NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

HEADQUARTERS

SCIENCE MISSION DIRECTORATE

RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES – 2016 (ROSES-2016)

NASA RESEARCH ANNOUNCEMENT (NRA)

SOLICITING BASIC AND APPLIED RESEARCH PROPOSALS

NNH16ZDA001N

CATALOG OF FEDERAL DOMESTIC ASSISTANCE (CFDA) NUMBER: 43.001

ISSUED: FEBRUARY 19, 2016

FULL (STEP-2) PROPOSALS DUE
STARTING NO EARLIER THAN APRIL 22, 2016
THROUGH NO LATER THAN JUNE 1, 2017

August 18, 2016: The final Section of Table 1 on separately uploaded HEC and Total Budget files was reformatted to make explicit that the Total Budget is a separately uploaded document and not part of the detailed budget section in the proposal PDF.

Amended March 24, 2016: Section IV(b)(iii) on redaction of salaries and indirect costs from peer reviewers and Table 1 have been updated to explicitly state that a "Total Budget" file uploaded separately from the proposal document is required, see Section IV(b)(iii). New text is in bold, deleted text is struck through.

RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES (ROSES)–2016

EXECUTIVE SUMMARY

This National Aeronautics and Space Administration (NASA) Research Announcement (NRA), Research Opportunities in Space and Earth Sciences (ROSES) –2016, 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 range from under $100K per year for focused, limited efforts (e.g., data analysis) to more than $1M per year for extensive activities (e.g., development of specialized science experimental hardware). The funds available for awards in each program element offered in this NRA range from less than one to several million dollars, which allow selection from a few to as many as several dozen proposals, depending on the program objectives and the submission of proposals of merit. Awards will be made as grants, cooperative agreements, contracts, and inter- or intraagency 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 investigations involving non-U.S. organizations will be conducted on the basis of no exchange of funds.

Details of the solicited program elements are given in the Appendices of this NRA. Proposal due dates are given in Tables 2 and 3 of this NRA, which will be posted at http://nspires.nasaprs.com/ and for which links are provided below. Interested proposers should monitor http://nspires.nasaprs.com/ or subscribe to the SMD electronic notification system there for additional new program elements or amendments to this NRA through February 2017, at which time release of a subsequent ROSES NRA is planned. A web archive (and RSS feed) for amendments, clarifications, and corrections to ROSES-2016 will be available at: http://nasascience.nasa.gov/researchers/sara/grant-solicitations/roses-2016/. This NRA will be available upon its release at http://solicitation.nasaprs.com/ROSES2016.

ROSES–2016 SUMMARY OF SOLICITATION

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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/ROSES2016table2 and http://solicitation.nasaprs.com/ROSES2016table3, respectively, or by going to http://solicitation.nasaprs.com/ROSES2016 and following the links there.

RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES (ROSES)–2016

LIST OF PROGRAM ELEMENTS (APPENDICES)

APPENDIX A. EARTH SCIENCE RESEARCH PROGRAM

Note: Any amendments to the Table of Contents for Appendices A through E will be indicated as red in Table 2 and Table 3 of this NRA, which are posted and updated as separate html documents on the web. These can be reached either by following the hypertext links above embedded in the electronic version of this document, at http://solicitation.nasaprs.com/ROSES2016table2 and http://solicitation.nasaprs.com/ROSES2016table3, respectively, or by going to http://solicitation.nasaprs.com/ROSES2016 and following links there. Potential proposers may receive notification of amendments to ROSES-2016 by signing up for the SMD NSPIRES mailing list and/or by signing up for the ROSES-2016 RSS feed at https://admin.science.nasa.gov/researchers/sara/grant-solicitations/roses-2016/

RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES (ROSES)–2016

SUMMARY OF SOLICITATION

I. FUNDING OPPORTUNITY DESCRIPTION

(a) Strategic Objectives of NASA's Research Program

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 execute a sustained and affordable human and robotic space exploration program and develop, acquire, and use civil space systems to advance fundamental scientific knowledge of our Earth system, solar system, and the universe. This direction allows the science objectives of the NASA Science Mission Directorate (SMD) to be clearly defined as the orderly pursuit of the Agency's strategic direction.

The *2014 NASA Strategic Plan* identifies the following strategic objectives as those to be pursued by SMD:

- Understand the Sun and its interactions with Earth and the solar system, including space weather;
- Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere;
- Discover how the universe works, explore how it began and evolved, and search for life on planets around other stars; and,
- Advance knowledge of Earth as a system to meet the challenges of environmental change and to improve life on our planet.

