaining data available upon request (at no cost).

Please refer to the last paragraph of Section 6 for information regarding the evaluation of the DMP.

Templates for the DMP (and the table of work effort) are available from the SARA web page.

4.4 Budget Information

The PSD expects to fund four to eight Participating Scientist awards. The maximum duration of awards is three years. The expected program budget for the entire duration of all the Participating Scientist awards is $3 million (~$1M/year for three years).

Proposers must request sufficient support during the mission and its close-out to participate in science team activities and meetings. Proposers should budget for two domestic trips and two trips to Korea each year**, for three-day KPLO science team or JST meetings. Proposers should assume that meetings in Korea will be held in Seoul or Daejeon, and that US meetings will be held in Phoenix, AZ. Final meeting locations, durations, and activities will be determined by the KPLO instrument PIs at a later stage. Proposals for additional trips to Korea are also permissible (e.g., for 'scientist in residence' purposes), but must be fully justified.**

Proposers may not request support for work on data sets that is unnecessary for the proposed investigation, or that would constitute a complete science investigation separate from analysis of KPLO mission data.

The Table of Personnel and Work Effort, and the Budget Narrative, must clearly identify a break point in the project in case the KPLO mission is not extended past the nominal mission.

4.5 Planetary Science Early Career Award

This program element partipates in the new Planetary Science Division Early Career Award (ECA) Program. 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. Selected PIs, or Science-PIs, from this program may be eligible to propose to the ECA program in ROSES-2019. Please see program element C.19 of ROSES-2019 for full details.

~~Full details of the new Planetary Science Division NASA Planetary Science Early Career Award (ECA) will be announced in the ROSES-2019 solicitation. The aim of the ECA is to support research and professional development of outstanding early-career scientists. The Award serves to stimulate research careers in areas supported by the Planetary Science Division. For now, interested proposers should refer to the draft text released for community comment.~~

5. 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, many programs use a two-step proposal submission process. Please refer to Section IV. (b) vii of the ROSES *Summary of Solicitation* and Section 2 of the Planetary Science Research Overview.

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 contain broadly 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 inform the point of contact below (and cc sara@nasa.gov) at least two weeks in advance of the Step-2 due date. NASA intends to respond within two working days. Submission of the Step-1 proposal does not obligate the proposer to submit a Step-2 (full) proposal.

5.1 Step-1 Proposal

Proposers should refer to the "Instructions for Submitting a Step-1 Proposal" under "Other Documents" on the NSPIRES web page for this program. The S/T/M section of the Step-1 proposal is restricted to the 4000-character Proposal Summary text box on the NSPIRES web interface cover pages. This section should include a description of the science goals and objectives to be addressed through the proposed work, 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 performed on Step-1 proposals.

NSPIRES will notify proposers whether or not their Step-2 proposal is encouraged, at which point they will be able to submit Step-2 proposals.

5.2 Step-2 Proposal

Proposers should refer to the "Instructions for Submitting a Step-2 Proposal" under "Other Documents" on the NSPIRES web page for this program. All proposals submitted to ROSES must strictly conform to the formatting rules in Section IV (b) ii of the ROSES *Summary of Solicitation*. Proposals that violate the rules may be rejected without review. In previous years, problems with the formatting of the S/T/M section have been noted. Please pay particular attention to:

- Length of the S/T/M section: maximum 15 pages.
- Margins: 1 inch on all sides, with a standard page size of 8.5 × 11 inches.

- Font: proposers must use a 12-point or larger font. The selected font must meet the requirement of having, on average, no more than 15 characters per horizontal 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 vertical inch. Proposers may not adjust line spacing settings for a selected font below single spacing.
- 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 to gain space.

5.3 Required Participating Scientist Request Appendix

The Step-2 proposal must include a "Participating Scientist Request Appendix" of up to two pages, placed after the DMP. The information provided in this appendix will be considered only for the evaluation of relevance. The appendix must demonstrate how the proposed effort would expand or enhance the scientific return of the KPLO mission. This discussion may reference material within the 15-page STM section of the proposal, and may include references to material outside of the proposal to clearly demonstrate how the proposed work relates to the mission scope.

6. Proposal Evaluation and Selection

6.1 Evaluation Criteria

The three basic evaluation criteria for this program are listed in the *ROSES Summary of Solicitation* Section VI (a) and Appendix D of the *NASA Guidebook for Proposers*. These criteria are intrinsic merit, relevance, and cost reasonableness. Clarifications specific to this program element:

- Intrinsic merit will include an evaluation of whether the KPLO instruments (for which work is proposed) are capable of providing the data needed to successfully conduct the proposed investigation.
- Intrinsic merit will include an evaluation of impact, including the extent to which the proposal addresses the goals and mission-level science objectives of the KPLO mission.
- Intrinsic merit will include an evaluation of the extent to which the proposed investigation, and the expertise of the proposer, complements or extends the existing investigations and expertise of the KPLO science team.
- An intrinsic merit strength may be awarded for projects that would effectively use anticipated KPLO mission data for comparative planetology. The absence of a comparative planetology aspect to the proposed work, however, will not result in a weakness.
- A relevance strength may be awarded to projects that would address NASA lunar Strategic Knowledge Gaps (SKGs), but proposers are not obligated to address those SKGs. The absence of a task to address SKGs will not result in a weakness.

- Relevance will include an assessment of the proposal's responsiveness to this call, including an evaluation of whether the proposed work requires the use of KPLO mission data, and if the proposed science objectives could be achieved with other existing mission data sets.
- The two-page Participating Scientist Request Appendix, as well as the information in the main page-limited S/T/M section of the proposal, will be used by the peer review panel and NASA to judge the relevance of the proposals to this program element.
- Programmatic factors taken into account by the selection official may include the extent to which the proposed investigation, and the expertise of the proposer, complements or extends the existing investigations and expertise of the science team.
- Cost reasonableness will include an evaluation of whether the Table of Personnel and Work Effort, and the Budget Narrative, clearly identify a break point in the project for the case where the KPLO mission is not extended past the nominal mission.
- Cost reasonableness will include an evaluation of the budget to ensure that participation in science team activities and meetings (see Section 4.4) is sufficiently supported.

In the case that a proposal includes the acquisition of observations, or the generation of data products, significantly outside the scope of standard KPLO standard operations, NASA reserves the right to conduct a second technical feasibility review. This second review would be performed with the direct cooperation of the KPLO mission team. It is anticipated that any findings produced by that review would be delivered to the proposer outside of the panel evaluation.

6.2 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 KPLO Participating Scientist selection process will include NASA's expectation—described in Section III (a) of the *ROSES Summary of Solicitation*—that its mission teams reflect the diversity within the relevant scientific communities. This will also include consideration of the proposer's previous mission participation, if any.

Upon selection, the PI of a selected proposal will be added to the KPLO Science Team as a Participating Scientist and will be given all of the rights and responsibilities of KPLO Co-Is, as per the "KPLO Data Rules of the Road" on the NSPIRES page for this program element under "Other Documents". Proposal Co-Is and collaborators, if any, will have no official status with the KPLO Science Team. They will only have access to

KPLO mission data that is not publicly available through the Participating Scientist with whom they are affiliated.

The evaluation of the DMP will not be part of the grade given to the proposal by the peer reviewers. The peer reviewers, however, will evaluate the DMP and if it is judged to be inadequate, awards will be delayed until an adequate DMP is received and approved by NASA. 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.

7. Summary of Key Information

Expected program budget for first year of new awards	$1M
Number of new awards, pending adequate proposals of merit	4–8
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	Six months after the proposal due date
Page limit for the central Science/Technical/Management section of proposal	15 pages. See also Table 1 of ROSES and the *NASA Guidebook for Proposers*, as well as Sections 4.3 and 5.3 of this program element regarding required appendices.
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 program element	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	Please see ROSES *Summary of Solicitation*, particularly 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 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	NNH19ZDA001N-KPLOPSP

Science Mission Directorate (SMD) Planetary Science Division (PSD) point of contact	Shoshana Weider Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1667 Email: shoshana.z.weider@nasa.gov
Human Exploration and Operations Directorate (HEOMD) Advanced Exploration Systems (AES) Division point of contact.	John Guidi Advanced Exploration Systems Division Human Exploration and Operations Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1644 Email: john.guidi@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.13 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.

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 (e.g., instrument development proposals, see Sections 3, 6, and 7, below). This requirement will be satisfied by responding to the compulsory NSPIRES cover page question about the DMP. It is expected that the majority of proposals will simply state that the proposer will meet the mandatory minimum requirement by 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.

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.

Unless otherwise noted in the individual program elements, NASA does not anticipate awarding contracts in response to proposals submitted to most program elements in Appendix D, because it would not be appropriate for the nature of the work solicited. Contracts may be awarded in response to proposals to D.3 APRA and D.8 SAT, as appropriate.

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. 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) 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.

3. Astrophysics Research and Analysis

The Astrophysics Research and Analysis program (APRA; program elementt D.3) supports suborbital and suborbital-class investigations, development of detectors and supporting technology, laboratory astrophysics, and limited ground based observing. 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 in response to the NSPIRES cover page question in lieu of presenting a plan.

4. 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 is not accepting ATP proposals as part of the ROSES-2018 solicitation, but will solicit ATP proposals in ROSES-2019.

5. Astrophysics Guest Investigators

Six 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 K2 mission with the Kepler spacecraft (program element D.7), the nuclear spectroscopic telescope NuSTAR (program element D.10), the Transiting Exoplanet Survey Satellite (TESS, program element D.11), and the Neutron star Interior Composition Explorer (NICER, program element D.12). Guest investigator programs for the Hubble Space Telescope (http://www.stsci.edu/hst/), the Chandra X-ray Observatory (http://cxc.harvard.edu/), Stratospheric Observatory for Infrared Astronomy (SOFIA) (https://www.sofia.usra.edu/), and the Spitzer Space Telescope (http://www.spitzer.caltech.edu/) are solicited separately by the respective science centers of those missions. Please note that D.7, the K2 Guest Observer program, uses a multiphase proposal submission process. Please carefully read Section 7 of the K2 program element.

6. Strategic Astrophysics Technology

The Strategic Astrophysics Technology program (SAT; program element D.8) 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.

7. 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.9, 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) Program described in program element D.3 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.

8. Exoplanet Research Program

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.

9. Habitable Worlds Program

The cross-division program on habitable planets is described in program element E.4. The Astrophysics Division will consider supporting investigations that are focused upon the characterization of potentially habitable exoplanets and their atmospheres in order to inform targeting and/or operational choices for current NASA Astrophysics missions and/or formulation data for future NASA Astrophysics observatories.

10. LISA Preparatory Science

The LISA Preparatory Science (LPS; program element D.13) Program has been created to provide support for U.S. investigators involved in analysis and interpretation of simulated LISA data. It is not intended as a vehicle for requesting funds to support hardware work, which is funded separately, or to develop mission concepts.

11. SOFIA Next Generation Instrumentation

The Stratospheric Observatory for Infrared Astronomy (SOFIA) consists of a German-built 2.7- meter (2.5-meter useable aperture) telescope mounted in a Boeing 747- SP aircraft supplied and modified by NASA. SOFIA observes primarily at mid- and far-infrared wavelengths with a suite of instruments that have a wide-range of imaging and spectroscopic capabilities. NASA expects to issue a call for proposals for the development of the next generation of instrumentation for SOFIA in February 2018 with an anticipated due date in June 2018, as described in program element D.14.

D.2 ASTROPHYSICS DATA ANALYSIS

NOTICE: Analysis of publicly-available data from the Neutron star Interior Composition Explorer (NICER), including science instrument commissioning, Science Working Group, and calibration observations, are eligible for support for the first time under this ADAP cycle.

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, the Astrophysics Data Analysis Program (ADAP) provides support for investigations whose focus is on the analysis of archival data from NASA space astrophysics missions.

1.1 Special Considerations for ADAP 2018 Proposers

- 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 Sec. 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.
- 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. For convenience, the NSPIRES proposal cover page now includes a mandatory text box for this purpose. It is expected that the majority of proposals will simply state that the proposer will meet the mandatory minimum requirement by 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 which involve the development of new databases, data products, or data analysis tools must satisfy the more rigorous requirements described in Subsection 1.3.3. Those proposers should simply indicate that the proposal is in one of these categories and refer to the appropriate section of their proposal in the NSPIRES text box where it asks for a data management plan.

1.2 Research Objectives

The Astrophysics Data Analysis Program (ADAP) solicits research whose primary emphasis is 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 2018 Proposal.

Advanced Satellite for Cosmology and Astrophysics (ASCA; formerly Astro-D)	Keck Interferometer (KI) and Palomar Testbed Interferometer (PTI) Archives
Beppo Satellite di Astronomia X (BeppoSAX)	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)	Two Micron All Sky Survey (2MASS)
Infrared Space Observatory (ISO)	X-ray Multi-Mirror-Newton (XMM-Newton)
International Gamma-ray Astrophysics Laboratory (INTEGRAL)	Wide-field Infrared Survey Explorer (WISE)
International Ultraviolet Explorer (IUE)	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 selected 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.

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 (http://exoplanetarchive.ipac.caltech.edu/)
- NASA/IPAC Extragalactic Database (NED) (http://nedwww.ipac.caltech.edu/); and
- Virtual Astronomical Observatory (VAO; http://www.usvao.org/)

Prospective proposers should be aware that the Keck Observatory Archive (KOA) has recently been expanded and now includes data from 11 different instruments, including the High Resolution Echelle Spectrograph (HIRES), the Near InfraRed echelle SPECtrograph (NIRSPEC), and the Near Infrared Camera 2 (NIRC2). The data holdings for the three named instruments extend back to 1994 for HIRES, 1999 for NIRSPEC, and 2001 for NIRC2. Data archived in the KOA are allowable as the primary data source for an ADAP proposal.

Analyses of data from non-Astrophysics NASA space missions are eligible for ADAP support, provided that all such data are available in the public domain at the time of ADAP proposal submission and provided the primary scientific goals of the investigation address NASA's science goals for Astrophysics described in the agency's 2014 Science Plan (Section 4.4, p. 74-85) and the 2013 Astrophysics Roadmap. In any such case, the onus is on the proposer to clearly establish the relevance of the proposed work to NASA space astrophysics in their proposal.

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 Sections 1.3.4 and 1.3.5 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 aspects/limitations of the ADAP are described in Sec.1.3.1 – 1.3.6 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, suborbital platforms, or non-NASA space missions; 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. The budget justification for any such proposals must include a summary of the work effort (in terms of personnel time commitment) and 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 2018 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 locked within them, 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 Sec. 1.4) accepts proposals for the development of publicly-accessible databases of observational data from NASA-sponsored balloon-borne and sounding rocket astrophysics suborbital 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 in this area clearly articulate what the final products of the investigation will be and how the products will be made available to the community. If the products are to

be ingested and curated at an existing astrophysics archive (see list in §1.2 above), the cost of any required support for the proposed activity from the relevant archive must be included in the proposal budget. If the proposing team does not include a representative of the relevant data center, proposers are strongly encouraged to include a letter of acknowledgement from that archive in their proposal.

Finally, prospective proposers should also 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 in the Astrophysical Databases research area must 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.

1.3.4 *Support for Approved Spitzer Guest Observers*

There is no funding available to support the analysis of observations selected under Cycle 14 of the Spitzer Space Telescope Guest Observer (GO) program. Therefore, the Principal Investigators (PIs) of approved Priority 1 GO observing programs selected under Cycle 14 are eligible to propose for data analysis support under ADAP 2018, even if those observations have yet to be executed or the data are still within their exclusive-use period at the time of the proposal deadline.

In addition, the Principal Investigators of approved Cycle 13 GO observing programs of < 200 hrs are also eligible to propose for data analysis funding under ADAP 2018, providing their observations have at least been initiated at the time of the ADAP proposal submission deadline.

Only one ADAP proposal is allowed per approved Spitzer GO program under this waiver. If it is found that more than one ADAP proposal has been submitted for a given Spitzer GO program, all such proposals will be declined and not considered for funding. This restriction expires at the end of the exclusive-use period, when all the data from the Spitzer GO program are released in the public domain. Also, the PI of an eligible Spitzer GO program need not be the PI of an associated ADAP proposal, but it is expected that they will at least be a member of the proposing team.

This waiver does not extend to Director's Discretionary Time (DDT) observations.

Proposers seeking funding support for an approved GO program are not relieved of the responsibility to provide a compelling proposal that meets all of the requirements of the ROSES-2018 NRA and the ADAP program element. It is generally not sufficient to simply submit the approved GO proposal.

1.3.5 *Support for US Co-Investigators on Foreign-led XMM GO Proposals*

U.S. Co-Investigators on foreign-led XMM GO proposals that are selected under the AO-17 cycle and rated as either Category A or Category B are eligible to propose for funding under ADAP 2018 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 US 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 US 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. Please note—this waiver does not apply to US-led Category A or Category B proposals selected under the AO-17 cycle (which are funded under the auspices of the XMM US Guest Observer Facility), or to any Category C XMM 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-2018 NRA and the ADAP program element. It is generally not sufficient to simply submit the approved GO proposal.

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 2018 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 2018 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 with a primary focus on Solar System objects or on the solar-terrestrial interaction (other NASA programs support this kind of research, see Appendices B and C). 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. Such research is eligible for funding through the Research and Analysis (R&A) programs of NASA's Planetary Science Division (see Appendix C).

- 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; or
- Proposals for the acquisition of substantial computing facilities or resources beyond nominal workstation or network requests.

1.3.7 *Proposal formatting*

In addition to the scientific scope of the ADAP described in the following sections, both the *NASA Guidebook for Proposers* and Section IV(b)ii of the *ROSES Summary of Solicitation* provide clear and specific requirements for the format of proposals submitted in response to this program element (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 ruled noncompliant and will not be rated or considered for funding. 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 ten defined ADAP Research Areas are:

1. Star and Exoplanetary System Formation —includes of studies star-forming clouds, protostars, protoplanetary and debris disks, and formation of exoplanets and exoplanetary systems;
2. Stellar Astrophysics and Exoplanets —includes studies of the structure and evolution of main sequence stars, brown dwarfs, and exoplanet detection and characterization;
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 X-ray Astrophysics —includes studies of neutron stars, stellar-mass and supermassive black holes, X-ray binaries, black-hole binaries;

5. Supernovae and Gamma Ray Bursts —includes studies of supernova progenitors, the physics of catastrophic stellar explosions, and supernova-driven nucleosynthesis, but not including studies of supernova remnants and their interaction with the interstellar medium (ISM);
6. Interstellar Medium —includes studies of dense clouds, the diffuse ISM, supernova remnants and their interactions with the ISM, interstellar dust, HII regions, and diffuse galactic emission;
7. Normal Galaxies and Galactic Structure —includes studies of the structure of the Milky Way and other galaxies;
8. Active Galaxies and Quasars —includes studies of interacting galaxies, starburst galaxies, Luminous/ultraluminous infrared galaxies, Seyfert galaxies, radio galaxies, active galactic nuclei, and quasars;
9. Large Scale Cosmic Structures —includes studies of clusters of galaxies, galaxy environment and evolution, intracluster medium, diffuse x-ray background, and cosmology); and
10. Astrophysical Databases —includes compilations of fundamental atomic, molecular, solid state parameters, development of publicly-accessible databases of observations from NASA suborbital astrophysics projects, higher-level data products based on existing archival astrophysical data sets, and data analysis tools).

2. Current Profile of the ADAP

2.1 ADAP 2017 Submission statistics

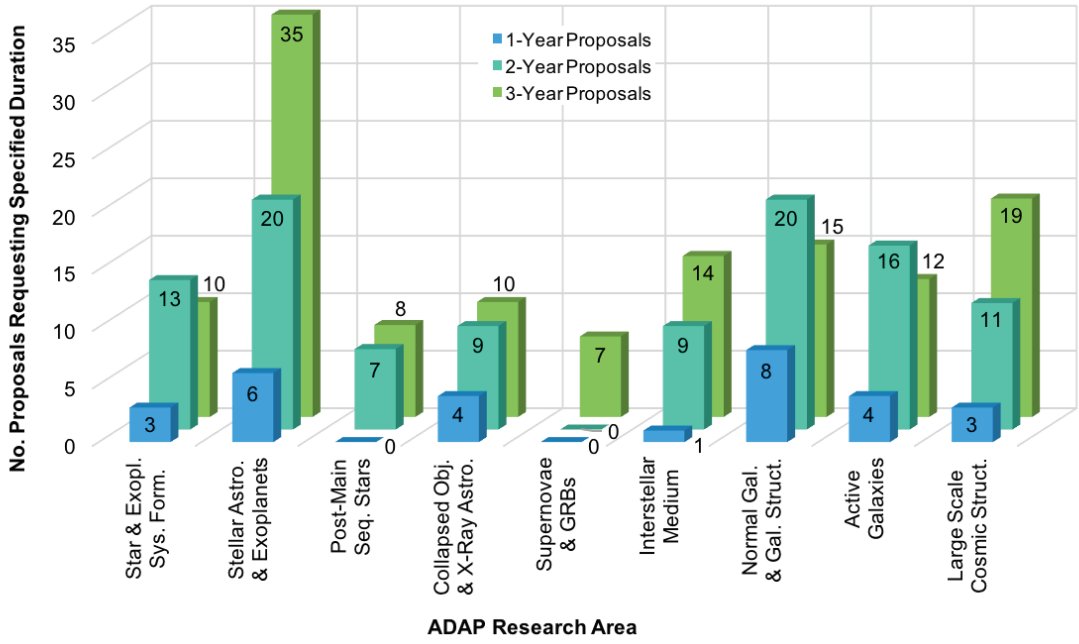


Figure 1. The distribution of 2017 ADAP proposal submissions, broken down by requested funding duration, across the Research Areas covered by the program. Proposals in the Astrophysical Databases Research Areas were

grouped into one of the Research Areas shown based on their subject matter. Three proposals were declared non-compliant and declined without review.

In 2017, a total of 264 proposals were submitted in response to the ADAP program element, an 11% increase in the number of proposals compared to the ADAP 2016 program element. The distribution of those proposals over the various research areas covered by ADAP 2017 is shown in Figure 1 above. 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.

2.2 Distribution of annual funding levels for ADAP tasks

With an annual budget of around $17.5M, the ADAP typically supports around 120 investigations in any given year (includes new starts, plus continuing investigations). Although the average annual ADAP award is approximately $139,000, actual award amounts span the range from as little as $40,000 per year to more than $200,000 per year. The plot in Figure 2 shows the distribution of annual awards for the ADAP in FY 2018.

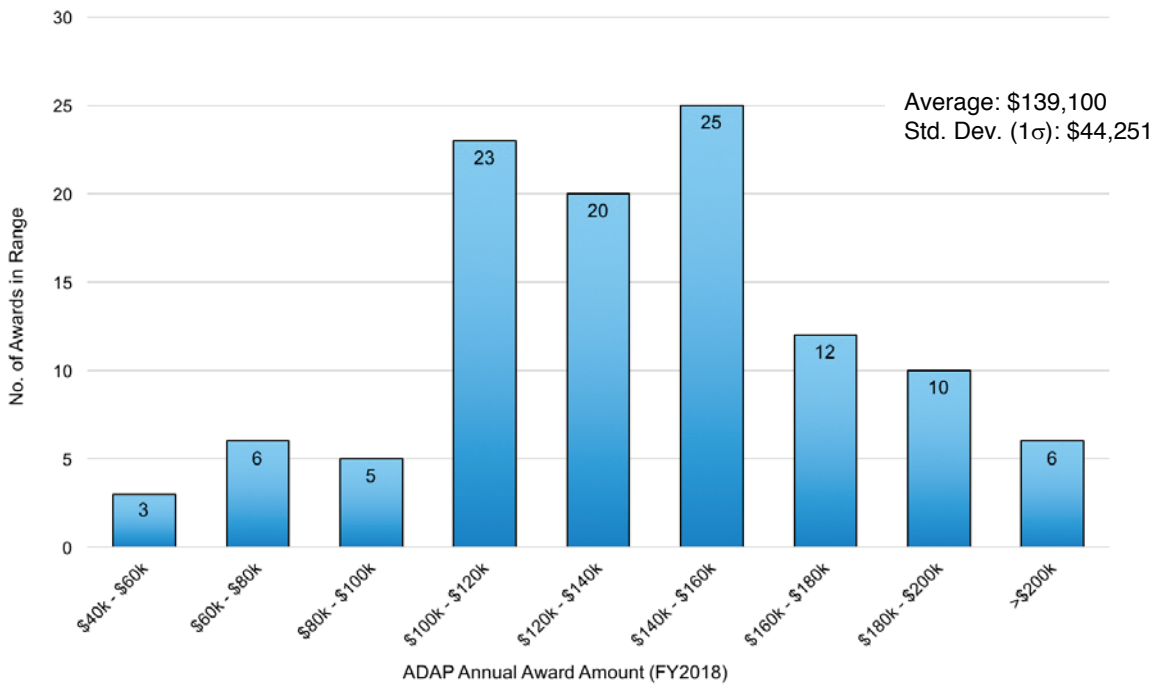


Figure 2. The distribution of annual awards for funded ADAP tasks in FY 2018. Data include both ADAP 2017 new starts and ongoing tasks from previous solicitations.