Further insight into SMD's Strategic Goals and Objectives (from the 2014 Strategic plan) and the Questions and Goals in the 2014 Science Plan, are given in the documents at http://science.nasa.gov/about-us/science-strategy/. All program elements in this NASA Research Announcement (NRA) are relevant to NASA's Strategic Goals and Objectives. Each proposal to this NRA demonstrates 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 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 (ISS) 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, 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 Program sponsors research 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 solar systems to the origin, evolution, structure, and destiny of the universe itself.

The program elements in 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

Proposers should be aware of the following significant changes in this NRA from last year:

- Salaries for all participants and overhead from all types of organizations must be included in the web cover page budget. This applies to 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 proposal. See Section IV (b) iii.
- Section I (h) has been added which describes what proposers should do when there are conflicts between ROSES vs. the Guidebook vs. Program Elements.
- Information about requested High-End Computing resources will be collected on the NSPIRES cover pages and as a separate, uploaded PDF document, see Section I (d), below.
- Table 1 indicates that CVs for collaborators are permitted, though discouraged in general.
- Table 1 indicates that Current and Pending Support are not required for Students or Foreign Co-Investigators (Co-Is) (since their organization already provides a letter attesting to their availability).
- 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).
- ROSES requires submission of Data Management Plans (DMPs) along with almost all proposals, see Section II (c). 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.
- NASA anticipates that, starting in 2016, award recipients will be required to archive all as accepted manuscript versions of publications that result from NASA awards in the National Institutes of Health PubMed Central full-text archive. This requirement will not go into effect until it is included in the terms and conditions of the research awards. Details and instructions for archiving manuscripts will be fully described in future grant information circulars, Frequently Asked Questions (FAQs) and other official Agency announcements and training materials.
- A number of changes have occurred in Appendix B: Three new Program Elements have been added (B.8-10) and B.2 Heliophysics Supporting Research (H-SR) will employ a "binding" two-step proposal submission process; only those proposals that pass threshold review can be submitted as Step-2 proposals. See the individual Program Elements for more information.
- A number of changes have occurred in Appendix C: The Overview in C.1 has been rewritten, Program Element Habitable Worlds is now a cross-division program between Planetary Science and Astrophysics and is located in Program Element E.4, and new Program Element C.19 New Frontiers Data Analysis is listed as TBD and will be added to Appendix C via Amendment. Much of Appendix C now invokes more stringent DMP requirements. See C.1 and the individual Program Elements for more information.
- A couple of changes have been made to Appendix D: Two new Program Elements have been added (D.10 and 11).
- Much of Appendix C has been added to the list of program elements that will not award contracts because it would not be appropriate for the nature of the work solicited. See Section II (a) for more information.

- As always, small changes have been made throughout this document and the associated Program Elements, so please read them carefully well in advance of the proposal due date.

Individuals who did not propose last year should be aware of the following features of note in this NRA, most of which are changes made in recent years:

- Table 1 became a checklist for proposers in 2015. It is to be hoped that this is helpful and will diminish the frequency of noncompliant proposals.
- In 2015, the *Guidebook for Proposers* moved the mandatory table of personnel and work effort out of the budget section and noted that any time commitment included that is not funded by NASA is not considered cost sharing, as defined in 2 CFR §200.29. The *Guidebook* applies this rule to grants, not contracts. This table of work effort, which is not in either the page limited technical/scientific section nor in the budget, is merely a reporting of all of the planned work commitment, funded by NASA or not. This is distinct from the page limited technical/scientific proposal, which should describe what work each team member will be doing. See Table 1.
- In 2015, what was Section IV(e) "Proposal Requirements for Relevance" in prior ROSES incorporated into an expanded and clarified Section VI. "Proposal Review Information".
- What was Section II(b) "Successor Proposals and Resubmissions" in prior ROSES was moved to I(g), clarified, and renamed "Successor, Resubmitted, Multiple and Duplicate Proposals" in 2015. This section includes restrictions on submissions.
- Section V, Suborbital-Class Investigations, was reorganized in ROSES-2015 to remove redundancy and it retains the form that it took last year.
- The Planetary Science Division Research Program was restructured in 2014 and the ROSES-2014 structure has been maintained into ROSES-2016, as can be seen in the Table of Contents for Appendix C. Unless otherwise specified, program elements in Appendix C will continue to use a two-step submission process that requires submission of a Step-1 proposal by the institution. See Section IV(b)vii of this *Summary of Solicitation*, Section 2 of Appendix C.1, and the individual program elements for details.
- The Cross-Division Program supported by the Astrophysics and Planetary Science Divisions, formerly known as "Origins of Solar Systems," was changed to the Exoplanets Research Program in 2014. See Appendix E.3 for details
- In accordance with restrictions in Appropriation Acts, NASA cannot support 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. See Section III (c) on restrictions involving China.
- Unsolicited proposals for topical workshops, symposia, conferences, and other scientific/technical meetings will not be accepted. Proposals for such events should be submitted to the few program elements that include it or in response to the Topical Workshops, Symposia, and Conferences program element found in Appendix E.2.
- Note in Section VII (c) that NASA funded projects that receive assistance from the U.S. Antarctic Program (USAP) should explicitly acknowledge USAP.