2.3 Evaluation Criteria

The evaluation criteria for all proposals are in the *Guidebook for Proposers* and the *ROSES Summary of Solicitation*. In addition, 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.

3. Summary of Key Information

Expected program budget for first year of new awards	~$7.0M
Number of new awards pending adequate proposals of merit	~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, 2019
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. 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	NNH18ZDA001N-ADAP

NASA 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 January 31, 2019. The proposal due dates for this program element were previously temporarily changed to "TBD" as a result of the partial government shutdown. This amendment releases new due dates for the effected program elements in Appendix D. For this program element the new deadline for the mandatory notice of intent is February 27, 2019, and the new due date for proposal submission is March 29, 2019.

Amended December 18, 2018. This amendment: (1) Removes the category of proposals for ground-based observations; (2) Updates points of contact; (3) Inserts a new section, 1.2.1.3, detailing CubeSat proposal guidelines; and (4) Adds a mandatory letter of support for unique sounding rocket or balloon investigation requirements. In addition, some clarifications and corrections of typographical errors have been made. Additions are shown in bold and deleted text is in strikethrough. The due dates have not been changed.

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.

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 on suborbital sounding rockets, stratospheric balloons, or other platforms; and (iii) supporting technology, laboratory research, ~~and/or (with restrictions) ground-based observations that are directly applicable to space astrophysics missions~~. To meet these goals, proposals are solicited in the following ~~five~~ **four** broad categories:

- Suborbital/Suborbital-class Investigations

- Detector Development
- Supporting Technology
- Laboratory Astrophysics
- ~~Ground-Based Observations.~~

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 program should be submitted to the Suborbital Investigations category.
- The Laboratory Astrophysics category of this program element includes theoretical investigations in the area of Atomic and Molecular Astrophysics. However, all other theoretical investigations are solicited separately under the Astrophysics Theory Program described in program element D.4 of this NRA.
- **The APRA program element is no longer intended to support ground-based observations except in the context of demonstrating maturity for new technologies intended for use in space flight.**
- ~~The Ground-Based Observations category of APRA will consider proposals only from observers who are ineligible for such support from the National Science Foundation (e.g., scientists employed by NASA or another Federal Agency). In addition:~~
  - ~~The program element is not intended to support ground-based observational studies of extrasolar planets. Such proposals should instead be submitted to program element E.3 of this NRA. Testing and validation observations conducted at a ground-based facility as part of an exoplanet technology research program are, however, acceptable.~~
  - ~~Proposals for any ground-based gamma-ray burst investigations are no longer eligible for support within the APRA program element and should be submitted to the relevant mission Guest Investigator program(s).~~
  - ~~Ground-based particle astrophysics observations are not supported by this program element. Such investigations in support of a NASA Astrophysics mission should be directed to the relevant mission Guest Investigator program(s).~~
- The Fundamental Physics discipline area supports proposals: 1) to test 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, 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 ROSES program element D.2.
- 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 *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 the Jet Propulsion Laboratory (JPL). The only exception is for Suborbital/Suborbital-class Investigations, see Section 1.2.1.3 below.
- Projects devoted to technology development efforts that do not generate scientific data need not provide data management plans but must note on the NSPIRES cover page that they do not need to provide a data management plan because they are in the Detector Development or Supporting Technology category.
- Proposals to advance technologies 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, WFIRST, Euclid, **XRISM**~~XARM~~) are excluded from APRA, as these technologies are expected to be supported by the mission funding. **Technology development for potential future Explorer 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.

Suborbital launch vehicle services include those provided by the NASA Sounding Rocket Program Office (SRPO) and the NASA Balloon Program Office (BPO) and commercial suborbital reusable launch vehicle services through the Flight Opportunities Program of NASA's Science and Technology Mission Directorate (STMD). The Science Mission Directorate also provides for CubeSats and International Space Station (ISS) payloads. 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. Please pay particular attention to the additional requirements for proposals for the ISS that are described in that section. ISS payloads will be subject to oversight beyond that of a typical sounding rocket or balloon payload.

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 should be given. Although most awards are for three- or four-years' duration, a five-year proposal may be accepted to develop a completely new, highly meritorious investigation through its first flight. Because of the anticipated greater degree of complexity, the

Scientific/Technical/Management section of proposals for these 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/dissemination. 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 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.

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 and 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.

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 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. 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 kbs LOS; 50-100 watts, regulated 28 V battery nominal	Ft. Sumner (Spring or Fall) Palestine (Summer)

Projects~~, including a flight from Antarctica or~~ 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 Summary of Solicitation* Section V(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*, launch and integration costs must be included in the submitted PI budget. Cost up to and including 3U are typically fully covered by CSLI, but for larger and/or more complex spacecraft the PI must budget for the cost above $300K. A range of approximate costs for integration into the spacecraft and launch to common orbits are shown below, however, proposers must contact CSLI for a more accurate cost estimate prior to submission.

Form Factor	Cost* to Low Earth Orbit	Cost* to ISS†
Single 3U	$225K - $350K	$245K - $320K
Single 6U	$450K - $1.5M	$415K - $575K
Double 6U	$800K - $3M	$900K - $1M
Single 12U	$900K - $3M	-

*** The first $300K will be covered by NASA; as a rough estimate before CSLI provides a cost for your specific mission, PIs should subtract up to $300K from any cost above $300K.**

† If ≤ 6U and the orbit needed is compatible with an ISS deploy (51.6 deg inclination, ~400km, ~1-year lifetime), the cost would be at the lower end of these ranges. Note that currently there is not a 12U deployer on the ISS.

1.2.1.4 *Special Instructions for Multiple-Institution Proposals for Suborbital/Suborbital-class Investigations: Co-Investigator Proposals*

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) may 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. If the PI is from a U.S. Government organization, Co-Is will be funded by awards from that organization. NASA centers apply no overhead cost to the budgets for Co-I organizations.

Alternatively, for some combinations of collaborating organizations, NASA recognizes that there may be advantages to providing separate awards to some of the collaborating organizations in response to "Co-Investigator Proposals." The lead investigator from the Co-I organization **should be given** ~~serves as~~ the **role** "**Co-I**/Institutional PI" **on the proposal by the main PI and should be listed as the PI on the proposal from the "Co-Investigator" organization**. ~~for the award to his/her organization (see the *NASA Guidebook for Proposers*)~~.

For teams wishing to take advantage of such multiple-award flexibility, the following instructions should be followed:

- Only the "lead proposal" for the overall investigation, submitted by a single PI, will be reviewed. This lead proposal must include:
  - A clear statement in the first sentence of the Proposal Summary that identifies the proposal as the lead proposal.
  - The Cover Page/Proposal Summary/Budget Summary of the lead proposal, showing the summary of the budget requested by the lead organization. This should not include the budgets for those organizations submitting Co-I proposals. Support for Co-Is at organizations that do not submit separate Co-I proposals should be included in the budget summary of the lead proposal in the usual way.
  - A work statement and budget justification (narrative and details) covering the items in the budget summary of the lead proposal, appending the Task Statements and the budget justifications (narrative and details) from each of the Co-I proposals (see further below).
- Each organization submitting a Co-I proposal must:
  - Have a Proposal Title that is identical to the title of the lead proposal, except that "[Organization Name] Co-I" is added to the end.
  - Have a Proposal Summary that clearly cross-references the PI of the lead proposal in the first sentence.
  - Complete the Cover Page/Proposal Summary/Budget Summary and include all materials indicated in the *NASA Guidebook for Proposers*.
  - Contain, in lieu of the Scientific/Technical/Management section, a *Task Statement*, not to exceed five pages, that describes the contribution of the Co-I organization and the role of the Co-I(s) to the overall investigation. In the case of multiple Co-Is from the same organization, a single Co-I serving as the "Institutional PI" must be identified.
  - Include a budget justification (narrative and details) covering the Co-I organization’s proposed activities.

- Be submitted electronically through the organization's Authorized Organizational Representative (AOR), with the Co-I (Institutional PI) from that organization listed as the PI.

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 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 for future space missions. 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. Missions already funded (pre-Phase A or beyond) are excluded. 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** ~~Astrophysics Recovery~~ Mission (**XRISM** ~~XARM~~) 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.

~~1.2.5 *Ground-Based Observations*~~

~~This APRA category will consider proposals for ground-based observations, but only from observers who are ineligible for such support from the National Science Foundation (e.g., scientists employed by NASA or another Federal Agency). Moreover, this element is not intended to support ground-based observations for general scientific objectives. Rather, these observations must be an integral part of a technology development or demonstration project for space astrophysics or directly support the planning and design of future NASA space astrophysics missions.~~

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 ~~five~~ **four** APRA categories in five recent cycles; note that proposals for APRA-12 (denoted A-12) were due in 2013 and funded in FY 2014, 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 new selections [$M]					Number of New Selections (including Co-I proposals)				
	A-12	A-13	A-14	A-15	A-16	A-12	A-13	A-14	A-15	A-16
Suborbital Investigations	6.1	5.7	9.1	8.7	6.8	15	17	17	26	24
Detector Development	3.1	1.6	4.2	4.1	3.7	7	5	11	15	12
Supporting Technology	1.9	2.3	2.8	1.9	1.4	6	9	9	12	7

Laboratory Astrophysics	0.6	1.1	1.0	1.4	1.3	5	8	8	11	10
~~Ground-Based Observations~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~

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.

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 proposal summary in the Notice of Intent, or E-mailed to the relevant Program Officer listed below.

2.4 New 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 may be returned without review. **This includes Institutional PI/Co-I proposals described in Section 1.2.1.4.**

The PI ~~can~~ **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(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.

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 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 please contact brian.ramsey@nasa.gov.

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	Between 1 January and 31 March in the year after the proposal due date (except that NASA Centers may plan for a start at the beginning of the fiscal year).
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 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	NNH18ZDA001N-APRA
Main NASA point of contact concerning this program	**Dominic J. Benford** Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-**1261** 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.

Astrophysics Division
Science Mission Directorate
NASA Headquarters
Washington, DC 20546-0001

NAME	PROGRAM RESPONSIBILITY	TELEPHONE	EMAIL
Eric V. Tollestrup	Infrared, Submillimeter, and Radio Astrophysics	(202) 358-0907	Eric.V.Tollestrup@nasa.gov
Michael R. Garcia	Ultraviolet and Visible Astrophysics	(202) 358-1053	Michael.R.Garcia@nasa.gov
Valerie Connaughton	X-ray Astrophysics	(202) 358-1763	Valerie.Connaughton@nasa.gov
Valerie Connaughton	Gamma-ray Astrophysics	(202) 358-1763	Valerie.Connaughton@nasa.gov
Thomas Hams	Particle Astrophysics and Fundamental Physics	(202) 358-5162	Thomas.Hams-1@nasa.gov
Douglas M. Hudgins	Laboratory Astrophysics	(202) 358-0988	Douglas.M.Hudgins@nasa.gov

D.4 ASTROPHYSICS THEORY

NOTICE: November 5, 2018. The point of contact for this program element is now Evan Scannapieco. See below for more information.

Beginning in ROSES-2017, the Astrophysics Theory Program (ATP) element of ROSES converted to soliciting proposals on a biennial basis. Thus, NASA is not accepting ATP proposals as part of the ROSES-2018 solicitation, but will solicit ATP proposals in ROSES-2019.

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 laboratory, including the Jet Propulsion Laboratory (JPL).

Proposals 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.

NASA 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 **[Updated November 5, 2018]**

D.5 NEIL GEHRELS SWIFT OBSERVATORY GUEST INVESTIGATOR – CYCLE 15

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 nontransient sources.

Cycle 15 observations and funding will commence on or around April 1, 2019, and last approximately 12 months. Further details on the Cycle 15 program will be posted on the Swift web pages (https://swift.gsfc.nasa.gov/proposals) in August 2018. As was the case in Swift GI Cycles 4 through 14, 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 × 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 ($E/\Delta E \sim 300$) 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, 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 15 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-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-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 nonmonitoring 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 nonmonitoring 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 15 to Cycle 16. Regular proposal targets whose observations have commenced in Cycle 15 will be awarded carryover time in Cycle 16 until the proposed observations are substantially complete. GIs whose observing programs have not begun in Cycle 15 will be required to repropose in Cycle 16 if they wish to acquire observing time. Similarly, Cycle-14-accepted proposals that have not been initiated by the start of Cycle 15 will not be carried over. Cycle 14 GIs concerned that their programs may not be started before the end of the cycle should repropose for Cycle 15.

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 15; 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/secure/toop/request.php. It is highly recommended that ToO proposers register as Swift ToO users in advance at https://www.swift.psu.edu/secure/toop/too_newuser.php. 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 15 ToO proposals may be triggered until March 31, 2020. GIs whose ToO programs do not trigger in Cycle 15 will be required to repropose 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 15 to Cycle 16, and may be triggered until March 31, 2021.

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/operations/obsSchedule.php).

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 $1.2M 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. The science/technical justification should contain a brief description of previous Swift programs carried out by the PI. 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.

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 (CV), pending/current support) is required or allowed;
- 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 4:30 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 4:30 p.m. deadline supersedes the deadline stated in the *Guidebook for Proposers* and in the *ROSES Summary of Solicitation.*

Instructions for the submission of ROSES proposals are given in the *ROSES Summary of Solicitation* and for topics not addressed there please refer to the *NASA Guidebook for Proposers* (http://www.hq.nasa.gov/office/procurement/nraguidebook/). Swift GI Proposers should follow these instructions, except where they are overridden by the instructions given in the *ROSES Summary of Solicitation* or in this program element.

2.2.2 *Evaluation of Proposals submitted to the Swift GI Program*

Proposals will be evaluated by a peer evaluation panel with respect to the criteria specified in the *NASA Guidebook for Proposers*, where it is understood that the intrinsic merit of a proposal shall include the following factors:

- 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.

2.2.3 *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 *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 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.

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	~$1.2M
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 proposals	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 15 observing) as a planning date for start of observation
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. LaTeX templates (available for download at https://swift.gsfc.nasa.gov/proposals/swiftgi.html) can be used for the proposals. No supporting material (e.g., CV, pending/current support) will be considered for Phase 1. 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*.
Detailed instructions for the preparation and submission of proposals	Please see 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 in PDF format; no hard copy is required. See Section IV of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*.
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	Martin Still Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-4462 Email: martin.still@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 12

NOTICE: Amended January 31, 2019. The proposal due dates for this program element were previously temporarily changed to "TBD" as a result of the partial government shutdown. This amendment releases new due dates for the effected program elements in Appendix D. For this program element Phase-1 proposals are now due (via ARK RPS) at 4:30 pm March 20, 2019.

December 13, 2018. Section 2.1 General Information has been corrected by referring to in Section 3 to make it consistent with the higher average award amounts provided on November 28. New Text is in bold and deleted text is struck through. The due date remains unchanged.

November 28, 2018. Three things have been clarified in this program element: 1) A new Section 1.3 has been inserted on the solar array anomaly and its implications on nonuniform sky coverage and Fermi's ability to respond to Targets of Opportunity and to perform pointed observations; 2) lower number of expected awards due to higher average award amounts; 3) uncertainties of future joint Fermi-Arecibo proposals (section 1.4.3). New Text is in bold and deleted text is struck through. The due date remains unchanged.

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), ~~Arecibo Observatory,~~ the VERITAS ground-based Cerenkov telescope facility and, the INTErnational Gamma-Ray Astrophysics Laboratory (INTEGRAL). Please refer to section 1.3.3 for important details. They may also apply for high-end computing resources.

Investigators may propose Fermi pointed observations, but 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 NASA funding is available only to principal investigators (PIs) who are employed at a U.S. institution at the time the Phase-2 proposal is submitted by that institution via NSPIRES.

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 survey mode – the main mode of operation – Fermi provides nearly uniform sky exposure every ~3 hours.

Modifications to this standard sky-survey mode were implemented during mission cycle 7 and may be considered in the future. Those alternative sky-survey strategies were designed to maximize the exposure at the Galactic Center and in turn to optimize the pursuit of several specific scientific objectives. They resulted from a solicitation of ideas from the community leading to an external committee recommendation to the Fermi project. It is anticipated that the resulting non-uniformity of sky exposure leaves Fermi's monitoring capability largely intact with a tolerable impact on other scientific endeavors. See http://fermi.gsfc.nasa.gov/ssc/proposals/alt_obs/obs_modes.html for details. Documents providing a more complete description of Fermi can be found at http://fermi.gsfc.nasa.gov/ssc.

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 mission design lifetime is five years, with a goal of ten years. After a checkout period, science operations began on August 4, 2008. Based upon the results of the NASA 2016 Senior Review, support for mission operations was extended through September 30, 2019.

The GI community is supported by the Fermi Science Support Center (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 (see http://fermi.gsfc.nasa.gov/ssc/).

1.3 Solar Array Anomaly [This Section added November 28, 2018]

Recently, due to an anomaly with one of the solar array drive motors, 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.

1.4 Types of Proposals

The Cycle 12 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 (but proposers should be aware that compelling science justification and analysis will be required to quantify the additional scientific benefit of such observations – see the Fermi Users' Group (FUG) analysis at http://fermi.gsfc.nasa.gov/ssc/proposals/pointing_analysis/). The total time allocated to pointed observations will be between 0 and 15% of the total available observing time in Cycle 12. 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.

1.4.1 *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 every ~3 hours; this mode will suffice for nearly all 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 (refer to 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.

1.4.2 *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. Because pointed observations often provide only moderate advantage over survey mode, requests for pointed observations must provide a

compelling scientific justification for interrupting survey mode. It will, therefore, be incumbent upon the proposer to demonstrate that a pointed observation is required to achieve the scientific objectives. Proposers thinking of requesting pointed observations are strongly encouraged to contact the FSSC and anyone considering modified observation strategies must do so. (http://fermi.gsfc.nasa.gov/ssc/help/).

1.4.3 *Multiwavelength observations* **[This Section edited November 28, 2018]**

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, ~~Arecibo,~~ VERITAS, and INTEGRAL. 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. **As noted the future of the previously supported joint program agreement with the Arecibo Observatory is uncertain. Any updated information will be posted on the FSSC website well in advance of the Phase-1 proposal deadline.** 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/arecibo.html,

http://fermi.gsfc.nasa.gov/ssc/proposals/veritas.html, and

http://fermi.gsfc.nasa.gov/ssc/proposals/integral.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. They 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.

1.4.4 *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.

1.5 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 should comply with the page limit and format requirements of Phase 1 Regular proposals. It should list the deliverables (papers, public software, etc.) that have resulted from the ongoing work, as well as an adherence to the schedule specified in the original proposal. Progress reports must be submitted through the Astrophysics Research Knowledgebase Remote Proposal System (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.

1.6 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, Arecibo, INTEGRAL, and VERITAS.

Proposals must be single-spaced, typewritten, English-language text on standard US 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 **[Corrected December 13, 2018]**

Awards for Regular and Large proposals will conform to the cost guidelines specified in section 3. ~~Awards for Regular (one or two-year duration) proposals are expected to average around $55,000 per year and $125,000 per year for Large proposals~~. Phase-2 proposals requesting more than the above are unlikely to be approved without an extremely compelling justification.

Awards for triggered analyses (e.g., transients meeting specific criteria) will not be released until after such triggers occur.

Fermi GI funding is open only to individuals employed at U.S. institutions. Only proposals led by a US-based PI 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.

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 budget for review 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.
- 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 the *ROSES Summary of Solicitation* 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.

NASA uses a single, uniform set of instructions for the submission of ROSES proposals. These instructions are given in the *NASA Guidebook for Proposers* (http://www.hq.nasa.gov/office/procurement/nraguidebook/). Fermi GI proposers must follow these instructions, except where they are overridden by the instructions given in the *ROSES Summary of Solicitation* or in this program element.

2.2.2 *Evaluation of Phase 1 Proposals Submitted to the Fermi GI Program*

A peer review panel will evaluate all proposals with respect to the criteria specified in Section C.2 of the *NASA Guidebook for Proposers*, where it is understood that the intrinsic merit of a proposal shall include the following factors:

- 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.

For data analysis development and theoretical investigations, the evaluation of relevance of a proposal shall include the degree to which the investigation directly advances Fermi science goals.

2.2.3 *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.

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~~-40~~ Regular proposals with average awards of ~~$55K~~ **$65K** and generally less than **$70K** ~~$60K~~ 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 of this ROSES NRA.
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 pages for regular proposals, 6 pages for large proposals; 1 additional page is required to describe joint program observations (see Section 1.5). 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*.

Detailed instructions for the preparation and submission of proposals	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 in PDF format; no hard copy is required. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
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	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	Julie McEnery Code 661 NASA Goddard Space Flight Center Greenbelt, MD 20771 Telephone: 301-286-1632 Email: Julie.E.McEnery@nasa.gov

D.7 K2 GUEST OBSERVER – CYCLE 7

NOTICE: November 2, 2018. Earlier this year ROSES program element D.7 K2 GO was solicited "contingent on the spacecraft health and fuel condition". Since the Kepler space telescope has run out of fuel needed for further science operations, this opportunity is being removed from ROSES. For more information see https://www.nasa.gov/press-release/nasa-retires-kepler-space-telescope-passes-planet-hunting-torch.

Although the mission operations of Kepler/K2 have ceased, science using archival data will still be solicited in ROSES-2019, primarily via program element D.2 Astrophysics Data Analysis, but also via program elements E.3 the Exoplanets Research Program and D.4 the Astrophysics Theory Program.

This program element solicited proposals for the acquisition and analysis of new scientific data from the K2 mission (http://keplerscience.arc.nasa.gov). K2 repurposed the space-borne hardware and ground-based operations of the Kepler mission for a pointed survey of predetermined locations along the ecliptic plane.

Earlier this year it was noted that this program element was contingent on the spacecraft health and fuel condition. Since the Kepler space telescope has run out of fuel needed for further science operations, this opportunity is being removed from ROSES. For more information see https://www.nasa.gov/press-release/nasa-retires-kepler-space-telescope-passes-planet-hunting-torch.

Although the mission operations of Kepler/K2 have ceased, science using archival data will still be solicited in ROSES-2019, primarily via program element D.2 Astrophysics Data Analysis, but also via program elements E.3 the Exoplanets Research Program and D.4 the Astrophysics Theory Program.

Technical questions concerning this program element may be directed to the Kepler Science Center	Geert Barentsen Kepler Guest Observer Office NASA Ames Research Center, MS 244-30 Moffett Field, CA 94035-1000 Telephone: (650) 604-2784 email: keplergo@mail.arc.nasa.gov
NASA point of contact for programmatic information	Mario Perez Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1535 email: mario.perez@nasa.gov

D.8 STRATEGIC ASTROPHYSICS TECHNOLOGY

NOTICE: Amended January 31, 2019. The proposal due dates for this program element were previously temporarily changed to "TBD" as a result of the partial government shutdown. This amendment releases new due dates for the effected program elements in Appendix D. For this program element the new deadline for the mandatory notice of intent is February 27, 2019, and the new due date for proposal submission is March 29, 2019.

Clarified November 28, 2018. In Section 1.3 the words "normal incidence" have been added between "…large space-based segmented" and "mirror telescopes".

Amended on November 27, 2018. This amendment releases final text for this program element, which was previously TBD. ~~Mandatory NOIs are due on January 24, 2019, and proposals are due on March 21, 2019.~~ Please note that these are the same dates as for D.3 Astrophysics Research and Analysis Program (APRA).

1. Scope of Program

1.1 Overview

Over the next decade and beyond, NASA's Astrophysics Division (APD) expects to undertake space flight missions that will explore the nature of the Universe at its largest scales, its earliest moments, and its most extreme conditions; missions that will study how galaxies and stars formed and evolved to shape the Universe we see today; and missions that will seek out and characterize the planets and planetary systems orbiting other stars.

To enable implementation of these strategic missions, APD has established the Strategic Astrophysics Technology (SAT) program to support the maturation of key technologies for potential infusion in space flight missions. Strongly endorsed by the 2010 Decadal Survey of Astronomy and Astrophysics (hereafter, Astro2010; http://www.nap.edu/catalog.php?record_id=12951, the SAT program is a key element of the strategy adopted by the Astrophysics Division in implementing (https://science.nasa.gov/astrophysics/documents) the Astro2010 recommendations.

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). Table D.8.1 (on the following page) provides the definitions for the midrange TRLs supported by the SAT program.

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.

Table D.8.1. Expanded Maturity Definitions for Midrange TRLs (SAT Program)

TRL	Definition	Hardware Description	Software Description	Exit Criteria
3	Analytical and experimental critical function and/or characteristic proof-of-concept	Analytical studies place the technology in an appropriate context and laboratory demonstrations, modeling and simulation validate analytical prediction.	Development of limited functionality to validate critical properties and predictions using nonintegrated software components.	Documented analytical/experimental results validating predictions of key parameters.
4	Component and/or breadboard validation in laboratory environment.	A low fidelity system/component breadboard is built and operated to demonstrate basic functionality and critical test environments, and associated performance predictions are defined relative to final operating environment.	Key, functionality critical software components are integrated and functionally validated to establish interoperability and begin architecture development. Relevant environments defined and performance in the environment predicted.	Documented test performance demonstrating agreement with analytical predictions. Documented definition of relevant environment.
5	Component and/or breadboard validation in relevant environment.	A medium fidelity system/component brassboard is built and operated to demonstrate overall performance in a simulated operational environment with realistic support elements that demonstrate overall performance in critical areas. Performance predictions are made for subsequent development phases.	End-to-end software elements implemented and interfaced with existing systems/simulations conforming to target environment. End-to-end software system tested in relevant environment, meeting predicted performance. Operational environment performance predicted. Prototype implementations developed.	Documented test performance demonstrating agreement with analytical predictions. Documented definition of scaling requirements.

6	System/subsystem model or prototype demonstration in a relevant environment.	A high fidelity system/component prototype that adequately addresses all critical scaling issues is built and operated in a relevant environment to demonstrate operations under critical environmental conditions.	Prototype implementations of the software demonstrated on full-scale, realistic problems. Partially integrated with existing hardware/software systems. Limited documentation available. Engineering feasibility fully demonstrated.	Documented test performance demonstrating agreement with analytical predictions.

1.2 Requirements for SAT Proposals

This section describes the general requirements for SAT proposals. Proposers are strongly encouraged to familiarize themselves with APD's technology needs prioritized by the APD program offices:

- Exoplanet Exploration Program's Technology Gap List and Technology Plan Appendix (both available at https://exoplanets.nasa.gov/exep/technology/gap-lists/)
- Physics of the Cosmos and Cosmic Origins programs' Program Annual Technology Report (PATR) available at https://apd440.gsfc.nasa.gov/technology/

In addition, NASA has identified four large mission concepts and chartered study teams to develop compelling science cases and the associated mission architectures for those missions. Those concept studies will be submitted for consideration and prioritization by the 2020 Astronomy and Astrophysics Decadal Survey for potential development as the next large astrophysics mission to follow the James Webb Space Telescope (JWST) and the Wide-Field Infrared Survey Telescope (WFIRST). Proposals for the development of technologies that feed into and enable these missions are particularly encouraged. More information about these studies and their technology development requirements can be found at their respective pages:

- HabEx: https://www.jpl.nasa.gov/habex/
- Lynx: https://wwwastro.msfc.nasa.gov/lynx/
- LUVOIR: https://asd.gsfc.nasa.gov/luvoir/
- OST: https://asd.gsfc.nasa.gov/firs/

Abstracts and reports on NASA APD's prior investments in funded strategic technology development is available in a searchable database at http://www.astrostrategictech.us/.

Proposers will be expected to:

- Identify a strategic mission or mission concept to which the proposed technology is anchored (competed missions, such as Explorers, are not considered strategic missions);
- Identify the Astrophysics science themed program most closely related to the proposed technology. Proposed technologies may be relevant to more than one of these three areas. Consequently, NASA reserves the right to reassign a proposal to any of the three Programs for the purposes of review;
- Describe the proposed path to achieving the goals of the proposed technology. In particular:

(a) Present a convincing case that the technology being proposed is already at TRL=3;
(b) Specify the expected end TRL at the conclusion of the proposed program. It is neither required nor expected that proposers will complete this entire development process (or even advance a full step on the TRL scale) within the two or three year duration of proposals solicited in this call. However, the program should result in a quantitatively demonstrable advancement of the subject technology;
(c) Define at least one objectively verifiable milestone that represents a meaningful advancement of their chosen technology and provide a schedule for achieving that (those) milestone(s) over the course of their proposed project;
(d) Describe a work plan that fully articulates the technical parameters to be demonstrated for all technical milestones identified. This work plan should include the measurements to be made, analyses to be applied, success criteria, and documentation to be provided. The work plan and associated milestones will be critically evaluated as part of the peer-review process.

In addition to the above, Section IV(b)ii of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers* provide additional specific requirements for the format of proposals submitted in response to this solicitation (e.g., page limits, acceptable font sizes, line spacing, margins, etc.). Proposals found to violate these guidelines will be penalized, even to the extent of being declined without review, or not being funded, independent of their intrinsic merit evaluation. Proposers are reminded that it is the PDF version of their proposal in NSPIRES that will be judged for compliance. Since, in rare cases, cross-platform translation of PDF documents can alter the formatting of a document, proposers are strongly urged to download copies of any documents they upload to the NSPIRES system to ensure that they still conform to all formatting requirements. NASA does not require a data management plan for proposals to this program element.

1.3 Specific Technology Development Exclusions

Proposals in the following areas are not solicited under SAT this year:

- Investigations that advance gravitational wave detection technologies to performance levels required for the Laser Interferometer Space Antenna (LISA) (funded through a directed technology development activity);
- Investigations that advance X-ray technologies to performance levels required for the Advanced Telescope for High Energy Astrophysics (ATHENA) technologies (funded through a directed technology development activity);
- Investigations that advance starshade technologies (funded through a directed technology development activity);
- Investigations that advance coronagraph technologies to the performance levels being targeted under the WFIRST technology development which include: (1) masks/apodizers for Shaped-pupil and hybrid Lyot coronagraphs; (2) low-order wavefront sensing and control; (3) data post-processing; (4) system-level performance demonstration and modeling of obscured, monolithic aperture systems;

- Proposals for the development of technologies for potential competed (e.g., Explorer) exoplanet direct detection missions;
- Investigations for system-level modeling, simulations, scalable fabrication, trade studies, testbed technology demonstrations for large space-based segmented **(normal incidence)** mirror telescopes (funded through separate technology development solicitations);
- Proposals for development and maintenance of testing facilities and/or tools that substantively reproduce the capabilities of existing ExEP infrastructure;
- Proposals requiring a dedicated suborbital flight (balloon or rocket) for technology tests or risk reduction.

1.4 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 is required for all submissions to this program element. Proposals that are not preceded by an NOI may be returned without review.

The PI cannot be changed, and proposers who want to add funded investigators in the period between the NOI submission and the proposal submission must inform the point(s) of contact identified in the summary table of key information and copy 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.

2. Reporting Requirements

Annual progress reports must be submitted to the respective Program Officer and NSSC-Grant-Report@mail.nasa.gov before funds for the following year of the award are disbursed. The annual report shall contain detailed documentation of the progress towards the milestones identified in the proposal, a description of the plan forward, and its expected outcomes.

NASA reserves the right to terminate an award if it deems that achievement of the proposed goals according to the proposed schedule is unlikely to occur.

NASA will assign oversight of successful SAT proposals to one of the two Astrophysics science-theme program offices (ExEP or PCOS/COR). Each program office has specific procedures for reporting and documenting progress.

2.1 Exoplanet Exploration Program (ExEP)

The ExEP model for advancement of technologies is founded on the following three interrelated components:

1. Demonstration of milestone performance must be stable and repeatable, thereby demonstrating that the result is not spurious or transient;
2. Modeling of the milestone demonstration must be consistent with the demonstrated result, thereby establishing that the behavior is thoroughly understood; and
3. Error budget for the milestone must be consistent with the models.

Milestones may involve one or all of these elements. In addition, milestones for all SAT investigations that make use of ExEP high-contrast imaging testbeds shall incorporate both predictive and post-test validated modeling. In the interests of consistency and comparability, investigators will be expected to make use of the ExEP's existing modeling capability.

For all technical milestones identified in a proposal, the Principal Investigator (PI) will be expected to prepare a milestone white paper—a work plan that fully articulates the technical parameters to be demonstrated, the measurements to be made, analysis to be applied, success criteria, and documentation to be produced. That white paper will be reviewed by an independent technology assessment committee and may be iterated until an agreement between the technologists, the reviewers, and NASA is reached. When the PI believes that his/her team has achieved all of the requirements set forth in their milestone white paper, they will be required to write a milestone report that addresses all of the aspects identified in the original white paper. The milestone report will then be subject to independent review and interaction by the same groups involved in the initial white paper.

2.2 Physics of the Cosmos (PCOS) and Cosmic Origins (COR) Programs

SAT PIs under the oversight of the PCOS or COR program office are expected to provide written and oral status reports throughout their grants' period of performance to inform the program of their progress. This reporting requirement includes: 1) a kickoff/annual presentation describing the investigation, progress to date, development milestones, and work plan, 2) bi-monthly progress reports covering technical and programmatic highlights, 3) a mid-year written status report that will be uploaded to the publicly accessible Astrophysics technology database (http://www.astrostrategictech.us), and 4) a final report summarizing the development activities and findings that will also be uploaded to the database. When a PI believes that his/her technology has advanced in technology readiness level (TRL), the PI will be asked to make a TRL advancement justification presentation to an independent board convened by the program office to vet the achievement.

In addition to the annual progress report, successful proposers may also be asked to present orally their results to the Program Office and other relevant officers NASA reserves the right to terminate an award if it deems that achievement of the proposed goals according to the proposed schedule is unlikely to occur.

3. Summary of Key Information

Expected program budget for first year of new awards	~$6M
Maximum duration of awards	3 years; proposals with a term shorter than 2 years will be accepted, but are not 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	January 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 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-2018 *Summary of Solicitation* 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	NNH18ZDA001N-SAT

In addition to the Program Officers listed below with their areas of expertise, NASA point of contact concerning this program is:

Nasser Barghouty
Telephone: (202) 358-1211,
Email: nasser.barghouty@nasa.gov

Astrophysics Division
Science Mission Directorate
NASA Headquarters
300 E Street SW
Washington, DC 20546-0001

Name	Science Area	Telephone	Email
Douglas Hudgins	Exoplanet Exploration	(202) 358-0988	Douglas.M.Hudgins@nasa.gov
Rita M. Sambruna	Physics of the Cosmos	(202) 358-2166	Rita.M.Sambruna@nasa.gov
Mario R. Perez	Cosmic Origins	(202) 358-1535	Mario.Perez@nasa.gov

D.9 NANCY GRACE ROMAN TECHNOLOGY FELLOWSHIPS IN SPACE ASTROPHYSICS FOR EARLY CAREER RESEARCHERS

NOTICE: Corrected December 18, 2018. Section 2.4 has been updated to indicate that the naming of the candidate a Roman Technology Fellow (RTF) will occur now within 3 months after the RTF-related APRA proposal is selected, instead of 18 months. In Section 3, proposals for Fellowship funds may now be submitted at any time within two years from the date the RTF-related APRA proposal is selected, instead of from the date of the naming of the candidate a Roman Technology Fellow. New text is in bold and deleted text is struck through.

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 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. 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 the Astrophysics Research and Analysis (APRA) Program described in program element D.3 of this ROSES solicitation. The Principal Investigator (PI) of a successful APRA, technology-centered 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), proposal PIs must meet the following requirements at the time of submission:

- Have received a Ph.D. degree on or after January 1 of a year that is no more than eight years prior to the issuance date of the ROSES NASA Research Announcement (NRA) to which the APRA proposal is submitted. Individuals who have interrupted their careers for substantive reasons, such as family leave or serious 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 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 nonpermanent position, as defined in Section 4.1 below. In the event that a proposer's institution does not allow nontenured 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 below on or prior to the submission deadline of this program.
- 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 program element D.3 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 proposal, as described below.
4. Receive an award letter for that APRA proposal.

Selection of the APRA proposal is a prerequisite for consideration as a Roman Technology Fellow, but does not ensure selection. Those who are named as Roman Technology Fellows will receive an award letter from the RTF program explicitly conferring the title.

[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 RTF application is a free-form narrative limited to a single page in length. It should convey to the review panel and selecting officials an applicant's qualifications to be named a Roman Technology Fellow, addressing the evaluation criteria in Section 2.3 below. 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 proposal.

The application should be included in the APRA 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 proposal.

2.3 Evaluation Criteria for Fellowship Selection

The APRA proposal containing the RTF application will be reviewed along with other proposals in the pertinent APRA 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 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 should also demonstrate how these skills will prepare the Fellow to become a Principal Investigator (PI) of future astrophysics missions or to develop innovative technologies for space astrophysics that have the potential to enable major scientific breakthroughs. It should also illustrate how the fellowship will put the applicant on a trajectory towards a long-term position.

2.4 Timing of Selections and Awards

The announcement of selections for the technical (APRA) proposals will be in accordance with the schedule of program element D.3 of the ROSES solicitation. The naming of the candidate a Roman Technology Fellow will occur within ~~18~~ **3** months after the RTF-related APRA proposal is selected. ~~If a candidate is not named a Fellow prior to the end of this period, then the applicant's eligibility for the RTF ends.~~

3. Fellowship Funds

Those 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 **the RTF-related APRA proposal is selected.** ~~of the naming of~~

~~the candidate a Roman Technology Fellow (and also within ten years from the date of the Ph.D. degree).~~ Proposers must contact the RTF Program Officer prior to submitting a proposal for Fellowship Funds.

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 provided 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 investigations, in preparation to become a Principal Investigator (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 completely independent of any prior evaluation of the affiliated APRA 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 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 positions include, but are not limited to, tenure-track faculty and certain term civil service appointments.

4.2 Award Type and Duration

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.

The Fellowship designation (and thus the eligibility to apply for Fellowship funds) cannot exceed ten years past the Ph.D. degree. However, if an award for Fellowship funds is made, the Fellowship designation will end when the funds award expires.

5. Summary of Key Information

Expected program budget for new awards	See program element D.3 of this ROSES solicitation.
Number of new awards pending adequate proposals of merit	Approximately 1-3 early-career selections of technical proposals anticipated.
Maximum duration of awards	The duration of an RTF ends 10 years after obtaining the PhD. 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 element D.3 APRA, see Section 2.2
Due date for proposals	Initial fellowship applications via program element D.3 APRA, see Section 2.2. Subsequent proposals for funds may be submitted in response to this program element at any time.
Planning date for start of investigation	For initial fellowship applications see Section 2 and D.3 APRA. 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 program element D.3 APRA; 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*.
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. 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 program element D.3 APRA, see Section 2.2
NASA point of contact concerning this program	Nasser Barghouty Astrophysics Division Mail Code 3U36 Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1211 Email: nasser.barghouty@nasa.gov

D.10 NuSTAR Guest Observer – Cycle 5

NOTICE: Corrected February 19, 2019. In Section 1.1 the nominal start date and duration of the fifth round of Guest Observations have been updated. New text is in bold and deleted text is struck through.

Amended January 31, 2019. The proposal due dates for this program element were previously temporarily changed to "TBD" as a result of the partial government shutdown. This amendment releases new due dates for the effected program elements in Appendix D. For this program element Phase-1 proposals are now due (via ARK RPS) at 4:30 pm March 29, 2019.

November 20, 2018. Section 1.3.1 has been updated to clarify what can be proposed for joint NICER/NuSTAR Target of Opportunity observations and Section 1.3.3 has also been updated for consistency. New Text is in bold and deleted text is struck through. The due date remains unchanged.

October 11, 2018. This Amendment announces a change in due date for this program element. ~~Phase-1 Proposals are now due January 25, 2019~~ via the ARK/RPS website, see section 2.2.1 for details. Also, the word coordinated has been replaced with the word 'joint' in the bold paragraph below and in the notice on the NSPIRES page for this program element.

This Amendment announces a total text replacement for this program element. Major changes include: New statements that the solicitation of this program element is dependent on the results of the upcoming 2019 Senior Review, a call for 'Large Programs' (> 500 ks) has been added, and ~~coordinated~~ joint observations with NICER are now included. In addition, many small changes have been made throughout. Please read the text carefully. ~~The due date remains unchanged~~.

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 Guest Observer (GO) Program solicits proposals for basic research relevant to the NuSTAR mission.

The fifth round of Guest Observations (Cycle 5) will commence on or about ~~June~~ **July** 1, 2019, and last for a nominal period of ~~12~~ **11** months. Based upon the outcome of the 2016 NASA Astrophysics Senior Review process, NuSTAR operations are currently

funded through September 30, 2019. NuSTAR is proposing for continued operations funding in the 2019 NASA Astrophysics Senior Review for operating missions. Further details on the Cycle 5 program may be found on the NuSTAR Guest Observer Program website (http://nustar.gsfc.nasa.gov). Observing time will be made available to scientists at both U.S. and non-U.S. institutions. **[Paragraph above updated February 19, 2019]**

Individuals may submit proposals for three general types of observations: "standard-mode", "Target-of-Opportunity" (ToO) (see Section 1.3.3), and "Large Programs" (LP) (see Section 1.3.4). In addition to proposals for ToO observations submitted in response to this Call for Proposals, 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 Guest Observer Program. The data from NuSTAR observations selected under the Cycle 5 Call for Proposals 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 receipt of the processed data by 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 Call for Proposals. Prospective proposers of joint observations with these facilities should refer to Section 1.3.1 for details concerning the constraints on and implementation of such proposals.

Opportunities for carrying out NuSTAR observations in conjunction with NASA's Chandra X-ray Observatory, Gehrels Swift observatory, and NICER observatory, and with ESA's XMM-Newton and INTEGRAL observatories are also available through the relevant Calls for Proposals for those observatories.

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 foreign-led proposals are not eligible for funding.

Proposals directed primarily towards supporting theoretical or laboratory astrophysics research or ground-based observations relevant to the NuSTAR mission are not solicited by this program.

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 × 610 km. After an initial six-week checkout period and subsequent two-year baseline mission, the NuSTAR GO program was initiated. Based upon the results of the NASA 2016 Senior Review, support for mission operations was extended through September 30, 2019 and is proposing for continued operations funding in the 2019 NASA Astrophysics Senior Review for operating missions. The observatory has no expendables, and the orbit lifetime is estimated at ~ 10–15 years from launch. Currently in its seventh 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)	2×10^{-15} erg cm^{-2} s^{-1}
Sensitivity (10–30 keV) (10^6 s, 3σ, ΔE/E = 0.5)	1×10^{-14} erg cm^{-2} s^{-1}
Background in HPD (3–10 keV)	9.0×10^{-4} counts s^{-1}
Background in HPD (10–30 keV)	1.1×10^{-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)

1.3 NuSTAR Cycle 5 General Information

The total amount of time allocated to Guest Observations during the fifth cycle of the GO phase of NuSTAR is expected to be 11.3 Ms (70% of the total observing time). Of this, it is anticipated that up to 8.5 Ms of observing time will be awarded to selected Cycle 5 investigations. Of the remaining time:

- up to 1.5 Ms is expected to be awarded to NuSTAR/XMM-Newton Joint proposals submitted to the XMM-Newton Cycle 18 Call for Proposals,
- up to 0.5 Ms to NuSTAR/Chandra Joint observing proposals submitted to the Chandra Cycle 21 Call for Proposals,

- up to 400 ks to NuSTAR/NICER Joint observing proposals submitted to the NICER Cycle 1 Call for Proposals,
- up to 300 ks to NuSTAR/Gehrels Swift Joint observing proposals submitted to the Gehrels Swift Cycle 15 Call for Proposals,
- and up to 100 ks to NuSTAR/INTEGRAL Joint observing proposals submitted to the INTEGRAL Cycle 17 Call for Proposals.

It is anticipated that approximately 80 investigations will be selected for implementation under the NuSTAR Cycle 5 GO program.

The remaining 30% of the observing time will be allocated through the NuSTAR Project roughly evenly split between NuSTAR legacy survey observations; NuSTAR PI discretionary time, including unsolicited ToO observations open to the scientific community; and, time reserved for calibration observations, engineering tasks, and resolution of operational issues.

The NuSTAR legacy surveys represent extensions of the Galactic and Extragalactic surveys conducted during the baseline mission. Community input will continue to be solicited to assist in defining the surveys (see http://www.nustar.caltech.edu/page/legacy_surveys for additional information); the NuSTAR science team will perform the detailed planning, execution, and analysis of the surveys. The legacy survey data will be immediately made public, and source catalogs and spectra will be released as soon as they have been processed.

During the baseline mission, the remainders of the fields of view for specific targets were used to create a wide-area serendipitous source survey. This practice is being continued in the GO phase, with the incorporation of non-target background sources in GO fields into the legacy surveys. However, the PI for a particular GO investigation will retain the data rights for the duration of the applicable exclusive-use period to any background source in the field of his/her primary target that is of interest beyond contributing to the wide-area survey statistics.

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 may be found at http://www.srl.caltech.edu/NuSTAR_Public/NuSTAROperationSite/AFT_Public.php, and lists of the approved NuSTAR Guest Observations from previous cycles are available at https://heasarc.gsfc.nasa.gov/docs/nustar/previous_cycles.html. Observations of targets proposed through this Call for Proposals 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 5 program will be restored to the legacy program. A list of legacy observations that are planned to be performed by the end of Cycle 5 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, or C) 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 all standard-mode Category A and B targets will be carried out during Cycle 5; any standard-mode, non-time-constrained Category A and B observations not observed during Cycle 5 will be carried over to Cycle 6. Time-constrained Category A and B observations not observed during Cycle 5 will be considered for possible scheduling in Cycle 6 (see Section 1.3.2). 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 reproposed to a future observing cycle. Finally, note that proposals for observations of Cycle 4 Category C targets that have not been scheduled prior to the Cycle 5 proposal due date may be submitted to Cycle 5. Such proposals will be considered for selection in Cycle 5 *only* if the corresponding Cycle 4 observation is not executed in Cycle 4. Multiyear observing proposals will not be accepted in Cycle 5.

Proposers should note that NuSTAR's low-inclination (6°), low-Earth orbit allows, on average, a maximum continuous exposure of ~ 3.2 ksec per 5.7 ksec satellite orbit for targets below a declination 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 1.3.2).

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 and a maximum of 500 ks;
- Targets for which time-constrained observations are requested will only be guaranteed scheduling if they are designated Category A (see Section 1.3.2);
- 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 5 will be limited to a maximum of 1 Msec. 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 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 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;
- Proposals for joint NuSTAR/XMM-Newton programs in Cycle 5 will be accepted up to a total of 1.5 Msec 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 or B rating to be considered for acceptance. Individuals considering submission of a Cycle 5 proposal for joint NuSTAR/XMM observations should consult the XMM-Newton-18 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/Gehrels Swift programs in Cycle 5 will be accepted up to a total of 300 ksec of Gehrels Swift observing time. Joint proposals must provide a compelling justification of the need for both the NuSTAR and Gehrels Swift data for achieving the primary science goals and receive a Category A or B rating to be considered for acceptance. Proposers are strongly encouraged to carefully read the Gehrels Swift /NuSTAR memorandum of understanding. 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 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 Gehrels Swift ToOs) without the need for a specific joint observing proposal. Individuals considering submission of a Cycle 5 proposal for joint NuSTAR/Gehrels Swift observations should consult the Gehrels Swift Cycle 15 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 projects in Cycle 5 should not exceed a total of 250 ksec 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 or B rating to be considered for acceptance. 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. **No ToO proposals of currently unknown targets (e.g. "the next black-hole transient") will be accepted through this solicitation for joint NuSTAR/NICER observations; joint NuSTAR/NICER observations of known targets that may be triggered at an unforeseeable time (e.g., by a state change) may be proposed.** ~~No proposals~~

~~for joint NuSTAR/NICER ToO observations will be considered for Cycle 5.~~ **[Updated November 20, 2018]**

- Proposals requesting coordinated observations with other space- or ground-based observatories will be designated time-constrained and subject to the restrictions described in Section 1.3.2.

1.3.2 *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 or B will be given highest priority for scheduling during Cycle 5. Time-constrained observations of Category C targets will be executed on a best-effort basis. Time-constrained Category A and B observations not scheduled during Cycle 5 may be carried over to Cycle 6 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 5 will *not* be carried over to Cycle 6.
- 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 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).