Proposers may also refer to the ROSES FAQ at http://science.nasa.gov/researchers/sara/faqs/. In addition to the listed significant changes, this NRA and the *NASA Guidebook for Proposers Responding to a NASA Research Announcement or Cooperative Agreements Notice* (hereafter referred to as the *NASA Guidebook for Proposers* or simply the *Guidebook*) incorporate a large number of additional changes, including both policy changes and changes to proposal submission requirements. Many sections of both documents have been clarified since last year. All proposers are urged to carefully read this NRA and the latest edition of the *NASA Guidebook for Proposers*, since all proposals must comply with their requirements, constraints, and guidelines.

(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 http://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 http://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, using the template described below, in no more than one page, which will not be counted toward the maximum page limit for a proposal. At a minimum, this justification must include how the computational resources would support the investigation and a multi-year resource-phasing plan, in annual increments, identifying the computing time and data storage requirements and the preferred location (facility) where the computational project will be accomplished for the duration of the proposed award period.

A template for populating the multi-year phasing plan is available on the HEC Website at http://www.hec.nasa.gov/request/science_call.html. The completed template should be converted to PDF and submitted as a separate appendix document. For proposals submitted via NSPIRES, the document should be uploaded using the "Appendix" document type. For proposals submitted via Grants.gov it should be attached as an appendix to any appropriate form location. Note that this requirement for a separate document supersedes the general rule in IV(b)(i) for provision of only a single PDF file. Note, computing time must be described in the plan 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. SBU Conversion Factors are available at http://www.hec.nasa.gov/user/policies/sbus.html. Proposers may also contact HEC support staff for further assistance calculating SBUs; contact information can be found at http://www.nas.nasa.gov/hecc/support/user_support.html for NAS User Support, and https://www.nccs.nasa.gov/index.html for NCCS User Services Group.

In addition, proposers must indicate on the NSPIRES Cover Page that a request for computing resources is included in the proposal.

As they review the intrinsic merit of the proposed investigation, science peer review panels will be asked to consider the realism and reasonableness of the computing time request and whether it is an appropriate utilization of the highly constrained resources dedicated for each program element under this NRA. Negotiations may be necessary to allow adjustments to computing time requests given resource constraints.

Allocation of HEC resources will be awarded based on the multi-year phasing plan confirmed during the selection process. Principal Investigators (PIs) have the opportunity to submit requests for minor modifications to their plan (e.g., allocation of additional HEC resources) on a semi-annual basis. The HEC website provides the mechanism for PIs to formally request modifications to computing time allocations as identified in their funded proposals. Visit http://www.hec.nasa.gov/request/science_call.html for process details. 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 PI 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 about NASA provided High-End Computing resources contact:

Tsengdar J. Lee
Earth Science Division
Science Mission Directorate
NASA Headquarters
Washington, DC 20546-0001
E-mail: Tsengdar.J.Lee@nasa.gov
Telephone: 202-358-0860

(e) Opportunities for Education and Communications

SMD strives to foster broad involvement of the Earth and Space science communities in Education and Communications (E&C). Some individual program elements within ROSES (See Appendix C) may include some E&C associated with the proposed research activities, but in general they do not. Regarding Education, SMD has awarded Science Education Cooperative Agreements that will cover this work. ROSES participants are encouraged to work with the science education providers, as appropriate. Questions and/or comments and suggestions about the SMD E&C program may be directed to: Kristen Erickson at kristen.erickson@nasa.gov.

(f) Availability of Funds for Awards

Prospective proposers to this NRA are advised that funds are not in general available for 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.

(g) 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* (Section 1.5 Successor Proposals) such successor proposals will be considered with neither advantage nor disadvantage along with new proposals that are submitted for that same program.

Generally, proposers are welcome to resubmit proposals (or tasks) that were not funded under a prior 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.

(h) Order of Precedence: The Guidebook vs. ROSES 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.*

An example of a case where individual Program Elements occasionally contradict and supersede the *Guidebook* is letters of endorsement. Section 2.3.9 of 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 Element in ROSES do allow letters of affirmation, see Table 1.