1.3.3 *ToO Observations*

A total of up to 500 ks of NuSTAR Cycle 5 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 5;
- Proposers should indicate 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 to be eligible for execution;
- Proposals for ToO observations that can be triggered from a class of objects or set of potential targets are permitted;
- Active ToO submissions to the Chandra/NuSTAR, XMM-Newton/NuSTAR, INTEGRAL/NuSTAR, or Gehrels Swift/NuSTAR**, or NICER/NuSTAR** GO Program Calls approved prior to this Cycle 5 call will take precedence over NuSTAR Cycle 5 proposals with the same targets and trigger criteria. **[Updated November 20, 2018]**

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 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 Accepted Cycle 5 ToO observations may be triggered until the end of the cycle. ToO observations not triggered during Cycle 5 will not be carried over to Cycle 6; such observations may be reproposed to a subsequent cycle. Data from approved Cycle 5 ToO observations will have a six month exclusive use period after which the data will be placed in the public archive.

ToO proposals to observe either a core collapse supernova in the Local Group or a Type 1a event to the distance of the Virgo Cluster will not be accepted. Such observations constitute part of the NuSTAR core science program and can be most expeditiously and effectively planned and executed by the NuSTAR Project; should either event occur, the discoverer(s) are invited to contact the NuSTAR PI concerning participation in the resultant publications.

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.

1.3.4 *Large Programs (LPs)*

A total of up to 2 Ms of NuSTAR Cycle 5 observing time will be made available for a new Large Program (LP) category. The minimum exposure time for LPs is 500 ks, and such proposals will have an additional page of text to describe the proposed program. Data from approved Cycle 5 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). An approved LP with a ToO would have a six-month exclusive use period.

2. Programmatic Information

2.1 General Information

It is anticipated that at least $3.0M will be available for the support of Guest

Observations during Cycle 5. Proposals ranked as Category A or B 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 5. 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 and B 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 5 can expect awards of $10,000 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. 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 and NuSTAR/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, Gehrels Swift, or NICER data. Such proposals should not be submitted to the U.S. XMM-Newton Guest Observer Facility nor to the Gehrels Swift or NICER Projects.

NASA does not anticipate awarding contracts in response to proposals submitted to these program elements, because it would not be appropriate for the nature of the work solicited.

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. U.S. PI's whose Phase-1 proposals are assigned a Category A/B 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 or B 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.

2.2.1 *Submission and Evaluation of Phase-1 NuSTAR GO Proposals*

Individuals submitting Phase-1 proposals to the Cycle 5 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 for LP proposals), 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;
- Optional LaTeX and MS Word templates for the Scientific/Technical/Management section are provided at http://nustar.gsfc.nasa.gov;
- The Scientific/Technical/Management section must be uploaded to the RPS website as a PDF file.

In order to be included in the review of proposals for this cycle of the NuSTAR Guest 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 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;
- The extent to which the proposed investigation complements and enhances the anticipated science return from the NuSTAR mission;
- The degree to which the proposed observation(s) places demands upon mission resources.

2.2.2 *Submission and Evaluation of Phase-2 proposals*

Subject to the availability of funding, eligible Phase-1 proposers with Category A/B 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 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.* Subject to the conditions stated above, proposers will be notified regarding the award amount for their Cycle 5 investigation(s) by NASA upon completion of the Phase-2 review process.

2.3 Supplemental Information

Further details concerning the proposal submission requirements and process can be found at the NuSTAR Guest 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 5 awards	~ $3.0 M
Expected number of new awards pending adequate proposals of merit	30–50
Maximum duration of awards	1 year
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
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, 2019 (4 months after start of the Cycle 5 observing program) as a planning date for start of observations.
Page limit for Phase-1 proposals	Standard & ToO proposals: 4 pages. Large Program (LP) 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., CV, pending/current support) will be considered for Phase-1. 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 (https://science.nasa.gov/about-us/science-strategy). 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 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 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 2.2.2
Programmatic information may be obtained from the NuSTAR Program Scientist	William B. Latter Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0734 Email: william.b.latter@nasa.gov
Technical questions concerning this program element may be directed to the NuSTAR Guest Observer Program Office	Andrew Ptak NuSTAR Mission Scientist Code 662 Goddard Space Flight Center National Aeronautics and Space Administration Greenbelt, MD 20771-0001 Telephone: (301) 286-1154 Email: andrew.ptak@nasa.gov

D.11 TESS GUEST INVESTIGATOR – Cycle 2

NOTICE: Amended January 31, 2019. The proposal due dates for this program element were previously temporarily changed to "TBD" as a result of the partial government shutdown. This amendment releases new due dates for the effected program elements in Appendix D. For this program element Phase-1 proposals are now due (via ARK RPS) at 4:30 pm March 14, 2019.

Amended October 2, 2018. This Amendment ~~delays the due date for Phase-1 proposals to February 28, 2019~~ (at 4:30 pm Eastern time via https://heasarc.gsfc.nasa.gov/ark/rps), makes a number of changes throughout the text, most significantly in Section 2.2.1. Other changes include presenting revised versions of the TESS Input Catalog and Candidate Target List in Section 1.2.2, the Web TESS Viewing Tool in Section 2.3, and the planning start date in Section 3. In all of these cases new text is in bold and deleted text is struck through. In addition, the technical point of contact has changed, see Section 3.

1. Scope of Program

1.1 Overview

The TESS Guest Investigator (GI) Program solicits proposals for the acquisition and analysis of scientific data from the Transiting Exoplanet Survey Satellite (TESS) mission, a NASA Explorer mission ~~currently scheduled for launch no later than June~~ **that launched in April 2018 and began science operations in July** 2018. In a 2-year, near all-sky survey, TESS will monitor the brightness of nearby, bright F, G, K, and M stars in order to photometrically search for transiting planets smaller than Neptune. (See https://heasarc.gsfc.nasa.gov/docs/tess/ & Ricker et al. (2015, *Journal of Astronomical Telescopes, Instruments, and Systems*, 1, 014003) for detailed descriptions). TESS will monitor the brightness of more than 200,000 stars spread over the celestial sphere with a photometric sensitivity sufficient to permit detection of transiting planets with a radius less than 2.5 Earth radii. The mission's high-precision, continuous baseline photometric capability is also well suited for 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.

Observations associated with the TESS Guest Investigator (GI) Cycle 2 solicitation will be collected during the second year of operations during which the spacecraft will survey the northern ecliptic hemisphere. Proposals submitted to this program **must** ~~should~~ be for new science investigations of the northern ecliptic hemisphere and outside the TESS core science program ~~only~~. The core program consists of 1) the detection of transiting exoplanets with periods up to 10 days around stars on the pre-selected transit candidate target list (CTL; see description of CTL in Section 1.2.2), 2) the detection of transiting exoplanets with periods up to 120 days near the ecliptic poles (optimal for JWST follow-up), and 3) assuring that the masses of fifty planets with radii less than 4

Earth radii are determined through ground-based follow-up and/or analytical techniques.

There will be no exclusive-use period associated with the data from TESS observations. All data will be made available through the 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). 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.

1.2 The TESS Mission

A detailed discussion of the TESS mission and its scientific objectives can be found at https://heasarc.gsfc.nasa.gov/docs/tess/.

The TESS instrument consists of four wide field-of-view cameras, each of which observes a 24x24 degree field. The cameras are aligned with their fields adjacent, such that the instantaneous field-of-view is 24x96 degrees. TESS observes a single sector continuously for two spacecraft orbits (2x13.7 days), with the boresight of the four-camera array pointed nearly antisolar, obtaining full-frame images (FFIs) every 30 minutes, and 2-minute cadence sub-image data for ~10,000 pre-selected stars within the field. After two orbits, the FOV is shifted eastward in ecliptic longitude by 27.7 degrees, to observe the next (adjacent) sector.

Adjacent sectors have overlapping regions in proximities close to the ecliptic poles, providing longer-term coverage for stars falling in these regions which in turn provides sensitivity to smaller and longer-period planets; objects within 12 degrees of the ecliptic poles may be observed for ~1 year.

1.2.1 *Observing Modes and Data Products*

Data for specific targets are saved onboard and transmitted as "postage stamp" subimages, 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 subimage pixels. All postage stamp observations are collected at 2-minute postage-stamp cadence. Additionally, the full 24x96 sq. deg. field-of-view of all four TESS cameras is collected at 30-minute cadence.

A fixed number of postage stamp pixels have been reserved for Cycle 2 GI observations and are available to successful proposers to this Cycle 2 solicitation. Assuming a default target size, this corresponds to 20,000 2-minute cadence GI targets over the duration of the 2-year primary mission, or about 700-800 unique GI targets per Observation Sector. Extended or bright objects requiring larger subimage sizes decrease the total number of targets available to the GI program.

The TESS data will be 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 postage stamp data. All TESS

2-minute cadence targets, regardless of whether they are GI targets or TESS-selected exoplanet targets, will flow through the TESS science processing and analysis pipeline. The calibration will correct for bias level, smear, galactic cosmic rays, flat fielding, dark current, background, and instrument noise.

Data distribution and archival services will be performed through the Space Telescope Science Institute's MAST. Final data products available to GI observers will include original and calibrated target pixel files, pipeline-produced light curves for each 2-minute postage stamp target, and raw and calibrated images for the FFI data.

Data will be archived in standard FITS formats for images, event lists 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 other science programs, and plan their analyses accordingly.

1.2.2 *Instrumentation and Technical Capabilities*

TESS has neither changeable filters nor dispersing elements. Photometry will be taken through a broad bandpass ranging from 600 to 1000 nm. The bright limit for TESS is expected to be $I_C \approx 4$ or perhaps even brighter.

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 the transit search, and the calculation of flux contamination in the TESS subimage for each target. Based upon the TIC, the TESS team is developing a transiting Candidate Target List (CTL). The CTL is a list of priority-ordered TESS targets for 2-minute cadence monitoring. The TIC and the CTL have been publicly released (**v7 and v7.02, as of September 2018; these will be superseded by revisions as available) and are searchable via MAST at http://archive.stsci.edu/tess/. The TIC and CTL are documented by Stassun et al. (2018; http://adsabs.harvard.edu/abs/2018AJ....156..102S).**

~~(v5.0) and are searchable via MAST at http://archive.stsci.edu/tess/. The TIC and CTL are documented by Stassun et al. (2017; https://arxiv.org/abs/1706.00495v1).~~

1.3 Permitted Guest Investigator Science

The primary purpose of the TESS Guest Investigator Program is to enhance and maximize the science return from TESS. The program facilitates and supports both 2-minute cadence observations with TESS and research undertaken with the FFIs. Any area of astrophysics may be proposed. However, proposals to detect planet transits within the 2-minute cadence data of the one hundred thousand (100,000) top-prioritized, northern hemisphere CTL (version ~~5.0~~ **7.01, as of September 2018**) targets are not solicited, and will be considered non-compliant. No restrictions are imposed on science using the full frame image data. Proposals for exoplanet detection and characterization using full frame image data are encouraged.

The following science categories are solicited for Cycle 2 Guest Investigator proposals:

1) Proposals for additional 2-minute cadence exoplanet (or potential exoplanet) targets beyond those objects already being observed by the TESS mission.

2) Exoplanet investigations using the FFI data, including ground-based observing components to confirm these planets. While Guest Investigators can expect some basic data analysis tools to be available, special purpose software development may be necessary for individual science investigations, and can be proposed as part of this category.
3) Astrophysics (i.e., non-exoplanet) investigations using TESS 2-minute cadence targets, including new targets and astrophysical investigations of targets already on the TESS transit candidate target list.
4) Non-exoplanet astrophysics investigations using FFI data. While Guest Investigators can expect some basic data analysis tools to be available, special purpose software development may be necessary for individual science investigations, and can be proposed as part of this category.
5) Development of novel planet confirmation techniques and/or algorithms that take advantage of TESS data.

Proposals may be a combination of both 2-minute cadence target requests and FFI analysis.

The scientific justification of a GI proposal should focus on a compelling science investigation, that requires the collection of new TESS data to succeed. For all of the above categories, the proposed TESS Guest Investigation must clearly enhance the science return of the TESS mission. The proposal may include limited theoretical components, limited ground-based follow-up, software development and/or data simulation that strengthens the proposal. At least 70% of the work effort should be focused on exploiting TESS data products. Proposed investigations in which the primary emphasis is theory/modeling, ground-based observing, or archival 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).
- 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).

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, and open source. Exoplanet-related ground-based follow-up data collected through TESS GI funding support must be made publicly available in a timely fashion at the NASA Exoplanet Science Institute (NExScI) ExoFOP service (https://exofop.ipac.caltech.edu) - NASA's repository for supporting exoplanet data. Supporting data for non-exoplanet science should be archived through a public data archive service such as the MAST high~~er~~ level **science** data product service (http://archive.stsci.edu/hlsp/).

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 deadline. Due to TESS mission constraints, ToO-triggered target definitions can only be uploaded to the spacecraft during uplinks that occur once every 13.7 days. 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 duration of the event, as well as 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 the trigger event, which could be as long as 2 months after the event. The impact to science of such a potential delay must be addressed in proposals requesting ToO observations.

1.5 On-source Monitoring Times

Targets can be observed for the maximum number of sectors for which they are observable. This ranges from 27.4 days for targets with lower ecliptic latitude and up to 356.2 days for targets near the ecliptic poles. All Cycle 2 GI observations terminate one year after the observing cycle begins.

1.6 Target Lists

Proposals requesting 2-minute cadence targets are required to submit a target list. Targets must be submitted electronically, at the same time as the science proposal, via the Remote Proposal System (RPS; 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. 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

It is anticipated that up to $2.5M in Cycle 2 will be available to US-based PIs through this solicitation for the support of approximately ~30 Guest Investigations. The performance period of each award will be 2 years. The Cycle 2 GI program will also include unfunded non-US-based investigations of high merit, as determined by peer review. Additional unfunded Guest Investigation targets may be offered to proposers, 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.

NASA does not anticipate awarding contracts in response to proposals submitted to this program elements, 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 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 ~~budget narrative~~ **work plan** in the 4-page science/technical section ~~describing in sufficient detail how the proposed funds will be used to achieve the goals outlined in the proposal~~. **This work plan must must give details on how the proposed effort will be carried out, including the allocation of effort amongst investigators. Investigators who are proposing to continue a program that was selected for funding in Cycle 1 must describe why additional funds are required in Cycle 2. All proposals requesting funds must also provide upon submission a bottom-line budget number in the provided field of the ARK 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, including the list of investigators, 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.

Awards for the majority of investigations (i.e., focused analysis and/or small numbers of targets) are expected to average $50,000 per award. 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 $200,000 range per award). Such large proposals will need to provide a compelling argument for the higher funding level. 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.

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, https://heasarc.gsfc.nasa.gov/docs/tess/;
- Target tables for all observation proposals are to be submitted through ARK/RPS;
- 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.

- Optional Latex and MS Word templates for the Scientific/Technical/Management section will be provided on the TESS Science Support Center web site at https://heasarc.gsfc.nasa.gov/docs/tess/;
- The Scientific/Technical/Management section must be uploaded to the 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. ~~Even though no funds are to be requested from NASA, all non-U.S. proposals must contain all of the required sections outlined in the NASA Guidebook for Proposers, including the required table of time commitments for all proposal team members.~~

All proposal materials must be submitted electronically by 4:30 pm 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 TESS Guest Investigator program. Note that the 4:30 pm deadline supersedes the deadline stated in the *Guidebook for Proposers* and in the *ROSES Summary of Solicitation.*

2.2.2 *Evaluation of Phase-1 Proposals submitted to the TESS GI Program*

Proposals will be evaluated by a peer evaluation panel with respect to the criteria specified in Section C.2 of the *NASA Guidebook for Proposers*, where it is understood that the intrinsic merit of a proposal shall include the following factors:

- The suitability of using the TESS survey and data products for the proposed investigation;
- 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.

2.2.3 *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 (as opposed to peer reviewers) will evaluate the Phase-2 cost proposals for 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.

2.3 Supplemental Information

Further details concerning the proposal submission requirements and process can be found at https://heasarc.gsfc.nasa.gov/docs/tess/, the TESS Guest Investigator Program 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 https://heasarc.gsfc.nasa.gov/docs/tess/ 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	~$2.5M
Number of new awards pending adequate proposals of merit	~30
Maximum duration of awards	2 years
Due date for Phase-1 proposals	4:30 pm on the due date given in Tables 2 and 3 of the *ROSES Summary of Solicitation*.
Planning date for start of investigation	**The first sector of Cycle 2 is expected to start in July 2019.** 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 2019.** ~~NASA center proposers should use October 1, 2018 as a planning date for start of observations.~~
Page limit for Phase-1 proposals	4 pages. LaTeX or MS Word templates (available at https://heasarc.gsfc.nasa.gov/docs/tess/) can be used for the proposals. 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 (https://science.nasa.gov/about-us/science-strategy). 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 Table 1 of the ROSES *Summary of Solicitation,* Section I(g) Order of Precedence, and the NASA Guidebook for Proposers (https://www.hq.nasa.gov/office/procurement/nraguidebook/).

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
Programmatic information may be obtained from the TESS Program Scientist	Martin Still Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-4462 Email: martin.still@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 Telephone: (301) 286-**5079** Email: **thomas.barclay@nasa.gov**

D.12 NICER GUEST OBSERVER – CYCLE 1

NOTICE: Clarified November 9, 2018. The target of opportunity response during regular business hours (in Table 1) has been updated to four hours, Subsection 1.3.2 ToO Observations has been updated, a link was updated in Section 2.2.3, and in Section 2.2.4 an "or" was changed to an "of" and a link was updated in the summary table of key information. New text is in bold and deleted text is struck through. The due dates remain unchanged.

Amended on September 21, 2018. This amendment presents final text for this program element, which was previously TBD.

Following the successful NICER Prime Mission Success Progress Review held in August 2018, this program element solicits Guest Observer proposals including targets to be observed during a "bridge" mission phase between March 1, 2019 and February 28, 2020, with time after September 30, 2019 contingent upon a successful Senior Review for NICER.

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. Following the end of its prime mission, NASA is initiating a Guest Observer (GO) program during a "bridge" mission extension that bridges the period between the prime mission and the Senior Review-recommended extended mission. Proposals for observations with NICER addressing all areas of astrophysics are solicited, with limited amount of funding available in FY19.

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 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 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, and the Technical

University of Denmark. The NICER Science and Mission Operations Center (SMOC) is located at NASA's Goddard Space Flight Center.

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 (~80 cm^2) geometric area from a ~30 $arcmin^2$ patch of sky, and focuses them onto small silicon drift detectors (SDDs). The SDDs detect individual X-ray photons, recording their energies and times of arrival to high precision. Together, this assemblage provides a photon counting capability with large effective area, high time resolution, moderate energy resolution, and relatively low background.

SDDs offer energy resolutions typical of silicon-based detectors, approaching the Fano limit. NICER's 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 30 $arcmin^2$ 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 summarizes the most important NICER characteristics for proposal preparation.

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.

Table 1: Key NICER Performance Parameters

Parameter	Value
Energy range	0.2–12 keV
Non-imaging angular resolution (FWHM)	6.2 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
Target of opportunity response	Within ~~2~~ **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.

1.3 Available GO Time and Visibility Constraints

The expected total amount of observing time available for the Cycle 1 NICER GO phase is 5 Ms. It is anticipated that approximately 25 GO observing programs will be selected for NICER Cycle 1, depending on the proposed exposures. The remaining observing time will be used for legacy science, PI discretionary time, 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 proposals 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 in Cycle 1. Category C observations will be completed on a best-effort basis. Multi-year observing proposals will not be accepted in Cycle 1.

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 ksec per 92-minute ISS orbit, but typically much less. 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 be designated Category A in order to guarantee scheduling (see Section 1.3.1).
- Proposals requesting coordinated observations with other space- or ground-based facilities will be designated 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 phase-constrained proposals and coordinated observing campaigns with ground-based or space-based facilities. Time-constrained observations are subject to the following limitations:

- Time-constrained proposals 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.
- Monitoring programs are defined as programs requiring two or more observations of the same target, each of which is considered a "visit". For monitoring observations, the time between successive visits must be longer then 1 day; if it is less than one week, the program will be considered time-constrained, and the exposure request per visit must be less than 15 ksec.

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, but at minimum two 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*

No ToO proposals **of currently unknown targets (e.g., "the next black-hole transient")** will be accepted through this solicitation for NICER Cycle 1**; observations of known targets that may be triggered at an unforeseeable time (e.g., by a state change) may be proposed, and will be considered time-constrained**. ToO requests **of either type** will be considered by the NICER project through a submission process found at https://heasarc.gsfc.nasa.gov/docs/nicer/.

1.3.3 *Coordinated NuSTAR observations*

Combined NICER and NuSTAR observations are a powerful diagnostic of high-energy sources, in the total energy range 0.2-79 keV. The NuSTAR Project has made up to 400 ks available to NICER Cycle 1 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 support of this. Joint observations with NuSTAR must be designated as Category A or B to be approved for observations in Cycle 1.

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.

Observations of high-count-rate targets with NuSTAR (>50 cps/NuSTAR 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 solicitation for the support of Guest Observations. Only Category A and B proposals will be eligible for funding. Proposal 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. Scientists participating in the NICER mission are eligible for support under this GO Program. Note that GO proposals from NICER team members who receive funding from the Project must clearly demonstrate that the proposed investigation is not redundant with their science team responsibilities. Budget proposals will be solicited from eligible investigators selected through this Cycle-1 solicitation during Phase 2 of this solicitation.

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 not necessary for the PI of the Phase-2 proposal to be the science PI but they must be from the same institution. All proposal materials will be submitted electronically.

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., CV, pending/current support) is required or allowed;
- The Scientific/Technical/Management section must be uploaded to the ARK/RPS website as a single 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 in order to be included in the proposal review for

this cycle of the NICER GO program. Note that the 4:30 p.m. Eastern time deadline supersedes the default NSPIRES deadline.

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 NRA or the *NASA Guidebook for Proposers*.

2.2.2 *Evaluation of Proposals submitted to the NICER GO Program*

Phase-1 Proposals will be evaluated by a peer evaluation panel for Merit and Relevance (see Section VI(a) of the ROSES Summary of Solicitation), with the evaluation of merit including:

- 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.

2.2.3 *Additional Proposal Constraints and Requirements*

The NICER Science Team has employed the payload to perform specific investigations in fulfillment of the mission's science objectives, as agreed to in the original Explorer proposal. The Team's targets and investigations are described at https://heasarc.gsfc.nasa.gov/docs/nicer/science_team_investigations **[this link was updated 11/9/18]**. All of the data from the NICER Team's observations are either in the NICER public data archive or will be. GO proposals for targets with existing or planned NICER observations must justify why additional data are warranted. In addition, projects proposed to this NICER Cycle 1 solicitation must not duplicate existing projects of the NICER Science Team (see **Team investigations link above** for a complete description)[1]. Proposers are strongly encouraged to familiarize themselves with the content of these programs; the onus is on the proposer to demonstrate that their proposed project does not significantly duplicate the goals of the current NICER science programs.

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 submission form requesting coordinated NuSTAR time.

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 NICER Program Officer and invited to submit a cost proposal as their proposal for

[1] Proposals for use of archival NICER data to duplicate existing projects can be submitted to the Astrophysics Data Archive Program (ADAP).

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 according to the instructions in the *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) with a detailed justification **of** ~~or~~ all proposed items for funding. Please also attach a copy of the original 4-pages technical proposal.

NASA program personnel will evaluate the Phase-2 cost proposals against the third evaluation criterion, cost reasonableness.

2.3 Supplemental Information

Further details concerning NICER, the proposal submission requirements and 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), are already 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.	The total program budget of $1.25M will allow the selection of ~25 proposals with average awards of ~$50k. Deviations from these targeted figures are possible.
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	See Section 2.2.1 and Tables 2 and 3 of this ROSES NRA
Planning date for start of investigation	Six months after proposal submission.
Page limit for Phase-1 proposals	4 pages. See Section 2.2.1 for details.
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 2.2.3
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/** **[This link was updated 11/9/18]** Phase-1 proposals may not be submitted via NSPIRES or grants.gov.
Programmatic information may be obtained from the NICER Program Officer	Rita Sambruna Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-2166 Email: Rita.M.Sambruna@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.13 LISA PREPARATORY SCIENCE

NOTICE: Amended on March 14, 2018. This amendment delays due dates in anticipation of power loss to New England as a result of the upcoming storm. The NOI due dates for D.13 LISA Preparatory Science has been changed to Monday March 19, 2018.

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.

1. Scope of Program

1.1 Overview

NASA is partnering with ESA on the ESA-led Laser Interferometer Space Antenna (LISA) gravitational wave observatory. 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://www.lisamission.org.