An example of a case where this *Summary of Solicitation* contradicts and supersedes the *Guidebook* is in the location of the Table of Personnel and Work Effort. Section 2.3 of the *Guidebook* places the Table of Personnel and Work Effort after the budget and special notifications, but this *ROSES Summary of Solicitation* emphasizes this table by moving it further up, right after Biographical Sketches/Curriculum Vitae.

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 with 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 or Program Elements.

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

(i) Access to NASA Facilities/Systems

For any awards where individuals need access to NASA facilities and/or systems, all award recipients must work with NASA program staff to ensure proper credentialing. Such individuals include U.S. citizens, lawful permanent residents ("green card" holders), and foreign nationals (those who are neither U.S. citizens nor permanent residents).

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*.

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 postselection 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 (see Section 2.3.10 of the *NASA Guidebook for Proposers*) to help expedite the processing of the award, should their proposal be selected.

Subject to limitations in particular program elements, ROSES allows the full range of award types: grants, cooperative agreements, contracts, and intra- or interagency transfers. 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, see Section 3 "Choice of Award Instrument" from the *Grants and Cooperative Agreement Manual (GCAM)*[1] and Appendix D of the *NASA Guidebook for Proposers*. In the case of any conflict, the *GCAM* takes precedence. Contract awards will be subject to the provisions of the Federal Acquisition Regulations (FAR) and the NASA FAR Supplement (see http://prod.nais.nasa.gov/cgi-bin/nais/nasa_ref.cgi).

Several program elements exclude contracts because it does not seem appropriate for the nature of the work solicited. If contracts are excluded, the program element will indicate that explicitly. At the time of this writing, some of the program elements that exclude contracts include most of Appendix C and A.15, A.26, A.39, B.2, and B.4. 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.

(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 usual 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, new terms and conditions about making manuscripts and data publically accessible may be attached to awards that derive from ROSES. 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. In most cases 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 and FAQs. Proposers that include a plan to archive data should allocate suitable time for this task. Unless otherwise stated, this requirement obviates the need for the data sharing plan mentioned in the *NASA Guidebook for Proposers*. 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

[1] The *NASA Grants and Cooperative Agreement Manual*, hereafter referred to as the GCAM, is at https://prod.nais.nasa.gov/pub/pub_library/Grant_and_CooperativeAgreementManual.doc

called "Grant and Cooperative Agreement Guidance" at https://prod.nais.nasa.gov/pub/pub_library/srba/.

(d) Rephasing of Award Budgets

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 practice, 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), as long as it does not compromise previously agreed upon project goals, timelines, or deliverables associated with a NASA requirement described in the contract (grants are not used for NASA requirements). This is consistent with NASA's policy that allows grantee initiated first time no-cost extensions of up to 12 months. See https://www.nssc.nasa.gov/nocostextension for more information.

To facilitate the reduction of funds from one fiscal year remaining unspent in the next fiscal year (uncosted carryover), SMD program officers engage in active grant management after appropriate communication with the grantees. Program Officers assess the uncosted carryover in the awards in their portfolios. While some uncosted carryover is necessary, those awards that are both (a) carrying a year (or more) of funding and (b) carrying a total carryover of $100K or more will be considered for rephasing. Program Officers take into account the history of funding and costing on a grant-by-grant basis.

In those cases where funds for a year or more are being carried over, Program Officers will inform the PI of their intentions regarding fund disbursement/rephrasing and give the PI an opportunity to respond. The total funds disbursed 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.

"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. 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. Proposers considering the use of these methodologies should be aware of the Federal Citizen Science and Crowdsourcing Toolkit, which gives prospective citizen science project developers tips for designing, carrying out, and sustaining their projects. Such activities are, like the rest of the proposal, subject to the announced evaluation factors, including relevance and merit.

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 Section 1.6 of the *NASA Guidebook for Proposers*). NASA does not normally fund foreign research proposals or foreign research efforts that are part of U.S. research proposals. Rather, cooperative research efforts are implemented via international agreements 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 Appendixes limit the number of proposals that may be submitted by an individual PI to a program element or bar duplicate proposals, see Section I(g). Moreover, each proposal must be a separate, stand-alone, complete document for evaluation purposes.

(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

If an institution of higher education or other not-for-profit organization wants to receive a grant or cooperative agreement, cost sharing is not required, although NASA can accept cost sharing if it is voluntarily offered (see 2 CFR 200.306, 2 CFR 1800.306, *GCAM 5.6 Funding*). If a commercial organization wants to receive a grant or cooperative agreement, cost sharing is required unless the commercial organization can demonstrate that it does not expect to receive substantial compensating benefits for performance of the work. If this demonstration is made, cost sharing is not required, but may be offered voluntarily (see references in parenthesis above and 14 CFR §1274.204, "Costs and Payments"). See also Section VI(a) "Evaluation Criteria" below.