NASA's contributions to LISA are still being discussed with ESA, but they are expected to include elements of the instrument payload, elements of the observatory and spacecraft, and aspects of operations, science data analysis, and interpretation The LISA Consortium has developed an initial set of Work Packages (WPs) detailing specific areas of work, and related tasks, to identify work required to build necessary data processing infrastructure to deliver core LISA science. The WPs can be accessed via https://lisa.nasa.gov and related links. While the development of hardware and ground-segment infrastructure is supported by NASA through NASA's LISA Study Office at Goddard Space Flight Center, this ROSES element concerns the support of U.S.-based investigators for developing data analysis tools and modeling to prepare for the analysis and interpretation of the LISA data within the framework of the WPs, or in augmentation of them.

1.2 Program Objectives

The LISA Preparatory Science (LPS) Program has been created to provide support for U.S. investigators involved in analysis and interpretation of simulated LISA data. It is not intended as a vehicle for requesting funds to support hardware work, which is funded separately, or to develop mission concepts.

Proposals to the LPS Program may request support for:

- Performing high-fidelity simulations of the expected waveforms for LISA sources;
- Developing data analysis and statistical techniques useful for the extraction of scientific measurements from LISA data (e.g., parameter estimators, etc.);
- Developing prototype data analysis tools, including innovative

approaches to instrument simulation, that take into account the anticipated LISA mission performance;
- Evaluate the capability of LISA data for enabling astrophysics investigations;
- Conduct astrophysics investigation that prepare for the analysis and interpretation of the LISA data.

Note that the LISA Study Office is responsible for NASA's role in designing the overall Science Ground Segment. More information on the current activities of the Study Office can be found at https://lisa.nasa.gov. Proposals must ensure the proposed investigations do not duplicate these activities.

Proposals to the LPS program may not:

- address topics that are predominantly theoretical in nature. Such proposals should be directed to the mission-specific programs or the Astrophysics Theory Program (ATP) described in program element D.4 of this solicitation;
- consist primarily of data reduction or analysis of archival data other than that in direct support of LISA-centric investigations. Such proposals should be directed, as appropriate, to the mission-specific programs or the Astrophysics Data Analysis Program (ADAP) described in program element D.2 of this solicitation;
- 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; or
- request support for substantial computing facilities or resources (Note: Requests for personal computers, at amounts typically under $5K, will be allowed, so long as they are used predominantly for the research being proposed).

1.3. Availability of High-End Computational Resources

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 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 Types of Proposals

Proposals will only be accepted from individual Principal Investigators (PIs) whose proposed work has a clear, single focus. Individual PIs may include as many Co-Investigators and Collaborators as needed on their proposals.

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.

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 Evaluation and Awards

The three basic evaluation criteria given in the *ROSES Summary of Solicitation* Section VI(a) and the NASA *Guidebook for Proposers* are Relevance, Merit, and Cost. In addition to what is described there, the evaluation factors will include:

a. The scientific merit of the science goals of the proposed work, specifically how they relate to or advance the goals in the LISA science case, as stated in the LISA proposal selected by ESA (https://www.lisamission.org);
b. A plan for disseminating the results of the research project to the broader community and to the LISA Consortium;
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;
d. The relationship to LISA efforts ongoing in the LISA Consortium, specifically, the relationship to the LISA WPs, and/or the level at which the proposed work complements and augments those efforts;
e. The relationship to LISA efforts ongoing in the NASA LISA Study Office.

Proposals must address items above. To this end, a link to the LISA Consortium WPs and a set of slides highlighting the efforts funded in the U.S. by the LISA Study Office has been posted to https://lisa.nasa.gov/. The proposers are strongly encouraged to familiarize themselves with the WPs and the content of the slides, and address any questions to the LPS Program Officer by March 30, 2018. The questions and the answers will be collected by the Program Officer and posted on NSPIRES under the solicitation URL.

2.3 Proposal Guidelines

In addition to the required proposal elements as outlined in Table 1 of the *ROSES-18 Summary of Solicitation* the Scientific/Technical/Management section of proposals for this program element must include the following:

- 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, if any;
- A description of how the proposed project complements and augments parallel science efforts undergoing in the LISA Consortium (see https://lisa.nasa.gov/).

2.4 Proposal Requirements

To facilitate the early recruitment of a conflict-free review panel, a Notice of Intent (NOI)

to propose will be required for all submissions to this program element. Proposals that are not preceded by an NOI may be returned without review. The proposers are strongly encouraged to finalize the Team's composition before submitting the NOIs. The NOIs are being used to recruit competent, non-conflicted reviewers, and any later changes to the Team composition would hinder this effort.

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 Eligibility

All U.S.-based researchers are eligible to apply to this solicitation. In particular, LISA Study Team members and LISA Core Team members are eligible to submit proposals to the LPS program. The members currently receiving funding from the LISA Study Office, or other means, for related activities are required to add a section in their LPS proposal clarifying how the proposed LPS investigation is separate from the work already supported by the Study Office.

3. Reporting

For each year of the investigation period, the PI shall prepare a summary white paper—a document that fully articulates the science investigation to be demonstrated, the results achieved, and the application to LISA. That white paper will be submitted to the LPS Program Officer at NASA HQ, and will be made public on https://lisa.nasa.gov.

NASA HQ will organize a special session at the Winter 2020 AAS for LISA Preparatory Science. The PIs of the selected proposals shall give a presentation with the results of their LPS projects. Associated poster presentations are encouraged.

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 welcome
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	November 15, 2018.
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	NNH18ZDA001N-LPS
NASA point of contact concerning this program	Rita Sambruna Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-2166 Email: rita.m.sambruna@nasa.gov

D.14 SOFIA NEXT GENERATION INSTRUMENTATION

NOTICE: Amended on March 6, 2018. This amendment releases final text for this program element. This program element requests a notice of intent (NOI) from proposers but also uses a binding two-Step process in which successful 25-page Step-1 proposals will be funded for a five-month (≤$500K) Instrument Concept Study Phase (see Section 6) culminating a Concept Study Phase reports in 2019 that will serve as Step-2 proposals from which instruments may be selected and funded for development. Data management plans will not be collected on the NSPIRES cover pages as the planned enhanced data products are part of the proposals (see Sections 4 & 6) and evaluation criteria (see Section 7). Optional NOIs are requested by June 1, 2018, Step-1 proposals are due August 1, 2018 and NASA will communicate directly with those selected regarding the submission concepts study reports as Step-2 proposals ~March 2019.

Table of Contents

1. Highlights Of Next Generation Science Instrumentation 3

2. SOFIA Project Overview 4

3. Overview Of The Solicitation 5

3.1 Notices Of Intent 5
3.2 The Two-Phase Instrument Development Process 6
3.3 Management Of Solicitation 6
3.4 Additional Documentation Needed For Solicitation 6

4. The Next Generation Science Instrument (NGSI) **7**

4.1 Motivation For Instrument 7
4.2 The Legacy Science Program (LSP) 7
4.3 Anticipated Requirements, Activities and Timeline From Development to Acceptance 9
4.3.1 *Requirements for Commissioning* 9
4.3.2 *Science Exploitation Period Following Commissioning* 9
4.3.3 *Instrument Transition to SOFIA* 10

5. Requirements for Step-1 Proposals 10

5.1 Science Requirements for Step-1 Proposals 11
5.2 Technical Requirements for Step-1 Proposals 11

6. Anticipated Requirements for ICS Phase Reports 13

6.1 Reporting / Status updates / QandA during the ICS Phase 15

7. Proposal Evaluation Criteria for Step-1 Proposals 15

8. Evaluation of the ICS Phase Reports 16

9. Eligibility and Conflicts of Interest. 16

10. Public Engagement and Communications 17

11. Remediation, Termination, or Cancellation 18

12. Submission Process and Requirements 18

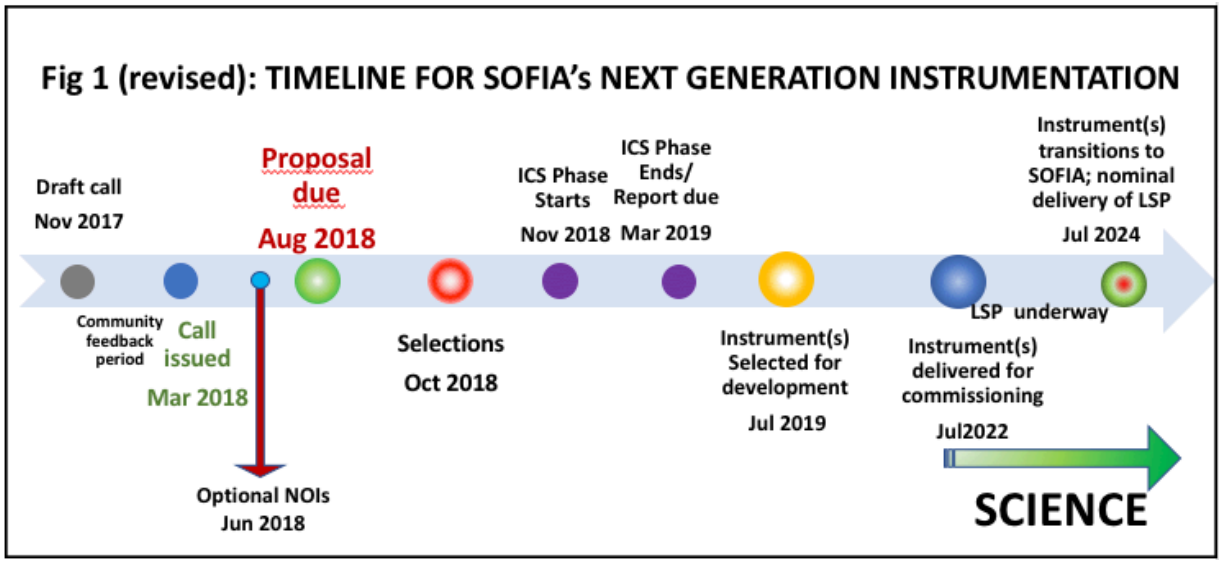
12.1 Pre-Proposal Workshops 19
12.2 Proposal Formatting 19
12.3 International Agreements 19

13 Award Administration and Funding 19

14 Summary of Key Information 20

1. Highlights of Next Generation Science Instrumentation Call

This program element requests proposals for scientific investigations that would develop and use scientific instrumentation capable of achieving the goals of NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA). The intent is to select and execute development of one or more new SOFIA science instruments and/or upgrades to existing instruments. The anticipated timeline is as follows:



1.1 Key Dates:

- November 3, 2017 - Draft program element was published
- March, 2018 - Final program element is released (this document)
- April 3, April 16, May 17, 2018 – Pre-proposal workshops
- June 1, 2018 – Due date for Notices of Intent to propose (NOIs) to expedite the review process
- August 1, 2018 - Due date for Step-1 Proposals
- ~ October 2018 - Selections announced / Instrument Concept Study (ICS) phase kickoff
- ~ March 2019 - Due date for ICS phase reports (Step-2 proposals)
- ~ Spring 2019 – Astrophysics Senior Review, including SOFIA
- ~ July 2019 - Instrument(s) selected for development
- ~ July 2022 – Nominal instrument(s) delivery (earlier delivery encouraged; longer or shorter timescale for optimal science return acceptable); Legacy Science Program (LSP) observations start
- ~ NLT July 2024, Instrument transitions to SOFIA, nominal completion and delivery of LSP

1.2 Philosophy for Solicitation of New SOFIA Instrumentation

- Motivate the next generation science instruments (NGSI) by compelling science
- Execute and deliver a well-defined Legacy Science Program (LSP) by the selected

team(s).

- Prioritize instruments that enable broad community usage and/or data of high archival value, but also allow for agile, “niche” instruments to solve important / outstanding science questions
- Allow for new instruments or upgrades/modifications to existing instruments; also allow for flexibility for future enhancements and modifications to NGSI
- Allow for a nominal three-year development period after funding begins but also allow for longer or shorter development timescales for optimal science return
- Allow for schedule and budget flexibility; make selections based on science return on investment
- Streamline requirements for the ICS phase
- Streamline instrument development / acceptance process

2. SOFIA Project Overview

The Stratospheric Observatory for Infrared Astronomy (SOFIA) consists of a German-built 2.7-meter (2.5-meter useable aperture) telescope with a suite of imaging, polarimetry and spectroscopy instruments, mounted in a Boeing 747-SP aircraft supplied and modified by NASA. Operations costs and observing time are shared by the United States (80%) and Germany (20%). Flying at altitudes up to 45,000 feet, SOFIA observes from above more than 99 percent of Earth’s atmospheric water vapor, thereby opening up wavelengths for astrophysical observations not available from the ground.

SOFIA is a near-space observatory that returns to base after every flight. Therefore, unlike most space missions, its scientific instruments can be exchanged periodically to accommodate changing science requirements and to incorporate new technologies, which is a tremendous advantage over space-based observatories. A key part of the SOFIA project has always been to include an instrumentation program that would periodically introduce new technologies in order to enable new scientific frontiers to be explored. NASA is soliciting proposals for compelling science investigations that are enabled by the development of one or more new Science Instruments (SI) and/or upgrades to existing science instruments.

The SOFIA observatory has been designed to support observations at wavelengths from 0.3μm to 1.6 mm. The observatory is capable of high-resolution spectroscopy ($R > 10^7$) in discrete wavelength bands at wavelengths between 5 and 600μm with its existing instruments. SOFIA produces the sharpest images of any current or planned IR telescope operating at wavelengths from 30 to 320 μm. The current SOFIA suite of instruments (EXES, FIFI-LS, FORCAST, FPI+, GREAT, HAWC+, and HIRMES) has a wide range of imaging, spectroscopy, and polarimetry capabilities (http://www.sofia.usra.edu/Science/instruments/).

A sample of science programs that might be undertaken with SOFIA is described in *The Science Vision for the Stratospheric Observatory for Infrared Astronomy*, available at http://www.sofia.usra.edu/Science/science_cases/. SOFIA science results in the literature are available at https://www.sofia.usra.edu/science/publications/sofia-publications. SOFIA data are archived and available via the SOFIA Data Cycle system

(https://dcs.sofia.usra.edu/). Starting in 2018, the SOFIA data archive will begin a transition to the NASA/IPAC Infrared Science Archive (IRSA, https://irsa.ipac.caltech.edu/frontpage/). It is anticipated that data from the next generation science instruments will be ingested in and served to the community via IRSA.

SOFIA is a project within the Astrophysics Division of the NASA Science Mission Directorate. The SOFIA Project is managed by Ames Research Center (ARC). The execution of the SOFIA Project is carried out under three management directors, coordinated by the SOFIA Project Manager at ARC: the Science Mission Operations (SMO) Director, whose staff is responsible for science observing proposal solicitation, evaluation and selection, science flight planning, pipeline processing of the science data, and operation of the SOFIA Facility Instruments; the Operations Director, whose staff is responsible for the aircraft operations and the Armstrong Flight Research Center (AFRC) ground facilities; and the Observatory Systems Director, whose staff is responsible for observatory improvements and new science instrument development (after science instruments are selected by NASA Headquarters).

3. Overview of this Program Element

This program element specifically requests proposals for compelling scientific investigations that require development and use of a next generation science instrument (see Section 4) or upgrades/modifications to an existing instrument for SOFIA. The scientific investigations must be aligned with NASA's astrophysics strategic goals (see D.1 of ROSES-2018 the Astrophysics Research Program Overview).
This program element is specifically not requesting (and will not accept):

- Proposals for only an individual's scientific research or development projects;
- Proposals for technology development or demonstration projects; and
- Proposals for ground-based technology test beds.

Investigators interested in technology development or technology demonstrations projects with SOFIA may contact the point-of-contact (POC) listed in Section 14 at any time – these activities are not relevant for this program element but NASA welcomes discussion of such ideas separately.

3.1 Notices of Intent

A brief Notice of Intent (NOI) to propose is encouraged, but not required, for the submission of proposals to this program element. The information contained in an NOI is used to help expedite the proposal review activities and, therefore, is of considerable value to both NASA and the proposer. To be of maximum value, NOIs should be submitted by the Principal Investigator (PI) via the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES, located at https://nspires.nasaprs.com) by June 1, 2018. It is understood that PIs may need to update their co-investigators after the submission of the NOI and this is allowed under this program element. Changes to the Co-investigator list after the submission of the NOI may be emailed to the main point of contact listed in the Summary Table of Key Information (Section 14).

3.2 The Two-Phase Instrument Development Process

Proposals submitted in response to this program element will be evaluated and selected through a two-phase competitive process:

- Phase I: In this phase all compliant proposals submitted in response to this program element will be subject to a scientific and a top level technical peer review. Requirements for Step-1 proposals are listed in Section 5. Evaluation criteria for this phase are listed in Section 7. Based on the results of that review, one or more proposals may be selected for a funded Instrument Concept Study (ICS) phase.
- Phase II: Through the rest of this document we refer to Phase II as the ICS Phase. Requirements for the ICS phase are listed in Section 6. At the end of the ICS Phase, organizations that received a grant for an ICS must submit a final ICS phase study report, which will serve as the Step-2 proposal for an instrument development contract. There will be a second review which will focus primarily on the technology, management and cost aspects of the instrument. Evaluation criteria for the ICS phase study evaluations are listed in Section 8. At that point, one or more instruments may be selected for further development following the approximate timeline shown above in Section 1 (see also Figures 1 and 2).

3.3 Management of Program Element

This program element and review of the proposals submitted in response to NASA (including Instrument Concept Study phase reports) are managed by the Astrophysics Division within the Science Mission Directorate (SMD) at NASA Headquarters, with programmatic and technical support from the SOFIA staff at the NASA Ames Research Center (ARC), SOFIA Mission Operations (SMO), and the NASA Armstrong Flight Research Center (AFRC). In accordance with this role, a conflict avoidance plan (see also Section 9) has been implemented to prevent any ARC, SMO, and AFRC personnel involved in the evaluation process from having had any involvement with proposers and proposing teams.

The SOFIA Science Instrument Development (SI Dev) team has a key role in the development and delivery of new science instruments and upgrades to the SOFIA observatory. The SI Dev team consists of approximately eight scientists, astronomers, and engineers within the SOFIA project who provide critical support during the solicitation process and later in the instrument development, commissioning and acceptance process.

3.4 Additional Documentation

NASA intends to maintain an essential degree of insight into instrument development to ensure that the implementation is responsive to requirements and constraints of the observatory, and remains within cost and schedule. NASA requirements and constraints are spelled out in a *SOFIA Instrument Developer's Handbook,* which is part of a final and complete set of documentation (collectively called "the SOFIA Instrument Development Library") located at https://www.sofia.usra.edu/science/instrument-call.

Proposers to this program element are strongly encouraged to review the contents of

the SOFIA Instrument Development Library as it contains the safety, reliability and quality assurance requirements, as well as Observatory policies and requirements, for the next generation instrument.

4. The Next Generation Science Instrument (NGSI)

4.1 Motivation for Instrument

The proposed SOFIA instrument must fundamentally be motivated by a compelling science investigation. The proposing team must propose a Legacy Science Program (LSP, see section 4.2) of high scientific value that requires the use of the instrument it builds and delivers. Instruments that will be of use to a broad scientific community and promise to deliver data of high archival value are encouraged. Niche, agile instruments that may be developed on a shorter time scale, presumably at a lower cost, to address specific, if narrow, scientific questions may also be proposed. An LSP is required for such niche, agile instruments; however, an LSP is not required (but is welcome) for upgrades or modifications to existing instruments

4.2 The Legacy Science Program (LSP)

The LSP is a scientifically ambitious, coherent investigation, not reproducible by any reasonable number of or combination of smaller guest observer investigations. The LSP should have general and lasting value to the broad astronomical community with the SOFIA data yielding a substantial and coherent database. The proposing team may design an LSP that makes use of other available instruments on SOFIA for a coherent investigation of long-lasting value. Teams are encouraged (but not required) to design an LSP that utilizes existing data or planned observations from other ground- or space-based observatories to increase the impact and utilization of SOFIA data by the broader astrophysics community.

The LSP is a core requirement for this proposal and hence teams are encouraged to appoint a science lead to oversee the assembly and management of the science team and deliverables, as well as an instrument lead to oversee the planning and development of the instrument hardware and software. The science and instrument leads may be the same person.

The LSP should be akin to major coherent observing programs that have been carried out at other NASA astrophysics observatories, e.g. Spitzer Legacy Programs, see http://irsa.ipac.caltech.edu/data/SPITZER/docs/spitzermission/observingprograms/legacy/, or Hubble Treasury Programs, see http://archive.stsci.edu/hst/treasury.html that significantly advance NASA's strategic objectives in astrophysics.

The proposal's description if an LSP must contain a detailed scientific justification and an observing plan which clearly describes the science targets, instrument modes and the time required to achieve the scientific goals, as well as the roles and expertise of the science team that will execute the LSP. The proposal must describe any planned enhanced data products (e.g. reduced images, spectra, maps, catalogs and appropriate documentation), as well as the anticipated scientific impact including a schedule for planned publications, presentations, science workshops and/or conferences, and any

other planned involvement of the astrophysics community. The planned scientific output by the team(s) is defined as the delivery product of the LSP. An initial high-level budget commensurate with this plan should also be included.

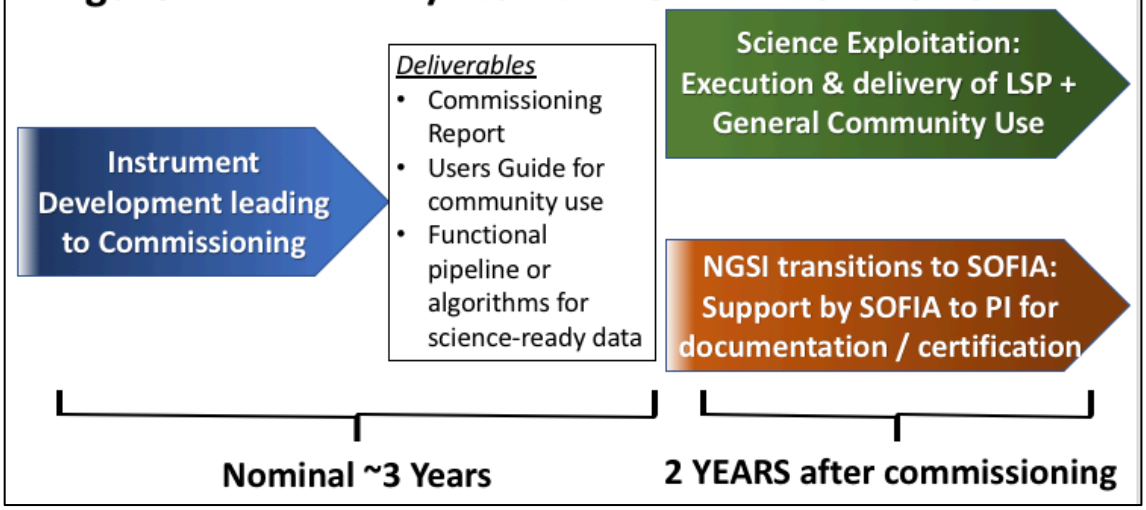
The LSP observing plan time request should be commensurate with the compelling nature of the science investigation, and to its legacy value and impact. Under exceptional and well justified circumstances, SOFIA will accommodate observing plans that require up to half of the available U.S. observing time in any given year for all LSP observations. The final LSP will be reviewed and allocated time after commissioning tests have demonstrated instrument capabilities. SOFIA will aim to execute the majority of the observations within the two-year period following commissioning.

Nominally LSP data have no period of exclusive use and the data will be made immediately public and available to the community via the SOFIA data archive at NASA/IPAC Infrared Science Archive (IRSA). If there is a strong justification for a very short period of exclusive use, the proposals must fully describe such a request.

In the ICS phase, the proposing team(s) may refine the needed observing time (possibly based on a better understanding of the instrument) but shall not change the scope of the scientific investigation. In this phase, the teams may add any other details to clarify the scope of the work to execute the LSP. The ICS report must also fully describe the funding and any other resources needed to execute and deliver the LSP with sufficient justification.

Following commissioning, upon better understanding of the instrument performance (and to allow for changes in the scientific landscape), as well as programmatic constraints at the time, the team(s), or NASA, or the SMO Director may revisit and request a re-negotiation of the LSP request. All such requests should be aimed at increasing and optimizing the science return from SOFIA. Also following commissioning, the LSP observing time request and science plan will be reviewed and authorized by the SMO Director, in concurrence with NASA.