Each proposal must include a Summary of Proposal 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. The *NASA Guidebook for Proposers* notes that any work planned that is not funded by NASA listed in the Summary of Proposal Personnel and Work Effort is not considered cost sharing as defined in 2 CFR § 200.29. This allows all proposers to accurately reflect the actual time they will devote, whether or not it is paid for by NASA. 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."

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 Appendix B of 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 rejected without review.

Questions regarding this NRA or its program elements should be directed to the cognizant 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.

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 in a fully electronic form. No hard copy of the proposal is required or permitted. Electronic proposals must be submitted 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.

Proposers may opt to submit proposals in response to this ROSES NRA via either of two different electronic proposal submission systems: either via the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) (http://nspires.nasaprs.com; see Section IV(b)(iv) below) or via Grants.gov (http://www.grants.gov; see Section IV(b)(v) below).

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 (http://www.sam.gov).

- 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 appendix, multiple PIs (as described in Section 1.4.2 of the *NASA Guidebook for Proposers*) are not permitted. The use of other categories of participation described in Section 1.4.2 of the *NASA Guidebook for Proposers*, including Science PI, Institutional PI, and Co-PI (from a non-U.S. organization under specific circumstances), remain permitted.
- 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.

Generically, an electronic proposal consists of electronic forms and one 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 only a single attachment (unless there is an accompanying HEC request; see Section I (d) above). The single attachment contains all sections of the proposal, including the Science/Technical/Management section, the budget narrative, and all required and allowed appendices; see Section IV(b)(ii) below for further requirements.

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 Table 1 for a summary) and in the *NASA Guidebook for Proposers* (e.g., Section 2.3). 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. Section 2 of 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 main body 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.

Proposals submitted in response to ROSES must follow the *Guidebook* rules for formatting: body text and captions maybe up to 15 characters per inch, typical of font Times New Roman 12, though text within figures and tables may be smaller if still judged by the reviewers to be readable. See Table 1 for details.

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. 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 Postscript and then to PDF. See http://nspires.nasaprs.com/tutorials/PDF_Guidelines.pdf for more information on creating PDF documents that are compliant with NSPIRES. 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 (Section 2.3(c) of the *NASA Guidebook for Proposers*). 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) New Budget Rules: Redaction of All Salaries and Indirect Costs

What is included in the budgets has changed this year, so please read this section carefully. Often, peer reviewers evaluate cost reasonableness of ROSES proposals, see Section VI (a), but they do not need salaries or overhead rates to do so. In an attempt to balance NASA's need to have all budget details, while having peer reviewers evaluate only work effort, all proposers, even NASA civil servants, must list all costs, including salaries and indirect rates, in the web cover page budgets. Subawards that include salary and overhead belong in Section F (Other Direct Costs) rows 5, 8, and 9. These rows will be automatically hidden from peer reviewers.

The budget justification in the proposal document must rationalize all costs other than salaries and overhead, which may not be mentioned. Proposals submitted in response to this ROSES NRA must include the Summary of Work effort (see Table 1) which, along with any rationale of the time provided in the budget justification, will allow peer reviewers to evaluate whether the level of effort is appropriate.

~~As in prior years, a detailed budget is recommended, the only difference this year is that no salary or indirect rate information should be included in the detailed budget in the main body of the proposal. Since NASA funding sent to NASA Centers must be obligated in the same fiscal year (FY) in which they are received, proposals submitted by NASA Centers (but not including JPL) should begin the budget section of the proposal with a breakdown of funding by NASA Center and by fiscal year, assuming the start date given in the Summary of Key Information table at the end of the program element (the default is six months after proposal submission). Thus, a ROSES-2016 proposal for a two-year award that starts in mid FY 2017 could phase the funds for a half year of funding in FY 2017, a full year in FY 2018, and a half a year in FY 2019.~~