Figure 2. TIMELINE / ACTIVITIES AFTER SELECTION



4.3 Anticipated Requirements, Activities and Timeline from Development to Acceptance

4.3.1 *Requirements for Commissioning*

- The Next Generation Science Instrument(s) (NGSIs) developed by the selected team(s) should plan for commissioning approximately three years after the development funding starts. Instruments that require a longer or shorter development time scale may be proposed with an adequate and compelling justification.
- The funds available for instrument development are anticipated to be ~$15--20M over three years (total for all NGSIs) which may be adjusted for the selected instrument(s) funding and schedule profile.
- Each instrument team must deliver a commissioning report immediately following the commissioning flights.
- The commissioning report must describe the instrument status and performance, operational modes, expected sensitivities in all modes and best practices for the use of the instrument for science.
- A "Users Guide" for the general community must be delivered at the end of commissioning.
- The team(s) must also provide a functional pipeline for science-ready data products at the end of commissioning such that the data may be expeditiously processed and ingested into IRSA; currently data are ingested into the archive within 2 weeks after the end of a flight series.

The final requirements for successful commissioning, the commissioning report, and timeline for delivery will be negotiated between the PI, NASA, and the Science Missions Operations Director towards the end of the instrument development process.

4.3.2 *Science Exploitation Period Following Commissioning*

Following commissioning, for up to two years, the team(s) will exploit the NGSI for science as follows during a Science Exploitation Period:

- The team(s) must execute and deliver on their Legacy Science Program.
  - The LSP observing plan will be approved at an LSP Kickoff Review anticipated to be held ~6 months prior to commissioning to allow SOFIA sufficient time to schedule the observations. A second review will be done post-commissioning, after the instrument performance is verified at which point the SMO Director will formally authorize the observations, in concurrence with NASA.
  - If the Legacy Science Program observations cannot be accommodated in two years, a phased execution plan will be considered that will most expeditiously execute the LSP to maximize the impact of the LSP science.
  - An annual review will be organized by the SMO, in consultation with NASA to evaluate progress and authorize continuation of the LSP.
- The team(s) must make their instrument available for general community use during the Science Exploitation Period, which may be on a collaborative basis, i.e.,
  - The team(s) must provide needed support for the community use of the instrument

    - In return, the team(s) may request reasonable participation in the community proposed science General Observer (GO) programs with the NGSI.
- It is understood that the NGSI data reduction pipeline may evolve and become more refined over these two years as the instrument is exercised for science.
- At any time during this two-year period, the PI may propose to enhance, modify and make upgrades to the instrument to improve / optimize its performance. The SOFIA project may choose to conduct an independent review of such requests to determine the potential impact on science (e.g. non-availability of instrument while being enhanced/upgraded versus community demand). Such a request will also be evaluated within constraints of the budget and other programmatic considerations.

4.3.3 *Instrument Transition to SOFIA*

At the end of the Science Exploitation Period, the NGSI must formally transition to the SOFIA project following the formal acceptance process that is detailed in the SOFIA Instrument Development Library. After this point, the instrument will become a facility class instrument. A facility class instrument is one wholly owned, maintained and operated by the SOFIA project. The intent of this transition period is to make the process smoother and easier by allowing for the transition to occur over a two-year period following commissioning and with support from the project as follows:

- Throughout the entire instrument development process, but especially towards the end of the development process and through the transition period, the selected team(s) are expected to work closely with the SI Dev team and the SMO with the goal of having common shared knowledge about the instrument hardware and performance, the software needed for operations, and the associated data reduction and analysis pipeline.
- At any time during development or after commissioning, the selected team(s) may request support from the SI Dev and/or the SMO team. For instance, the team(s) may request support to help with such things as airworthiness certification or other documentation.
- During the transition period after commissioning, the SI Dev and SMO team will work closely with the selected team(s) for the needed documentation and certifications to ensure a smooth transition of the instrument from the proposing teams to SOFIA.

5. Requirements for Step-1 Proposals

Although the discussion above has described some of the necessary information needed for selection, this section lays out the requirements for Step-1 proposals. Section 6 lays out the anticipated requirements for Step-2 proposals, the ICS Report. Requirements on standard proposal content and format are provided in Table 1 and Section IV(b)ii of the ROSES-2018 *Summary of Solicitation*. Budgets are required for these Step-1 proposals, see below. Proposals submitted in response to this program element must address all aspects of this next generation instrument program element, including, but not limited, to the following requirements listed in Sections 5.1 and 5.2. These requirements will be considered in the evaluation as described in Section 7.

5.1 Science Requirements for Step-1 Proposals

The proposal must include, but not be limited to, the following elements:

- A substantial and compelling science investigation that drives the need to develop the next generation science instrument on SOFIA. Describe how the science fits into fulfilling one or more of NASA's strategic astrophysics objectives.
- An LSP plan, consistent with Section 4.2, that clearly describes the coherent scientific investigation, team's scientific objectives for the requested LSP time, and a plan for achieving the scientific goals. As part of this plan, provide a realistic description of the necessary observations (i.e., a high level observing plan estimating the needed number of flights, number of targets, etc.), any enhanced data products to be delivered, schedule of planned science output (e.g. papers, presentations, conferences, community engagement, etc.), and a high-level estimate of the funding and other resource requirements.
- A discussion of other scientific investigations that may be undertaken by the general scientific community with the new instrument assuming it shall be available for at least ~5 years after commissioning. Connect these plausible investigations to NASA's strategic astrophysics objectives and discuss whether investigations enabled by the NGSI could be preparatory or complementary to those possible with current or upcoming astrophysics facilities such as the James Webb Space Telescope (JWST), Wide-Field Infrared Survey Telescope (WFIRST), Transiting Exoplanet Survey Satellite (TESS), Atacama Large Millimeter/submillimter Array (ALMA), etc.
- A high-level community usage plan describing how the team will support science with the instrument by the general community and needed resources for this effort during the two-year time period after commissioning and before the formal transition of the instrument to the project (consistent with Section 4 and see specifically sections 4.3.1 and 4.3.2)
- Required instrument performance (in context of the science enabled).

5.2 Technical Requirements for Step-1 Proposals

The Step-1 proposals must contain enough technical detail to provide sufficient confidence that the preliminary instrument design can meet the required performance to meet the science goals, and that the final instrument can be successfully completed within the technical, schedule, and cost goals proposed. Proposals may accomplish this task by explicitly identifying the areas that will be the topic of further development in the ICS phase, i.e., the Step-1 proposal may present less detail on technical, management, and cost, as these aspects are to be defined and detailed in the report provided at the end of the ICS phase.

The proposal must include, but not be limited to, the following elements:

1. A list of performance requirements that the science instrument shall achieve in order to enable the LSP and broader scientific investigations. These minimum performance requirements will form the basis of the top-level science and technical performance requirements.
2. A description of instrument design and fabrication, including a high-level

preliminary schedule and cost estimate for the NGSI and/or enhancements/ upgrades to a current instrument.

- If modifying or upgrading an existing instrument, indicate the down time when that instrument would not be available for observations on SOFIA
- Include a description of what components or aspects of the design are subject to further definition or identification during the funded ICS phase concept study
- Describe development of instrument control software and data reduction and analysis pipeline software
- If applicable, provide a discussion of possible future upgrades / continued improvement of the instrument capabilities to push the scientific boundaries and discovery space.

3. Identify all enabling technologies and define and justify the claimed NASA Technology Readiness Level (TRL), establishing confidence that the instrument design can be adequately developed within the proposed budget and timescale of the concept study. Details of the technical architecture will be further developed in the ICS phase.
4. A detailed budget, not exceeding $500K over five months, for the ICS phase must be entered into the NSPIRES cover page budget form and uploaded as a "Total Budget" PDF. The Step-1 proposal must include a budget justification for conducting the instrument concept study (see Section 6 below for requirements) but Consistent with Section IV(b)(iii) of the ROSES-2018 *Summary of Solicitation* salary, fringe and overhead should not be included in the proposal, which will be peer reviewed.
5. The budget justification section must include a separate appropriately labeled section with a high-level cost plan for the instrument development phase with an appropriate funding profile that does not exceed ~$15-20M over three years from the start of instrument development (i.e., from the end of the ICS phase). If the cost is higher than this, adequate justification must be provided in the proposal. Note that this is the total anticipated funding for one or more instrument(s) selected for development.
6. Potential, high-level de-scope options to the instrument, when such de-scopes could be exercised, along with the associated anticipated science impacts.
7. A high-level development, implementation, and commissioning plan with estimates for all costs associated through commissioning. The commissioning plan will be further developed in the ICS phase.
8. A high-level estimate of the scope of work and funding required to support the community usage (consistent with Section 4.3.2). The proposing team(s) are required to provide the needed support for broad community use as well as the data reduction pipeline that will provide users with science-ready data and data products. The community usage plan may be refined in the ICS phase upon better understanding of the instrument.
9. A high-level plan for the scope of work in transitioning the instrument to the SOFIA project for formal acceptance within the (up to two year) transition period after commissioning. This plan must detail how the team(s) propose to

collaborate with SI Dev team and the SMO to smooth the transition of the instrument for acceptance by the project.

10. Brief discussion of the methodology and rationale used to develop the proposed estimated cost of the instrument development (including a brief discussion of sources of cost uncertainties) and provide a discussion on the proposed management approaches for controlling cost growth.
11. If a proposal includes contributions from other institutions that are essential to the success of the proposed instrument development or are in the critical path, the proposal must include: (i) demonstrations of clear and simple technical and management interfaces in the proposed cooperative arrangements, (ii) explicit evidence that the proposed contributions are within the contributor's scientific and technical capabilities, and (iii) contingency plans for coping with potential failures of proposed cooperative arrangements or, where no mitigation is possible, an explicit acknowledgement to that effect and an explicit rationale for accepting the risk. A letter of commitment clearly describing the partner institutions role and commitment must be included in the proposal.

6. Anticipated Requirements for ICS Phase Reports

The ICS phase is expected to last approximately 5 months. We anticipate that teams will be required to include the following items in their final ICS report (Step-2):

1. A list of the science requirements and their flow-down to SI performance requirements including sensitivity/error budgets. The requirements do not need to be flowed down at the level of a System Requirements Review (SRR). But they should be specified in enough detail that a technical review panel is able to judge the scope of the development effort. The SRR is described in more detail in the SOFIA Instrument Development Library (see Section 3.4).
2. A proposed design, including hardware, electronics, software, and data analysis that could achieve these requirements, given in enough detail that the technical review panel can evaluate whether this design would be adequate. This does not, however, have to be at a Preliminary Design Review (PDR) level of design. The PDR is described in more detail in the SOFIA Instrument Development Library (see Section 3.4). The report should present enough information of the design and its required reviews to demonstrate to the technical review panel that the proposal team fully understands what is necessary to have an airworthy and reliable instrument flying on SOFIA.
3. Any technology development work that would be needed before a final design can be developed (e.g., raising TRLs of enabling technology).
4. Any outstanding design trades.
5. Possible de-scopes and their consequences.
6. A detailed work breakdown structure (WBS), with accurate labor and the required skill-set estimates for each WBS element.
7. Apportionment of the WBS elements among the different institutions in the proposal, with detailed letters of commitment from each institution.
8. An integration and test plan in enough detail that the technical review panel can

judge its feasibility, including any required documentation submissions to the SOFIA Project for their review.

9. A plan for developing the data reduction pipeline in collaboration with the SMO that will be ready for use at the end of commissioning. A clear plan with milestones must be provided on how the pipeline will be developed, tested, verified and delivered. The plan should also include any contemplated modifications, upgrades or refinement in the future.
10. A plan for management of data products (commissioning, GO, and LSP data) so that they are expeditiously available for ingestion into IRSA, which will serve the data to all users. The data products must conform to standard requirements used by IRSA for serving the data to the scientific community for analysis.
11. A schedule for the development effort, explicitly showing the location and duration of any funded schedule reserve, as well as the times and locations of any reviews.
12. A Master Equipment List (MEL) including the costs, supported by quotes, of all of the major procurements.
13. Identification of the key personnel, with statements of commitment for their time as specified in the WBS.
14. A risk plan for those items that are threats to the successful completion of the development effort on time and within cost.
15. A cost plan, broken down into enough detail with skill-sets and rates so that the technical review panel can gain confidence that the final costs are realistic.
16. A description of the facilities that will be used in the development program, including any test facilities, with letters of commitment that they will be available during the time periods shown in the development schedule.
17. A description of the organizational structure, include authority and lines of reporting.
18. A concept of operations for the instrument.
19. A detailed commissioning plan with an estimate of the number of flight research hours required to verify their instrument's performance, commission the instrument for use by GOs, and obtain any required generic calibration data. Observing time estimates do not need to include observatory overhead values (for telescope set-up and initial source acquisition), but should include observation overheads (time on target, time off-target for background subtraction via chop and/or nod, etc.). The estimated number of 'line operations observing hours' (observations with telescope operational and the aircraft parked on the ground) required to commission the instrument shall also be estimated. The number of hours proposed for commissioning the instrument and for line operations should be kept as small as practical and should be well-justified.

    Commissioning data that can also lead to publication of scientific results will be viewed as a strength of the proposal - therefore a carefully crafted commissioning plan at the end of the ICS is recommended. Offers to provide the larger astrophysics community with commissioning data and/or other help for full exploitation of the instrument will be considered a strength.

20. A further detailed estimate (if needed) of the schedule and resources needed for the execution and delivery (science ready data products, enhanced products, papers, presentations, conferences, community engagement, etc.) of the LSP.
21. Any minor refinements of the needed observing time for the LSP (based only on a better understanding of the instrument) but without changing the scope of the scientific investigation. Any other details to clarify the scope of the work to execute the LSP such as the funding to execute the LSP.
22. Refinement of the community usage plan from Phase I describing how the proposing team will ensure the maximum exploitation of science for programs from the broader science community. The plan should describe how the team plans to support the community and describe with justification their request for any desired participation in the community's proposed science GO programs with the NGSI. The funding needed to support the community should be described with adequate justification.
23. If applicable, a discussion of plausible future upgrades / updates to the instrument or software, estimated cost of the upgrades and their impact on the observatory and the science.

6.1 Reporting / Status updates / Q and A during the ICS Phase

During the ICS phase, the selected instrument teams should anticipate providing the SOFIA project with a monthly progress/status report. All teams may ask questions or clarifications during this phase - answers will be posted for all teams on a public web page since the ICS phase is a competitive phase.

7. Proposal Evaluation Criteria for Step-1 Proposals

The evaluation of proposals submitted in response to this program element will be in accordance with the evaluation factors stated in Section VI(a) of the ROSES Summary of Solicitation and the *NASA Guidebook for Proposers*, as well as consideration of the requirements described above.

- The evaluation criterion "intrinsic merit" will include consideration of the scientific merit of the proposed investigation and feasibility of technical success. The greatest weight will be placed on the compelling nature of the proposed LSP, the clarity of its goals and objectives, and the potential for fundamental progress, as well as filling gaps in our knowledge relative to the current state of art. Additional factors that will be evaluated are the expertise of the team, appropriateness of the instrument to address the goals and objectives, scientific potential of the instrument for the broader community including the community usage plan, data reduction and analysis pipeline plan, the archival value of data expected from the instrument, technical feasibility of the instrument, and the overall science return on the investment.
- The evaluation criterion "relevance" will include consideration of the scientific relevance of the proposed LSP and broader science enabled by the NGSI to NASA, with an emphasis on the degree to which the proposed instrument is able to uniquely advance the scientific capabilities of SOFIA.

- The evaluation criterion "cost realism and cost reasonableness" will include consideration of the implementation and cost risks factors such as: the feasibility and maturity of the design, the probability of technical success including de-scope options, the technology readiness level, the probability of meeting cost and schedule, the adequacy and costs of the ICS phase study plan. Also included in this criterion will be factors such as the proposed management plan and schedule, probability to conform and meet SOFIA Observatory requirements, the merits of the implementation and commissioning plans as well as the team's plan for transitioning the NGSI to SOFIA. The adequacy of the costs for executing the LSP and the community usage effort will also be considered in this criterion.

The evaluations will be used for the development of a selection recommendation by the POC for presentation to the selecting official (the Director, Astrophysics Division, Science Mission Directorate). The selection recommendation and selection decision may also include consideration of programmatic factors, such as the availability of funds, total cost, anticipated operational date, implementation and management risk, and potential benefit to other NASA missions.

8. Evaluation of the ICS Phase Reports

The evaluation of the ICS Phase reports (Step-2 proposals) will be done by a technical review panel. The science will not be judged again unless changed from what was originally proposed. The review will focus on the technical feasibility of the instrument as well as the feasibility and adequacy of its planned development schedule, costs and risks. The evaluation criteria for the ICS Phase reports will be described at a ICS kickoff meeting anticipated to be held soon after the selections are announced in ~October 2018.

9. Eligibility and Conflicts of Interest

Proposals from any category of organizations or institutions, U.S or non-U.S. (but not German, see below), are welcome to respond to this program element. 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.

SOFIA is a joint US-German partnership. Co-Investigators (Co-Is) at German institutions are welcome to participate on a no exchange of funds basis in proposals submitted by non-German institutions. Since the Memorandum of Understanding (MOU) between NASA and Deutsches Zentrum für Luft und Raumfahrt (DLR), the German Aerospace Center, gives the authority for selection of German participants in the SOFIA Project to DLR, German institutions are not eligible to submit proposals as PI to NASA in response to this program element (see also Section 12.3)

Any non-U.S. participation in this solicitation is subject to the requirements set forth in the ROSES-2018 Summary of Solicitation, Section III(a).

NASA ARC is eligible to submit and participate in proposals in response to this program element. In order to manage ARC's two potential roles as both proposers and in its role as SOFIA Science Center, SMD has established functional and organizational firewalls between the SOFIA Project and its associated Science Center, and those components of ARC that might participate in proposals. These firewalls ensure that personnel identified as supporting SMD in the solicitation process will protect all nonpublic information from all proposers, including those at ARC, and will be free of financial and other conflicts of interest with proposers.

Organizational conflicts of interest (OCI) between proposing, evaluating, and executing organizations must be avoided. The approach to avoiding organizational conflicts of interest depends on the unique characteristics and roles of each evaluating organization. For non-Governmental organizations, this requires limiting the extent to which the outside evaluating organizations can participate in proposal development and/or execution of the work proposed.

The NASA contract with Universities Space Research Association (USRA) for SOFIA science and mission operations includes technical evaluation support under this program element. In the event that any business unit of USRA has a proposed role as prime contractor, subcontractor, or participating organization, this support creates an organizational conflict of interest for USRA that cannot be mitigated. Because of this organizational conflict of interest, USRA personnel are precluded from participating in any capacity in support of a respondent under this program element.

Although NASA's Postdoctoral Project (NPP) is now managed by USRA, NPP fellows are not formally employees of USRA and therefore are eligible to participate in any capacity as principal or co-investigators, or in support of a respondent under this program element. NPPs should not propose as being affiliated with USRA, but instead should participate through another organization (such as their NASA center).

USRA is a private, nonprofit corporation whose current membership consists of 105 universities in the U.S. and abroad that have graduate programs in space-related sciences and/or engineering. NASA has determined that there is a need for USRA employees to perform technical evaluations of proposals for new science instruments due to their unique qualifications. In order to address any apparent or actual organizational conflict of interest that arises between USRA employees and the 105-member universities of USRA, the NASA Assistant Administrator for Procurement has approved a waiver in accordance with FAR 9.504(e) to permit peer review evaluation by USRA employees for all proposals received, including proposals received from the USRA member universities.

10. Public Engagement and Communications

Successful media relation activities require close cooperation between NASA and the selected investigations. All selected investigations shall coordinate media relations and/or public affairs with the SOFIA public affairs office. NASA is to be informed in a timely manner of any newsworthy mission event or issue before public release of information. Strategies for using new and social media shall also be developed

collaboratively to ensure that common and consistent messaging will occur in a timely manner. NASA and the selected investigation will establish and maintain a detailed coordination media relations plan and communication process.

11. Remediation, Termination, or Cancellation

For the ICS report, each selected Principal Investigator (PI) must include a commitment by the PI for the PI-managed instrument development cost, schedule, and award associated with the instrument. To maximize the efficiency of the concept study investment, the selected PI shall work with NASA to develop top-level science and technical performance requirements, including a set of performance metrics for evaluation with NASA. These metrics shall include cost, schedule, and others, as appropriate.

Once an investigation has been selected for implementation following down-select after the ICS phase, failure of the PI to maintain reasonable progress within the committed schedule and cost, and/or failure to operate within other applicable constraints, will require a review by NASA to ascertain if the development should continue. If, at any time, the cost, schedule, or scientific performance commitments made in the ICS concept study report appear to be in peril, the instrument development will be subject to cancellation, accompanied by appropriate award action, which may involve termination of the award.

Overall oversight of the instrument development will be provided by the SI Dev Manager at ARC. Additional independent oversight will be conducted by the SOFIA Chief Engineer's staff and the SOFIA Safety and Mission Assurance staff.

12. Submission Process and Requirements

Proposers should refer to the PDF entitled "How to submit a Step-1 proposal" under "Other Documents" on the NSPIRES page for this program. The process for preparation and submission of the Step-1 proposals is essentially identical to that associated with any other ROSES proposal, subject to the following program-specific constraints:

a) The Scientific/Technical/Management section of the Step-1 proposal, which consists of text, tables, and figures, must not exceed 25 pages. References do not count against the 25-page limit.
b) Proposals may only be submitted electronically through either NSPIRES (https://nspires.nasaprs.com) or Grants.gov (https://www.grants.gov/). No other submissions types or methods are permitted.
c) All electronic proposal materials must be submitted by 11:59 p.m. Eastern time on the due date given in Tables 2 and 3 of ROSES in order to be eligible for review for this program element.

Instructions provided in this program element supersede the instructions in the ROSES-2018 NRA and in the Guidebook for Proposers.

12.1 Pre-Proposal Workshops

NASA will provide three opportunities to the community to participate in a pre-proposal workshop on the dates noted in Section 14, Summary of Key Information. The workshop will cover the scope and intent of the solicitation, as well as expectations for the Instrument Concept Study, and NASA oversight of the development and commissioning process, and the characteristics of SOFIA. Detailed information on how to connect to the video/teleconference workshop will be provided at least one week prior to each workshop on the web page for this solicitation in NSPIRES and also on the SOFIA project web page. There will be a question and answer session at the workshop which will be recorded and also put on a webpage.

12.2 Proposal Formatting

Formatting of the proposal must conform to the stylistic requirements described in the ROSES-2018 *Summary of Solicitation* and if not addressed there refer to the 2018 *NASA Guidebook for Proposers*. There is no minimum requirement for fonts used within figures and tables but all text in figures and tables shall be legible; fonts smaller than 8-point are often illegible. 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.

12.3 International Agreements

Proposals from scientists employed at non-U.S. institutions will 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. All foreign investigators, whether proposing as PI from a foreign organization or Co-Is participating on proposals from U.S. organizations, must be endorsed by a funding/sponsoring institution or agency in the foreign country to demonstrate that resources are available to support the proposed investigation. Proposals from non-US participants should adhere to Section III(a) of the ROSES-2018 Summary of Solicitation and the *NASA Guidebook for Proposers*.

13. Award Administration and Funding

The award types depend on the nature of the work proposed, but it is anticipated that ICS Phase awards (made in response to Step-1 proposals) to non-Federal institutions will be grants and any subsequent (full) awards made in response to Step-2 proposals will be contracts. The initiation of the selected award(s) will take place as soon as possible after notification of selection. If the proposing organization of the instrument selected for implementation is external to the Federal Government, funding for the development, installation, and commissioning of the instrument may be issued as a contract from ARC. If the proposing organization is a NASA Center or other Government agency, funding will be issued through normal internal NASA or interagency processes, for both the ICS phase and post selection.

Once an instrument is selected for implementation (following the ICS phase), the technical oversight and management of the selected next generation SI development will be assigned to the SI Dev manager located at ARC. The responsibilities of this

manager include the overall oversight of the design, development, and implementation of the next generation science instrument. The SOFIA Project will provide system engineering methodology to assist the PI-led team in tracking progress against milestones, decision key points, budget and schedule, and goals and objectives, as well as the program plan, and specific aspects unique to SOFIA, such as airworthiness considerations.