No salary or indirect rate information may be included in the detailed budget, or anywhere else in the proposal document. All ROSES program elements are set up to allow proposers to separately upload a "Total Budget" PDF to the same ROSES program element NSPIRES "response structure" to which the proposal is submitted. This Total Budget PDF will not be seen by peer reviewers. Unless otherwise specified in the ROSES program element, all proposers are required to include the complete detailed budget in this separate Total Budget PDF. Where more than one organization is involved, the total that was simply given as a single number in row 5, 8, or 9 of Section F should be broken out in the separately uploaded Total Budget PDF. That is, 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. See Section IV. (d). Where the funds are passing through the proposing organization, the Total Budget PDF must specify any overhead. Since ROSES funding for NASA Civil Servant salaries must be obligated in the same fiscal year (FY), proposals that include NASA Civil Servant salaries may need to phase the funds for NASA Centers by fiscal year. Proposers from non-Governmental organizations with NASA Civil Servant Co-Investigators need to get this information from their NASA Civil Servant Co-Investigators. For examples see the SARA Frequently Asked Questions at http://science.nasa.gov/researchers/sara/how-to-guide/nspires-CSlabor/ [Added March 24, 2016].

Proposers from JPL should not include the JPL award fee in the total requested amount, nor should the budgets of JPL Co-Investigators on proposals from other institutions include the JPL award fee in their total requested amount. The total requested amount is that which appears on the NSPIRES online (cover page) budget form or the Grants.gov standard budget form. JPL award fees are paid for and accounted for by a different mechanism than the mechanism used to fund research investigations.

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

Proposals may be submitted electronically via NASA's master proposal data base system, the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES). The only exceptions are occasional joint calls with the National Science Foundation (NSF) that use FastLane and the Swift and Fermi Guest Investigator and NuSTAR Guest Observer programs in Astrophysics (Program Elements D.5 Swift Guest Investigator – Cycle 13, D.6 Fermi Guest Investigator – Cycle 10, and D.10 NuSTAR Guest Observer – Cycle 3), see those program elements for details. 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 E-mail 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 E-mail 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 comprised 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. See the *NASA Guidebook for Proposers*, Sections 2 and 3, for further details.

Although NSPIRES has the ability to accept many, separate proposal documents, 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 the *NASA Guidebook for Proposers* (see Section 2.3) and uploaded as a single attachment using the tools in NSPIRES. The proposer is responsible for assembling the complete proposal document for peer review. All required and permitted appendices must be included in the PDF file and should not be uploaded as separate attachments, unless specified otherwise in the program element description in the appendices to this NRA or in Section I (d), if an HEC request is being made. Including any part of the proposal twice creates an additional burden on the peer reviewers. Documents such as team member biographical sketches, letters of commitment, and current and pending support 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 two parts of the proposal (Cover Page form, proposal document) 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 E-mail 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 this ROSES NRA. Grants.gov requires that the PI download an application package and an instruction package from Grants.gov. Identifying the appropriate application package requires the funding opportunity number for that program element; the funding opportunity number may be found in the Summary of Key Information subsection that concludes each program element description in the appendices of this NRA. 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, 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.
- Download the application package from Grants.gov by selecting "Select package" 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, in addition to the "Package" 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.
- 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 Section 2 of 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.
- 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.

Additional instructions for formatting and submitting proposals via Grants.gov may be found in Sections 2 and 3 of the *NASA Guidebook for Proposers*. Instructions for the use of Grants.gov may be found in the Grants.gov Applicant User Guide at http://www.grants.gov/web/grants/applicants/applicant-resources.html. Instructions for NASA-specific forms and NASA program-specific forms may be found in the application. For any questions that cannot be resolved with the available online help menus and documentation, requests for assistance may be directed by E-mail 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

For most of the program elements in Earth Science (Appendix A) and Astrophysics (Appendix D), a brief Notice of Intent (NOI) to propose is encouraged, but not required, for the submission of proposals to this solicitation. 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 PI via NSPIRES (located at http://nspires.nasaprs.com) by the dates given in Tables 2 or 3 of this NRA. Note that NOIs may be submitted within NSPIRES directly by the PI; no action by an organization's AOR is required to submit an NOI.

Grants.gov does not provide NOI capability; therefore, when possible NOIs 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. Since NOIs submitted after these deadlines may still be useful to NASA, late NOIs may be submitted by E-mail 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 was 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 sometimes just the contents of the 4000 character limited Proposal Summary field in the cover pages but sometimes also requires a PDF document upload. The required contents for the Step-1 proposal will be specified in the program element description. In some cases, the investigation team is not considered binding for Step-1 (i.e., it can be adjusted between the Step-1 and Step-2 proposal), but in other cases, the Step-1 team is binding.

Some 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-2016 NRA, the program elements that solicit proposals using a two-step process include: A.2 Land-Cover/Land-Use Change, A.37 Water Resources, all of the Heliophysics program elements (Appendix B), most program elements in Planetary Science (Appendix C), the K2 Guest Observer call in Appendix D, and E.3, the Cross-Division Exoplanets Research Program and E.4 the Cross-Division Habitable Worlds Program. This year Program Element B.2 Heliophysics Supporting Research will employ a "binding" two-step proposal submission process; only those proposals that are "invited" can be submitted as Step-2 proposals.

(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 for funding. 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.

At the time of release, this ROSES-2016 NRA contains four guest investigator/guest observer program elements using the two-phase proposal process: Swift Guest Investigator (D.5), Fermi Guest Investigator (D.6), NuSTAR Guest Observer (D.10) and ASTRO-H Guest Observer – Cycle 1 (D.11).

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

(c) Proposal Submission Due Dates and Deadlines

For each program element in Appendices A through E of this NRA, 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 or 3 of this NRA. Unless stated otherwise in the relevant appendix to this NRA, the proposal deadline is 11:59 p.m. Eastern Time. Unless otherwise specified, all proposals must be submitted electronically using either NSPIRES or Grants.gov (see Sections IV(b)(i–iii) above).

Proposals submitted after the proposal due date and deadline will be considered "late." Proposals that are late will be handled in accordance with the SMD Policy on Late Proposals. Proposals received after the due date may be 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.
- Other than the special cases discussed in Section 2.3.10(c)(ii) of the *NASA Guidebook for Proposers*, and 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 the solicitation, SMD will send funds directly to Co-Is at NASA centers and other Government laboratories, 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 and costs of procurements (not labor or overhead) at NASA centers and other Government laboratories should 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 Government laboratories. (See Section 2.3.10(c)(ii) of the *NASA Guidebook for Proposers*).
- Allowable costs are governed by 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 Topical Workshops, Symposia, and Conferences (Appendix E.2).
- Regardless of whether a conference is sponsored by NASA, individual conference travel by grantees is permitted and proposers from universities 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. 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 (see Section 1.6 of the *NASA Guidebook for Proposers*; see also Appendix B, part (c)(8)(iv)). 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 (see Section 1.6 of the *NASA Guidebook for Proposers*; see also Appendix B, part (c)(8)(iv)).
- 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 (for further information, see http://www.hq.nasa.gov/fullcost). Proposal 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 salaries and overhead for 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 their costs to the proposing organization so that the proposing organization may 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, with the exception of aircraft, are discussed in this section of ROSES. Requirements for proposals using aircraft are discussed within the description of the Earth Science Research Program found in Appendix A.

Generally speaking, 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, NASA Headquarters, Washington, DC 20546; Tel.: 202-358-2211; E-mail: dtomko@nasa.gov.

(b) Points of Contact for Suborbital-Class Platforms

NASA provides different 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 Woomera, 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:

Philip Eberspeaker
Sounding Rockets Program Office
Code 810
GSFC/Wallops Flight Facility
National Aeronautics and Space Administration
Wallops Island, VA 23337
Telephone: (757) 824-2202
E-mail:Philip.J.Eberspeaker@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
E-mail: 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, education, and technology advancement. The NASA STMD's Flight Opportunities Program (FOP) has issued commercial contracts to several sRLV flight service providers. Information on sRLV vehicles, including general vehicle capabilities and contact information for some vendors, is available at http://flightopportunities.nasa.gov/platforms. 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 sRLV flights must either be automated or remotely operated. The remote operation capability should be confirmed with the flight operator.

Proposals for investigations 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 required to conduct the proposed investigation.

Proposals for investigations using sRLVs as platforms must specify the technical requirements that their investigation places on the vehicle. The proposal 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.

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.

The cost to SMD for the flight and all other services provided by the sRLV vendor must be clearly stated in the proposal but not in the proposed investigation budget. All other costs for conducting the investigation must be included in the PI's proposed investigation budget. Upon final selection for flight, the flight and all other services provided by the sRLV vendor will be procured directly by the FOP and will not be funded through the PI's award.

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. 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. A proposal for a sRLV-based project must describe the proposed schedule for CIR and the proposed funding required to reach CIR.

Proposals for sRLV-based investigations must be submitted to the appropriate ROSES program element, depending on the science 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.

All proposals will be evaluated with respect to the criteria specified in Section C.2 of 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 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;

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

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

Note that the Flight Opportunities Program is available to assist the PI with this process. Investigators proposing sRLV 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.

Questions concerning potential sRLV investigations may be addressed to:

LK Kubendran
Flight Opportunities Program
Space Technology Mission Directorate
NASA Headquarters
Washington, DC 20546
Telephone: (202) 358-2528
E-mail: lk@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, including nadir pointing locations. NASA has available annual external launch opportunities after 2016 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 the 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. In order to be compliant, a proposal 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 Section C.2 of 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 http://www.nasa.gov/pdf/462947main_2010_June_Jones_ISS%20Accomodations1.2a.pdf.