14. Summary of Key Information

Expected total program budget	$15M-$20M over three years (higher values need adequate justification).
Number of new awards	One or more proposals selected to conduct ICS
Maximum duration of awards	ICS phase to be approximately 5 months. The schedule for implementation and delivery of the selected instrument will be determined during the ICS
Dates for Pre-proposal Workshops	Tuesday, Apr 3, 2018 at 2 pm Eastern Monday, Apr 16, 2018 at 4 pm Eastern Thursday, May 17 2018 at 2 pm Eastern
Submission of NOIs (not required)	Preferably by Jun 1, 2018
Due Date for Step-1 proposal	11:59 PM Eastern Time on August 1, 2018 via NSPIRES
Anticipated due date for invited Instrument Concept Study (Step-2 Proposals)	~ March, 2019
Planning date for Instrument Concept Study start	~3 months after Step-1 due date
Page limit for the Scientific, Technical, and Management section of proposal	25 pages. See Section 12 above and Section 2 of the *NASA Guidebook for Proposers* for information.
SOFIA Instrument Development Library	https://www.sofia.usra.edu/science/instrument-call
SOFIA Project web site	http://www.sofia.usra.edu/
NASA on-line Document Information System	NASA Policy Directives (NPD) and NASA Procedural Requirements (NPR) documents are available through the NASA On-line Document Information System (NODIS) at http://nodis3.gsfc.nasa.gov/.
Relevance	This program is relevant to the Astrophysics strategic goals and objectives in NASA's Strategic Plan. Proposals that are relevant

	to this program are, by definition, relevant to NASA.
General information for this solicitation	See the ROSES-2018 *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-2018 *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 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 proposals via Grants.gov	https://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH18ZDA001N-S4THG
NASA point of contact	Kartik Sheth Astrophysics Division, Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: 202-358-4805 Email: Kartik.sheth@nasa.gov

D.15 ASTROPHYSICS SCIENCE SMALLSAT STUDIES

NOTICE: April 18, 2018: In Section 3.1 SmallSat/CubeSat Design Assistance Points of Contact a correction has been made to the information for the GSFC mission design group. New text is in bold and deleted text is struck through.

April 13 2018. This amendment creates a new opportunity in program element D.15 Astrophysics Science SmallSat Studies. Neither Notices of Intent nor data management plans are requested for this program element. Proposals are due by July 13, 2018. A FAQ will be posted on the NSPIRES page of this program element under "Other Documents".

1. Scope of Program

This program element supports six-month studies of spaceflight mission concepts that can be accomplished for low cost using small spacecraft in standard form factors, including CubeSats, CubeSat constellations, Expendable Launch Vehicle Secondary Payload Adapter (ESPA) and ESPA-grande-ring compatible spacecraft, launched as secondary payloads. All proposed investigations must be responsive to the science goals of the Astrophysics Division, as described in the *2014 NASA Science Plan*[1]. All proposed investigations must be more capable than the suborbital-class CubeSat missions that are solicited within the Astrophysics Research and Analysis (APRA) program (D.3 of ROSES-2018).

The Astrophysics Science SmallSat Studies (AS^3) program is intended to capitalize on the creativity in the astrophysics science community to envision science enabled by smaller and significantly lower cost missions. NASA expects to make awards for mission concept studies that will span the breadth of possible science investigations that are enabled by CubeSat/SmallSat technologies and available secondary launch opportunities. Mission design assistance, if required, for these mission concepts will be offered by NASA during the six-month studies (see Section 3.1). If such assistance is proposed, the proposal must include its cost within the submitted budget (see the FAQ on this topic). NASA is considering including missions of this class in future Announcements of Opportunity for Astrophysics Explorers Missions of Opportunity.

2. Background

Recently, small satellites have been suggested as a means to execute scientific missions at far lower cost and complexity than typical space science missions.[2,3]

There are frequent launch opportunities for CubeSats as secondary payloads. CubeSats are small satellites that are built from a set of standardized subunits that each measure 10x10x10 cm and weigh 1.33 kg (designated '1U'). Common configurations include 1U, 2U, 3U, and 6U (2Ux3U) spacecraft. 12U and 24U configurations are also

[1] http://science.nasa.gov/about-us/science-strategy/
[2] http://sites.nationalacademies.org/SSB/CurrentProjects/SSB_160539
[3] http://kiss.caltech.edu/final_reports/SmallSat_final_report.pdf

being developed, although they are not yet fully documented as standard formats. NASA has previously developed Astrophysics 6U CubeSat missions for low-Earth orbit operations (e.g., ASTERIA, HaloSat) as well as constellations of SmallSats (CYGNSS) for Earth observing.

Another class of SmallSats for which frequent launch opportunities are available are Evolved Expendable Launch Vehicle Secondary Payload Adapter (ESPA) and ESPA-grande mounted satellites.

Proposals to this program element may propose to use CubeSat form factors (from 1U up to 6U, 12U and 24U), ESPA or ESPA-grande mounted satellites. Hosted payload concepts are not solicited at this time. Because of the availability of frequent launch opportunities, it is anticipated that the majority of the selections will be for investigations that would operate in low Earth orbit (LEO), geosynchronous orbit (GEO), or sun-synchronous orbit (SSO); other orbits are allowed provided the case is made that launch opportunities as a secondary payload could reasonably be expected.

It is acceptable that some, but not all, proposed science investigations would, by necessity, push the current state-of-the-art for payload and spacecraft technologies, and involve innovative thinking, advanced engineering, and technology development for instruments, optical systems, and/or spacecraft systems.

Mission cost ranges (Phases A through F) to be explored are up to $35M and mass ranges from 1U (~1.3kg) to ESPA and ESPA-grande class over a variety of form factors. Given the lower cost point and possible use of new technologies, NASA would adopt a risk posture described as "streamlined Class D"[4] for these astrophysics SmallSat missions.

For information on NASA's small satellite platform technologies, visit the NASA Small Satellite Technology Program[5] website.

3. Requirements

Studies must be led by a designated Principal Investigator (PI) with a small science and engineering team. Student involvement is welcome. Mission design will be a critical part of these studies as teams make trades, explore feasibility, and refine the mission concept.

Proposals should include team members to conduct mission design and/or a statement that they have made arrangements 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 will provide study teams access to mission design assistance if needed. It is up to the proposing team to contact one of the field center contacts in Section 3.1 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.

[4] https://soma.larc.nasa.gov/standardao/ClassD.html
[5] https://www.nasa.gov/directorates/spacetech/small_spacecraft/index.html

3.1 SmallSat/CubeSat Design Assistance Points of Contact

Ames Research Center - Mission Design Center
http://www.nasa.gov/centers/ames/engineering/divisions/missiondesign/
Scott Richey, charles.s.richey@nasa.gov, 650-604-0333.

[Corrected, April 18, 2018]
~~Goddard Space Flight Center - Integrated Design Center~~
~~https://idc.nasa.gov/mdl/index.php~~

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/
Mark Dillard, mark.a.dillard@nasa.gov, 281-244-8640.

Marshall Space Flight Center - Advanced Concepts Office
https://www.nasa.gov/centers/marshall/capabilities/advanced_concepts.html
Bruce Wiegmann, bruce.m.wiegmann@nasa.gov, 256-544-3498.

Successful proposers will be required to produce a publicly releasable mission concept study summary and fact sheet and present a summary of their study at a special session of a domestic astrophysics science conference, to be arranged by NASA after awards have been made. Additionally, a full written report to NASA is required (see Section 5.4).

Short proposals (up to 15 pages) are solicited that clearly summarize the mission concept, science target(s) and objectives, relevance to NASA Astrophysics Science objectives, and the nature of the science advancement expected from the mission. Proposals must include a baseline spacecraft design and architecture from which the study will begin, and a rationale for why the mission could be realizable for under $35M. Proposals must clearly describe the nature of work to be carried out during the proposed study.

This program element solicits only concept studies for astrophysics science SmallSat missions; it does not solicit technology development, flight instrumentation, or any hardware development. Proposals for mission concepts not appropriate for astrophysics science programs, and those not adhering to the guidelines in Section 4, will not be considered.

4. Mission Concept Parameters

Mission concepts that are proposed must adhere to the following parameters:

- The missions must carry out an astrophysics science program.

- Mission concept architectures requiring multiple spacecraft are permitted.
- Mass/Volume of up to 24U CubeSat format, ESPA or ESPA-grande mounted secondary payload are allowed.
- Studies must determine if new dispenser/deployment designs will be required to accommodate the mission design.
- The mission concepts must target mission costs of up to $35M, excluding launch and integration into carrier (if required).

NASA intends to award a range of studies across the spectrum of astrophysics science, mission mass, mission volume, and mission cost.

5. Programmatic Information

Answers to questions will be posted on the NSPIRES web page for this program element under "Other Documents".

5.1 Additional Proposal Guidelines

As well as following the guidelines in the *NASA Guidebook for Proposers*, proposers should be aware of the following additional guidelines when preparing their proposals:

- Proposal teams must be led by a PI and supported by a small science team. 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 must include a description of how and to what extent the proposed research will advance our current state of knowledge.
- Mission concept studies must be completed within six months of award.
- NASA expects to fund a number of studies at a level of $100,000 to $150,000 per study that span the range of CubeSat/SmallSat science, capability, and mission cost.
- Proposals must strictly conform to the formatting rules in Section IV(b)ii of the *ROSES Summary of Solicitation*. Proposals that violate the rules may be rejected without review.
- Proposers must allocate sufficient travel funds to be able to present their concept study results at a special session of a domestic Astrophysics Science meeting, to be arranged by NASA after awards have been made.

5.2 Evaluation Criteria

The three basic evaluation criteria for this program are listed in the *ROSES Summary of Solicitation* Section VI (a) and Appendix D of the *NASA Guidebook for Proposers*. These criteria are intrinsic merit, relevance, and cost realism/reasonableness of the proposed study. Clarifications specific to this program element are listed below.

For this program, the evaluation of merit specifically includes:

- Impact and importance of the science advancement expected from the mission and
- Realism and feasibility of the proposed study plan.

For this program, the evaluation of cost specifically includes:

- Likelihood that the concept being studied will be achievable at up to the $35M funding guideline.

For this program, relevance will be evaluated according to:

- Relevance of the proposed mission concept to NASA astrophysics objectives as demonstrated by linkages between the mission concept objectives and the *2014 NASA Science Plan*.

5.3 Compliance Requirements

- Proposals must be submitted by an institution hosting a scientist serving as the Principal Investigator (PI) for the study. Proposals must contain all elements described in Table 1 of ROSES-2018. The Scientific/Technical/Management section of the proposals is limited to 15 pages. This section must discuss/include the following elements:
- High level summary of mission concept study (one page).
- Science objectives for the mission concept study, science target(s), and rationale for the mission concept study (two pages; it is recommended that the objectives take a full page).
- Aspects of the mission concept that will be evaluated during the study, with emphasis on the flowdown from the science objectives to the science requirements to the technical requirements.
- It is anticipated that some concepts may use technologies with Technical Readiness Levels (TRLs)[6] lower than that typically associated with Explorer concepts; if so, the current and projected TRL and rationale for use must be adequately addressed.

5.4 Final Report

It is expected that mission design work during the study will lead to changes in the original mission concept described in the proposal. Selected studies must provide a final report to NASA describing the final mission concept and the rationale for changes from the original proposed mission concept, including the technological challenges and gaps identified. Reports marked as "Proprietary" will be treated as such. This report is due six months after the start date of the award and must, as a minimum, contain the following elements:

- Science objectives,
- Science requirements, traceable to the science objectives, and the proposed instrument complement with supporting rationale,
- Core science team expertise and traceability to science objectives,
- Mission design/architecture (orbit LEO/GEO/SSO, multiple spacecraft, etc.),
- Spacecraft concept (CubeSat form factor, ESPA or ESPA-grande class), mass budget, power budget, telemetry rates,
- Technology needs, quantified gaps, and development required,

[6] https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20170005794.pdf

- Concept of Operations,
- Launch vehicle interface and deployment method,
- Estimated Mission Costs and explanation of the cost estimation method, and
- Top mission risks and key mission trades to be studied in the future.

A two-page publicly-releasable mission fact sheet must be provided with the final report.

6. Summary of Key Information

Expected annual program budget for new awards	$1.0 M
Number of new awards pending adequate proposals of merit	~6 to 10
Maximum duration of awards	6 months
Due date for proposals	See Tables 2 and 3 of this ROSES NRA.
Planning date for start of investigation	October 2018
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* of this NRA.
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 permitted. See also Section IV in the *Summary of Solicitation* of this NRA and Chapter 3 of 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	NNH18ZDA001N-AS3

NASA point of contact concerning this program	Michael Garcia Astrophysics Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546 Telephone: (202) 358-1053 Email: michael.r.garcia@nasa.gov

D.16 SECOND ASTROPHYSICS DATA ANALYSIS

NOTICE: Amended on February 6, 2019. The release of ROSES-2019 will be later than normal this year as a result of the partial government shutdown. In order to maintain May proposal due dates and the standard 90-day period between release and (full or Step-2) proposal due date, a number of program elements that were to have early due dates in ROSES-2019 are being released now as part of ROSES-2018. This is the first of such amendments. This amendment releases the second Astrophysics Data Analysis opportunity in ROSES-2018 as D.16 2ADAP. A Notice of Intent is requested by April 5, 2019 and Proposals are due by May 17, 2019.

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 second solicitation of the Astrophysics Data Analysis Program (ADAP) program in ROSES-2018 (2ADAP) provides support for investigations whose focus is on the analysis of archival data from NASA space astrophysics missions.

1.1 Special Considerations for 2ADAP Proposers

- Analyses involving publicly available data from NASA's Transiting Exoplanet Survey Satellite (TESS) are eligible for support for the first time under 2ADAP. TESS data products are available through the TESS portal at the Mikulski Archive for Space Telescopes (MAST) and include high-precision photometry of selected target stars with a cadence of approximately two minutes and Full Frame Images (FFIs) of the entire the 24x96 degree TESS field-of-view collected with a cadence of approximately 30 minutes. Prospective investigators are reminded that proposals for TESS data analysis are limited to those data that are available in the public domain at the time of the 2ADAP proposal submission deadline and that proposals may not anticipate future public data releases (see Section 1.3).
- Analysis of data from the European Space Agency's *Gaia* mission is an allowable component of an ADAP proposal. However, *Gaia* is an example of a space astrophysics mission with no significant NASA involvement. As such, *Gaia* data may be used to support the analysis of allowed data from a NASA mission (e.g. Table 1) but may not itself be the primary object of an ADAP investigation. In any such instance, the onus is on the proposer to clearly establish that (1) the use of *Gaia* data is necessary to affect the analysis of the approved NASA space astrophysics data used in the proposed investigation, and (2) analysis of the *Gaia* data is not itself the primary object of the investigation (see Sections 1.3.1 and 1.3.7).

- 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.
- 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. For convenience, the NSPIRES proposal cover page now includes a mandatory text box for this purpose. 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 which involve the development of new databases, data products, or data analysis tools must satisfy the more rigorous requirements described in Subsection 1.3.3. Those proposers should simply indicate that the proposal is in one of these categories and refer to the appropriate section of their proposal in the NSPIRES text box where it asks for a data management plan.

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.

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.

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 the Keck Observatory Archive (KOA) has been expanded and now includes data from 11 different instruments, including the High Resolution Echelle Spectrograph (HIRES), the Near InfraRed echelle SPECtrograph (NIRSPEC), and the Near Infrared Camera 2 (NIRC2). The data holdings for the three named instruments extend back to 1994 for HIRES, 1999 for NIRSPEC, and 2001 for NIRC2. Data archived in the KOA are allowable as the primary data source for an ADAP proposal.

Table 1. A Representative List of Projects/Missions that had a Significant NASA Contribution and may Represent the Primary Data Source for an ADAP 2018 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 selected 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.

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.

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 Sections 1.3.4 and 1.3.5 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, suborbital platforms, or non-NASA space missions; 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. The budget justification for any such proposals must include a summary of the work effort (in terms of personnel time commitment) and 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 2018 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 locked within them, 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 in this research area clearly articulate what the final products of the investigation will be and how the 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. If the proposing team does not include a representative of the relevant data center, proposers are strongly encouraged to include a letter of acknowledgement from that archive in their proposal.

Finally, prospective proposers should also 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 in the Astrophysical Databases research area must 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.

1.3.4 *Support for Approved Spitzer Guest Observers*

Only very limited funding was available to support investigations selected under Cycle 14 of the Spitzer Space Telescope Guest Observer (GO) program, and those funds were allocated to investigations involving more than 200 hours of observations. Therefore, the Principal Investigators (PIs) of approved Spitzer Cycle 14 GO investigations involving less than 200 hours of observing time are eligible to propose for data analysis support under 2ADAP, even if those observations have yet to be executed or the data are still within their exclusive-use period at the time of the proposal deadline.

Only one ADAP proposal is allowed per approved Spitzer GO program under this waiver. If it is found that more than one ADAP proposal has been submitted for a given Spitzer GO program, all such proposals will be declined and not considered for funding. This restriction expires at the end of the exclusive-use period, when all the data from the Spitzer GO program are released in the public domain. Also, the PI of an eligible Spitzer GO program need not be the PI of an associated ADAP proposal, but it is expected that they will at least be a member of the proposing team.

This waiver does not extend to Director's Discretionary Time (DDT) observations.

Proposers seeking funding support for an approved GO program are not relieved of the responsibility to provide a compelling proposal that meets all of the requirements of the ROSES-2019 NRA and the ADAP program element. It is generally not sufficient to simply submit the approved GO proposal.

1.3.5 *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 under the AO-18 cycle and rated as either Category A or Category B are eligible to propose for funding under 2ADAP 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 US 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 US 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. Please note- this waiver does not apply to US-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-2019 NRA and the ADAP program element. It is generally not sufficient to simply submit the approved GO proposal.

1.3.6 *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.

1.3.7 *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-2019 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-2019 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; or
- Proposals for the acquisition of substantial computing facilities or resources beyond nominal workstation or network requests.

1.3.8 *Proposal formatting*

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 ten defined ADAP Research Areas are:

1. Star and Exoplanetary System Formation - includes of studies star-forming clouds, protostars, protoplanetary and debris disks, and formation of exoplanets and exoplanetary systems;
2. Stellar Astrophysics and Exoplanets - includes studies of the structure and evolution of main sequence stars, brown dwarfs, and exoplanet detection and characterization;
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 X-ray Astrophysics - includes studies of neutron stars, stellar-mass and supermassive black holes, X-ray binaries, black-hole binaries;
5. Supernovae and Gamma Ray Bursts - includes studies of supernova progenitors, the physics of catastrophic stellar explosions, and supernova-driven nucleosynthesis, but not including studies of supernova remnants and their interaction with the interstellar medium (ISM);
6. Interstellar Medium - includes studies of dense clouds, the diffuse ISM, supernova remnants and their interactions with the ISM, interstellar dust, HII regions, and diffuse galactic emission;
7. Normal Galaxies and Galactic Structure - includes studies of the structure of the Milky Way and other galaxies;
8. Active Galaxies and Quasars - includes studies of interacting galaxies, starburst galaxies, Luminous/ultraluminous infrared galaxies, Seyfert galaxies, radio galaxies, active galactic nuclei, and quasars;

9. Large Scale Cosmic Structures - includes studies of clusters of galaxies, galaxy environment and evolution, intracluster medium, diffuse x-ray background, and cosmology); and
10. Astrophysical Databases - includes compilations of fundamental atomic, molecular, solid state parameters, development of publicly-accessible databases of observations from NASA suborbital astrophysics projects, higher-level data products based on existing archival astrophysical data sets, and data analysis tools).

2. Current Profile of the ADAP

2.1 ADAP 2018 Submission statistics

In 2018, a total of 247 proposals were submitted in response to the ADAP program element, a modest decrease (6%) in the number of proposals compared to ADAP 2017, but consistent with the average proposal pressure in recent years (~250 proposals). The distribution of those proposals over the various research areas covered by ADAP 2018 is shown in Figure 1. 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.

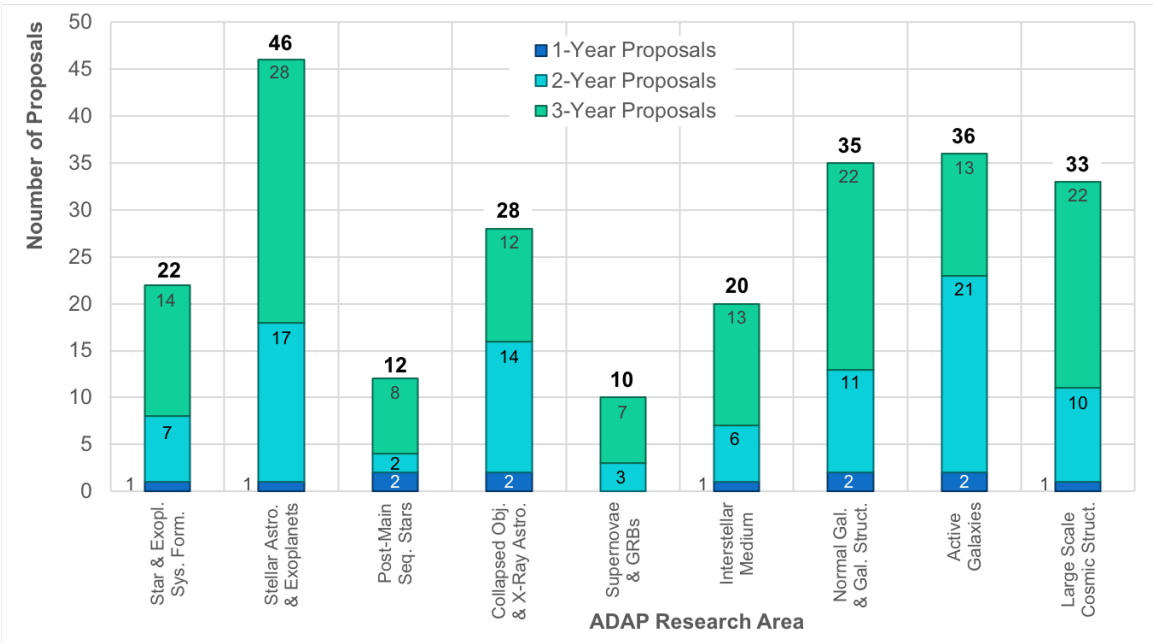


Figure 1. The distribution of 2018 ADAP proposal submissions, broken down by requested funding duration, across the Research Areas covered by the program. The bold number at the top of each column gives the total number of proposals in the corresponding research area. Proposals in the Astrophysical Databases Research Areas were grouped into one of the Research Areas shown based on their subject matter. Five proposals were found to be non-compliant and were declined without review.

2.2 Distribution of annual funding levels for ADAP tasks

With an annual budget of around $20M, the ADAP typically supports around 120 investigations in any given year (includes both new starts and continuing investigations). Although the average annual ADAP award is approximately $143,100, actual award amounts span the range from less than $50,000 per year to more than $225,000 per year. The plot in Figure 2 shows the distribution of annual awards for the ADAP in FY 2018.

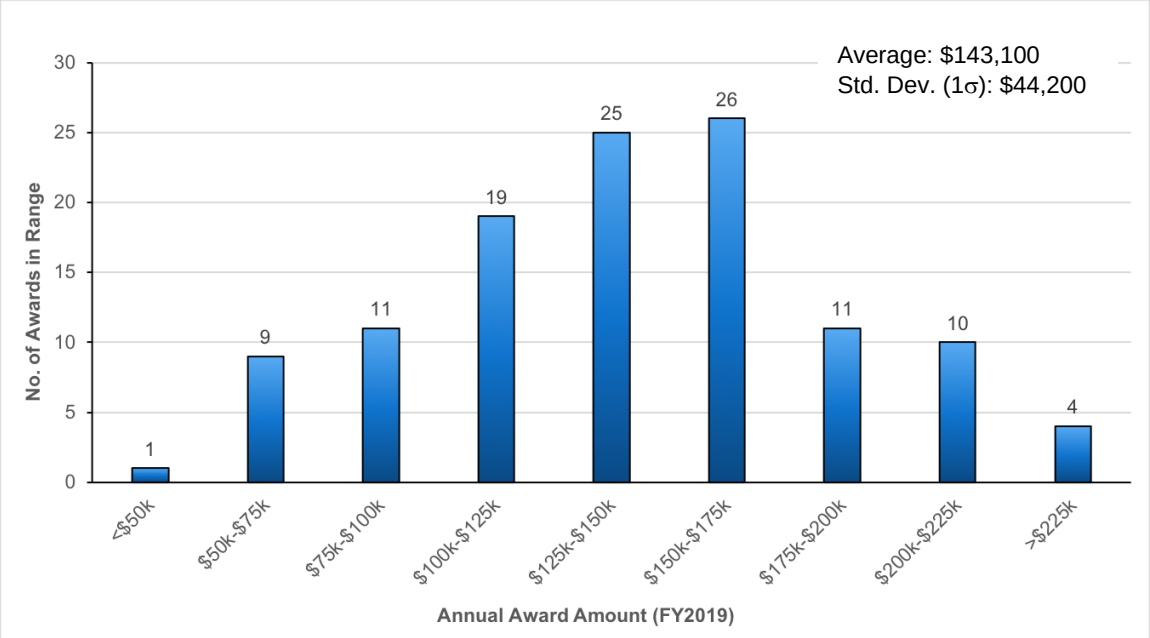


Figure 2. The distribution of annual awards for funded ADAP tasks in FY 2019. Data include both ADAP 2018 new starts and ongoing tasks from previous solicitations.

2.3 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.

3. Summary of Key Information

Expected program budget for first year of new awards	~$7.0M
Number of new awards pending adequate proposals of merit	~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, 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 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. 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	NNH18ZDA001N-2ADAP
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

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 three 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. The three program elements in Appendix E handle this quite differently. 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. Proposers to E.3 The Exoplanets Research Program, must satisfy the DMP requirement by responding to the compulsory NSPIRES cover page question about the DMP. Proposers to E.4 The Habitable Worlds Program, must meet the more involved requirements described in Appendix C.1.

3. Program Elements

The Topical Workshops, Symposia, and Conferences program element (E.2) solicits proposals for topical workshops, symposia, conferences, and other scientific/technical meetings that advance the goals and objectives of the 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.

The Exoplanets Research Program (E.3) solicits basic research proposals to advance our knowledge and understanding of exoplanetary systems. This program is shared between the Planetary Science Division and the Astrophysics Division. 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.

The Habitable Worlds Program (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 Astrophysics, 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.

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: August, 21, 2018. The point of contact for this program element is now Mary F. Sladek. See Section 6 for details.

Potential proposers to this program are strongly advised to visit http://science.nasa.gov/researchers/sara/program-officers-list/ and contact the appropriate SMD Program Officer there to ascertain the availability of funds for funding proposals to this program element prior to submitting a proposal to this program element.

1. Introduction

In order to address its strategic goals and objectives (see Section I of the *ROSES Summary of Solicitation*), the Science Mission Directorate (SMD) acknowledges the need to bring together members of scientific communities relevant to NASA in order to:

- encourage and facilitate the use of mission data,
- increase the efficiency of investigators through advanced scientific/technical training,
- increase the efficiency of investigators through the open exchange of ideas, and
- expose investigators to new subject areas.

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 that constrain proposals in response to this program element; in particular, the proposed participants, logistics, and level of NASA support must be, and appear to be, appropriate given NASA's science goals and objectives.

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 only the following SMD Divisions: Earth Science, Heliophysics, and Planetary Science.

Proposals are not limited to traditional in-person meetings of scientists, but may also include requests for support of other methods of bringing together members of the scientific communities relevant to NASA, such as online discussion forums and web-based collaboration portals, especially in support of a traditional event. 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 education, public outreach, or administrative conferences. Moreover, this program element may not support research or fellowship programs of any type.

Where other ROSES program elements specifically solicit for events, proposals must be submitted in response to those program elements instead of this one.

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 not only high-level SMD goals and objectives, but also specific (existing or anticipated) outcomes identified in ROSES program elements, SMD roadmaps, other SMD program documents, the *NASA Science Plan*, findings in decadal surveys, or the reports of NASA advisory bodies or groups relevant to NASA. Proposers are not constrained to show relevance to the program elements that appear in ROSES; some calls do not appear every year, but research in that area continues and proposals would still be considered relevant. The subjects of the proposed events are not limited to the targeted science itself (or data analysis that leads to science), but also include technologies, methods, and capabilities that enable the attainment of relevant goals, such as (but not limited to) code development, data compression algorithms, higher order data products, model intercomparisons, the enhancement and/or application of new equipment to make pertinent measurements, etc.

Proposers must explicitly state from what source (e.g., ROSES program element, roadmap, or decadal survey) the claim of 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 Science Plan* for NASA's Science Mission Directorate. 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 (http://science.nasa.gov/earth-science/earth-science-data/). 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.

4. Program Principles and Proposal Constraints

4.1 Allowable Focus of Proposals

The goal of any proposed activity must be to enable science, and the support to pay for person time and/or logistics, which may be funded as a result of the proposed activity, are merely an incidental means to achieve that goal. Proposals to this program must be written so that the objective of the proposed activity is clearly focused on the desired effect that is to be achieved (e.g., science), rather than the means to that end (e.g., logistics). 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. However, a proposal with a stated goal of simply paying for logistics in support of an event would not be considered responsive to this program element.

4.2 Competition and Criteria for Selecting Event Participants

SMD principles include the use of competition to increase the effectiveness of awarded funds. Although SMD may provide only a small fraction of the total funds required for an event, SMD expects the individuals participating in the event to be identified through competition; exceptions require adequate justification. If funds are requested for limited participants to attend an event, then an open call for abstracts is expected where their evaluation would play a role in selecting participants.

The merit rating of the science abstract need not be the only factor; consideration of other factors, such as diversity, is to be expected. Indeed, proposers are reminded that, 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.

There may be compelling reasons to justify selecting certain participants without competition in order to attain the stated scientific or technical aim of the event; in such cases, the justification must be provided in the proposal.

4.3 Availability of Funding

No specific budget is identified for this program element; selected proposals will be funded by the benefitting program. The number of proposals selected will be dependent on the number and quality of proposals submitted and on the availability of funds from the benefitting program. Potential proposers are encouraged to contact the appropriate SMD Program Officer to investigate the availability of funds in that specific program for funding proposals to this program element. Contact information for SMD Program Officers is available at http://science.nasa.gov/researchers/sara/program-officers-list/.

4.4 Constraints on Logistics

The logistics of the event must be, and appear to be, appropriate for accomplishing the stated purpose. This includes the size, location, duration, scheduling, and cost of the event for both sponsors and attendees. Proposers are discouraged from choosing what might appear to be a resort location. Similarly, proposers are discouraged from choosing a foreign location; proposed events outside of the U.S. must be adequately justified.

The funding request, whether a small grant to subsidize student participation or full sponsorship of a large symposium, must be commensurate with (a) the role of NASA in stewarding the subject science and the benefiting science community, and (b) the importance of the event to NASA in attaining its goals and objectives.

Proposers to this program element are strongly encouraged to review the guidelines found in the SMD memo on "Priorities for Conference Spending" of April 27, 2009. This document can be found by following the link entitled “Conference Sponsorship Memo”, available at https://science.nasa.gov/researchers/sara/library-and-useful-links.

4.5 Award Duration

Most awards from this program element are expected to be one year in duration. Under certain circumstances, and if properly justified, it may be permissible to propose multiple meetings that span across a period of more than a year. For example, a pair of meetings before and after fieldwork, targets of opportunity (oil spills, comet appears, etc.) or another large project, make sense to plan and propose together. Otherwise, proposers should plan on a single meeting.

5. Other Factors

The amount that NASA can spend on conferences is limited. Support for administrative conferences is not solicited within this program element, which is exclusively for scientific/technical subjects, see Section 1.

This program element cannot result in the award of a contract, only a grant, cooperative agreement, an interagency agreement, or internal funding to a NASA Center.

Letters of affirmation from the relevant community are permitted for proposals to this program.

Not all proposals to this program element are necessarily 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 call must have the benefit of the event flow directly to the recipient and its members, not to NASA. The principal purpose of the event will be to advance the research or other purposes of the recipient. 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.

NASA Interim Directive (NID) 9700.1 provides the financial management requirements for conference planning, approval, attendance, and reporting for NASA. The NID notes that it is applicable to recipients of grants and cooperative agreements only to the extent specified or referenced in the award. Specifically, Section 4.3.2. (b) Non-Reportable Expenses indicates that "Conference costs paid by a recipient of financial assistance (i.e., using grant or cooperative agreement funds from NASA)" are not subject the reporting requirements. However, it goes on to note: "To ensure proper use, cooperative agreements should limit the use of funds for conference activities directed at a public purpose, like technical assistance to presenters. To the extent a proposed grant or cooperative agreement also supports NASA mission needs and objectives related to hosting or assisting another to host a conference, the proposed use shall be reviewed with procurement and legal to determine whether a procurement contract should be used in lieu of all or part of the proposed grant or cooperative agreement."

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) and the result of the award is that NASA will be the primary sponsor of a conference (see FAQ 4-2 of NID 9700.1 for a discussion of when NASA is a primary sponsor), then the proposal must clearly state this fact, because NASA must provide detailed reports for NASA-sponsored conferences. In addition, there are other constraints imposed by both statute and regulation that limit options for NASA-sponsored conferences (e.g., use of non-Federal facilities, charging of registration fees).

No NSPIRES cover page question on data management plans will be posed for proposals to this program element, but you may present one or NASA may require one, if appropriate. In order to assist in routing a proposal to appropriate personnel, proposers are asked to provide on the NSPIRES cover page the name of a NASA Headquarters point of contact and to identify the relevant science program(s).

6. Summary of Key Information

Expected annual program budget for new awards	No specific budget is identified; selected proposals will be funded by the benefitting 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 benefitting 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, 2019

Planning date for start of investigation	6 months after proposal receipt.
Page limit for the central Science/Technical/Management section of proposal	5 pp; see also Table 1 of ROSES and the *NASA Guidebook for Proposers*.
Relevance	See section 3. 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. 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	NNH18ZDA001N-TWSC
NASA 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** **[POC changed August 21, 2018]**

E.3 EXOPLANETS RESEARCH

Notice: June 6, 2018. The main planetary science point of contact for this program element is now Stephen Rinehart, see Section 4 Summary of Key Information.

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 merely must fill in the Proposal Summary text box on the NSPIRES cover pages. Only proposers who submit a Step-1 proposal are eligible to submit a Step-2 (full) proposal. See Section 3 for details.

1. Scope of Program

The Exoplanets program element solicits basic research proposals to conduct scientific investigations related to the research and analysis of extrasolar planets (exoplanets). Its broad objectives include the determination of compositions, dynamics, energetics, chemical behaviors of extrasolar planets, and the detection and characterization of other planetary systems. This program element is shared between the Planetary Science Division and the Astrophysics Division.

Research supported by this call may include observations, laboratory studies, theoretical studies, and modeling. Investigations that incorporate theory, modeling, laboratory studies, correlative analyses, and/or other research that would greatly increase the use of, or significantly facilitate the interpretation of, observational studies of exoplanetary systems are eligible for the Exoplanets Research Program. Such tasks that don't directly contain observational studies will be judged on the perceived impact of the proposed work upon the interpretation of observations of exoplanetary systems, including the ability to compare results of laboratory measurements to observations, and the ability to test the validity of theories against observations.

Investigations are expected to directly support the goal of understanding exoplanetary systems, by doing one or more of the following:

- detect exoplanets and/or confirm exoplanet candidates in order to provide high-value targets for current and future NASA observatories or support NASA's ongoing exoplanet surveys;
- observationally characterize exoplanets, their atmospheres, or specific host star properties that directly impact our understanding of the exoplanetary system, in order to support NASA's ongoing exoplanet surveys, inform target and operational choices for current NASA missions, or deliver targeting, operational, and formulation data for future NASA observatories;
- understand 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.

For administrative purposes, the Astrophysics Division will manage investigations aimed primarily at observations to detect and/or characterize exoplanetary systems. Proposals to understand the chemical and physical processes of exoplanets and/or to improve the understanding of the origins of exoplanetary systems (including all theory, laboratory, and modeling proposals) will be managed by the Planetary Science Division. Programs that combine two or more divisional disciplines to investigate exoplanet properties (Astrophysics, Planetary Science, Heliophysics, and Earth Science) are especially encouraged.

Observationally-based proposals are required to provide their relevance to NASA by referencing which past, current or planned mission the proposed program is augmenting or preparing for, and describing how, the proposed work benefits that mission.

Proposed investigations may include ground-based observations made at any ground-based facility, public or private, including those supported by NASA. If new observations are to be made, the facility, including 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 are expected to provide evidence of current instrument performance and data quality. The observations must directly support the goals of the Exoplanet Research Program (XRP) call and must also include scientific analysis and publication.

Proposed investigations with a main focus on stellar objects (including host star atmospheres) or brown dwarfs will be evaluated specifically upon the impact of the proposed work upon our understanding of exoplanets. The onus is upon the investigation team to argue convincingly that the main benefit of their program is the advancement of exoplanet science.

For investigations with laboratory, theoretical, and modeling components, it is imperative that proposals provide the observable or measurable consequences of their investigations and indicate the validity tests and uses for such non-observational tasks.

The scientific impact of XRP investigations must be near-term. Proposal reviewers will be requested to assess the impact on exoplanet science of investigations over a 5-year timeframe. A failure to provide convincing evidence that an investigation will impact exoplanet science over the next five years will be considered a major merit weakness of a proposal.

2. Programmatic Information

2.1 Exclusions

The breadth of this call inevitably results in overlap in subject matter between this and other ROSES program elements.

Proposals to investigate the formation, early evolution, and structure of our Solar System are not solicited. Investigations to develop the theory of planets or planetary systems as they relate directly to our Solar System should instead be submitted to the Emerging Worlds program element (C.2).

Observational proposals aimed at identification, validation, and characterization of extrasolar planets that may harbor life are within the scope of this program. Theoretical and laboratory proposals aimed at identification and characterization of signals and/or properties of extrasolar planets that may harbor life are not within the scope of this program. Theoretical or Laboratory research aimed at investigating the habitability of an exoplanet should be submitted to the Habitable Worlds program element (E.4).

Investigations with a primary focus on analysis of NASA space astrophysics data from a public domain archive (including the Kepler and K2 missions) are not solicited in this program element. If there is an archival data analysis aspect to the proposed program, then the proposal is required to provide justification for why it is not compliant with the Astrophysics Data Analysis Program (ADAP) element of ROSES (program element D.2).

Proposed programs containing major work elements of collecting and analyzing data from currently operating or future space missions that have Guest Investigator programs will not be considered for grant funding through the XRP. Such proposals should respond directly to the Guest Investigator programs of the relevant missions.

Investigations with the primary objective of maintaining and operating observing facilities, or developing, commissioning, or determining the integrated performance of instrumentation are not solicited in this program.

2.2 Facilities Available to Proposers

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 the Exoplanets Research program 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.

2.3 Fellowship Programs

See program element C.21 for the application process for the 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.

2.4 Duration of Awards

We anticipate 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. Four-year proposals may be selected if the need for the longer duration is sufficiently well justified.

2.5 Selecting Officials

The Selecting Official for investigations that are managed by the Planetary Science Division is the Research and Analysis Lead for the Planetary Science Division. The Selecting Official for investigations that are managed by the Astrophysics Division is the Director of the Astrophysics Division.

2.6 Nexus of Exoplanet System Science

Although XRP does not solicit proposals aimed specifically at habitability, 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 (for example, planet formation) are eligible to be part of 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/.

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 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. Proposers will be notified when they are able to submit their Step-2 proposals. 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 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: The *NASA Guidebook for Proposers* requires that you 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). 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 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. Summary of Key Information

Expected program budget for first year of new awards	$2.0-2.5 M
Number of new awards pending adequate proposals of merit	15-20
Maximum duration of awards	3 years; 4 years if well justified (see Section 2.5)
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, 2019

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 and 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. 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	NNH18ZDA001N-XRP
NASA points of contact concerning this program	**Stephen Rinehart [Added June 6, 2018]** **Planetary Science Division** **Science Mission Directorate** **NASA Headquarters** **Washington, DC 20546-0001** **Telephone: (301) 286-4591** **Email: stephen.a.rinehart@nasa.gov** Martin Still Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-4462 Email: martin.still@nasa.gov

NASA points of contact concerning this program, continued	Melissa A. Morris Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 774-8476 Email: melissa.a.morris@nasa.gov

E.4 HABITABLE WORLDS

NOTICE: Amended February 1, 2019. The proposal due date for this program element were previously temporarily changed to "TBD" as a result of the partial government shutdown. This amendment releases new due dates for the effected program elements in Planetary Science. For this program element the new due date for Step-2 proposal submission is March 29, 2019.

Proposals to this program are 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 the Step-1 proposal. Step-1 proposers merely must fill in the Proposal Summary text box on the NSPIRES cover pages. Only proposers who submit a Step-1 proposal are eligible to submit a Step-2 (full) proposal. See Section 3 for details.

1. Scope of Program

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 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 (all in the Planetary Science Division), Exoplanet research in the Astrophysics 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.

2. Programmatic Information

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.

The Habitable Worlds element will be administered primarily by the Planetary Science Division. As such, this solicitation is governed by information contained in program element C.1. However, highly-rated proposals of strong programmatic relevance to the Astrophysics or Heliophysics Division will be considered for funding by the Astrophysics or Heliophysics Division, respectively. The Astrophysics Division will consider supporting investigations that are focused upon the characterization of potentially habitable exoplanets and their atmospheres in order to:

- inform targeting and/or operational choices for current NASA Astrophysics missions, or
- provide targeting, operational, and/or formulation data for future NASA Astrophysics observatories.

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 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.

2.2 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.2 Emerging Worlds. 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. Refer to those solicitations 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.8 Lunar Data Analysis Program (LDAP), C.9 Mars Data Analysis Program (MDAP), C.10 Cassini Data Analysis Program (CDAP), C.11 Discovery Data Analysis Program (DDAP), C.19 New Frontiers Data Analysis Program (NFDAP), and C.20 Rosetta Data Analysis Program (RDAP) 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: 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 solicitation 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 Nexus of Exoplanet System Science

Although Habitable Worlds solicits proposals aimed at habitability of any planet, including those within the Solar System, 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 specifically are eligible to be part of 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/.

2.7 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.

In response to proposals submitted to this program element in ROSES-2014 – 2016, 10-15 awards were made (16-23% selection rate). The average size of awards resulting from Step-2 proposals submitted to Habitable Worlds was ~$150-175 K per year per award, but with a wide range, depending on the nature of the work proposed. When selections are made for proposals submitted in January of 2019 in response to ROSES-2017 those data will be included in the grant stats spreadsheet on the SARA grant stats web page. Proposers are encouraged to request what they actually need to conduct the research proposed.

2.8 Planetary Science Division Early Career Fellowship Program

See Program Element C.21 for the application process for the 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.

2.9 Antarctica

The Habitable Worlds Program is no longer 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 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. 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, and D.1 Astrophysics 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 the *NASA Guidebook for Proposers*, a letter of support may be required from any facility required for the proposed effort.

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 NASA Postdoctoral Program (NPP) Fellows. The tenure of a Fellow must begin 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.\

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

This is a reminder that 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.

4. Summary of Key Information

Expected program budget for first year of new awards	~$2M
Number of new awards pending adequate proposals of merit	See section 2.7
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 pp; see also Table 1 of ROSES and the *NASA Guidebook for Proposers*.
Relevance	This program is relevant to Planetary Science, Heliophysics, and Astrophysics 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*.
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.
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	NNH18ZDA001N-HW

NASA points of contact concerning this program	Mitch Schulte Planetary Science Division NASA Headquarters Washington, DC 20546 Telephone: (202) 358-2127 Email: mitchell.d.schulte@nasa.gov Mary Voytek Planetary Science Division NASA Headquarters Washington, DC 20546 Telephone: (202) 358-1577 Email: mary.voytek-1@nasa.gov Martin Still Astrophysics Division NASA Headquarters Washington, DC 20546 Telephone: (202) 358-4462 Email: Martin.Still@nasa.gov Galen Fowler Heliophysics Division NASA Headquarters Washington, DC 20546 Telephone: (202) 358-0039 Email: galen.fowler@nasa.gov

E.5 SECOND EXOPLANETS RESEARCH

NOTICE: May 29, 2019. Due to inconsistent due dates provided to proposers, the Step-2 proposal due date for this program element has been delayed by one day. Step-2 Proposals are now due May 30, 2019.

Amended on February 26, 2019. The release of ROSES-2019 will be later than normal this year as a result of the partial government shutdown. In order to maintain the May Step-2 proposal due date for this program and the standard 90-day period between release and Step-2 proposal due date, this amendment releases the second Exoplanets Research opportunity in ROSES-2018 through this program element. Step-1 proposals are due by March 29, 2019 and Step-2 Proposals are due by May 30 ~~29~~, 2019. Read the text carefully, changes have been made to the text since the prior version from Spring 2018.

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. See Section 3 for details.

1. Scope of Program

The Exoplanets Research Program (XRP) element solicits basic research proposals to conduct scientific investigations focused on extrasolar planets (exoplanets). Broad objectives of this program include, but are not limited to: the detection and characterization of other planetary systems; characterization of individual exoplanets, through exploration of their composition, dynamics, energetics, chemical behavior, etc.; and the origins of extrasolar planets. This program element is cross-divisional, and jointly managed by the four science divisions within the Science Mission Directorate.

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.

This call supports observational, laboratory, and theoretical studies (including modeling) that focus on improving our understanding of exoplanetary systems. Proposed investigations should have significant impact on the study of exoplanets, by: 1) collecting new data that delivers unique insight into the nature of exoplanetary systems 2) improving the interpretation of data on exoplanetary systems, through collection and

interpretation of laboratory data for comparison to observations and/or providing an observationally testable theory. All such investigations will be judged, 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 should demonstrate relevance to NASA by describing the benefit for NASA missions, with specific past, current, or future missions or programs identified.

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.

Proposed investigations with a main focus on stellar objects or brown dwarfs are in scope, but should demonstrate convincingly that the research investigation will advance exoplanet science.

Investigations with laboratory, theoretical, or modeling components should clearly describe how results will support 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.

Investigations that combine two or more divisional disciplines to investigate exoplanet properties (Astrophysics, Planetary Science, Heliophysics, and Earth Science) are especially encouraged.

2. Programmatic Information

2.1 Clarifications and 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).

Observational, theoretical, and archival proposals focused upon the detection of technosignatures are within scope of the XRP, except for archival proposals that exploit data within a NASA public domain archive. Such proposals should be submitted to D.16, the Second Astrophysics Data Analysis Program (ADAP) element of ROSES-18.

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 telescopes also fall

within the scope of the XRP. Theoretical or laboratory investigations focused on the studies defining, understanding, or characterizing biosignatures generally fall in the scope of the Exobiology Program (C.5), and 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, HW, and/or ExoBio Program Officer is encouraged.

Investigations with a primary focus on analysis of data from a NASA public domain archive (including the Kepler and TESS missions) are not solicited in this program element. Such proposals should be submitted to ADAP. Should a proposal submitted to XRP contain an archival data analysis component, a clear justification should be made for why the proposal is not compliant with ADAP.

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 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.

2.2 Facilities Available to Proposers

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 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.

2.3 Early Career Programs

This program element will participate in the Planetary Science Early Career Award (ECA; see program element C.19 of ROSES-19 on its release later in 2019), with the aim of supporting research and professional development of outstanding early-career scientists.

XRP is a Planetary Science ECA-participating ROSES program element, and researchers wishing to apply for an ECA must:

1. Be the PI (or Science PI) of a full proposal submitted to this program element;
2. Check the Early Career Award checkbox on the NSPIRES cover pages of that proposal; and
3. Have received their PhD (or equivalent degree) within 10 calendar years of the year of submission of that proposal.

An ECA applicant whose proposal is selected will be invited (by the Program Officer of the participating program element) to submit a full application for the ECA. Note that

only the PIs of proposals that are deemed relevant to the scientific aims of the Planetary Science Division will be considered for the ECA program.

See program element C.19 (of ROSES-2019) for full details of the ECA and its two-tier application process.

2.4 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 justify the need for the longer duration.

2.5 Selecting Officials

Selections from XRP will be jointly made by the Resource and Analysis Leads of the divisions within the Science Mission Directorate.

2.6 Research Coordination Networks

PIs of proposals selected for funding from this program element are eligible to become members of the Steering Committees of the newly-established Research Coordination Networks (RCNs: for more information, see: https://astrobiology.nasa.gov/news/astrobiology-program-faqs/), provided that the proposed investigation is aligned with the goals of an RCN. 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 a conflict-free review panel, 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. Proposers will be notified when they are able to submit their Step-2 proposals. 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 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: The *NASA Guidebook for Proposers* requires that you 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). 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 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 Data Management Plan

In order to maximize the impact of NASA-funded science, all XRP investigations must include a Data Management Plan (DMP). The intent is to ensure broad and timely availability of data to the community and a clear plan for the long-term access to the

data. Data management plans are to be submitted via the NSPIRES cover pages in response to the DMP question.

4. Summary of Key Information

Expected program budget for first year of new awards	~$2.5 M
Number of new awards pending adequate proposals of merit	15-20
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, 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 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	NNH18ZDA001N-2XRP

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