Attached payloads must be certified for transportation and use in a human tended vehicle. External payloads would be required to complete PDR approximately 36 months before launch, 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:

Sharon C Conover
ISS Research Integration Office/OZ
Johnson Space Center
National Aeronautics and Space Administration
Houston, TX 77058
Telephone: 281.244.8518
E-mail: sharon.c.conover@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 can be built as a single unit (1U), weighing less than 1.33 kg, or combined in units of two, three or six.

CubeSats: 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.

Launch: Launch services will be provided under the NASA/HEOMD CubeSat Launch Initiative (CSLI) at no cost to the investigation. The CubeSat Launch Initiative (CSLI) program regularly provides launch opportunities for small satellites to fly as secondary (auxiliary) payloads on rockets 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 following 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 clearly indicate both the required and the acceptable range of orbital parameters needed to meet mission objectives.

NASA's CubeSats are deployed from a Poly-Picosatellite Orbital Deployer, or P-POD. CubeSats must be compliant with the NASA/KSC Launch Services Program (LSP) Program Level Poly-

Picosatellite Orbital Deployer (PPOD) and CubeSat Requirements Document 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 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 Section C.2 of 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 (one "Cube" or "1U" defined above) 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 NPR8715.6 NASA Procedural Requirement 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 and delivering the CubeSat for launch must be included in the proposal. No launch service charges should be included in the proposal cost request.
- 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:

David L Pierce,
Senior Program Executive for Suborbital Research,
Phone: 202-358-3808,
E-mail: david.l.pierce@nasa.gov

For further information on CSLI, please contact:

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

or

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

(c) General Guidelines for Suborbital-Class Investigation Proposals

ROSES supports science investigations and/or technology development utilizing payloads flown on suborbital-class platforms, as defined in Section I(b), 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.

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 ordinarily are evaluated on three criteria: intrinsic merit, relevance, and cost realism and reasonableness. *NASA Guidebook for Proposers* Section 1.2.3 Proposal Review and Selection indicates that peer review will be used to determine merit, and that "NASA peer review members may also participate in determining the relevance…and cost realism and reasonableness", but that the evaluation of cost and relevance may be done by NASA. Consistent with this, ROSES proposals may be scored by peer reviewers for all three criteria, or may be scored for only merit, with comments provided for relevance and cost, or the peer review panel may not be asked to comment on relevance and cost at all. NASA may return a proposal without peer review if it is not relevant. 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. This focus on relevance to the program element supersedes the instructions in the *NASA Guidebook for Proposers*. 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 cost realism and cost reasonableness) and by NASA program personnel. 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 Summary of Proposal 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.
- 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 the Federal Awardee Performance and Integrity Information System—FAPIIS) accessible through the System for Award Management (SAM, https://www.sam.gov) (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.

(b) Review and Selection Processes

Review of proposals submitted to this NRA will be consistent with the general policies and provisions given in Sections C.1 through C.4 of Appendix C of the *Guidebook*, and selection procedures will be consistent with the provisions of Section C.5 of that document. In this NRA, 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 element (or his/her delegate) 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 when 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," e.g., to clarify something that is unclear in the evaluation or for an explanation of whether there were factors other than the peer review that played a role in the decision.

(d) Processes for Appeals

(i) Reconsideration by SMD

SMD has a process for requesting reconsideration of the declination of a proposal submitted in response to an SMD NASA Research Announcement. 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://nasascience.nasa.gov/researchers/sara/library-and-useful-links (the SARA website is 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

Director, Contract and Grant Policy Division
Office of Procurement
NASA Headquarters
Washington, DC 20546-0001
Telephone: 202-358-4483
E-mail: 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 http://science.nasa.gov/researchers/volunteer-review-panels/ or by sending an E-mail 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. All award requirements are posted at https://prod.nais.nasa.gov/pub/pub_library/grantnotices/GrantNotices.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. Any such requirements will be identified in the Notice of Award.

If the Federal share of any award issued under this NRA is more than $500,000 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.

For science projects that receive assistance from the U.S. Antarctic Program, 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
E-mail: 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 http://nasascience.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 E-mail 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 E-mail 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/ROSES2016 (or by going to http://solicitation.nasaprs.com/open and selecting "NNH16ZDA001N"). 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://nasascience.nasa.gov/researchers/sara/grant-solicitations/roses-2016/. 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. 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 E-mail and telephone, difficulty may arise at any point, including 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."

(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 "E-mail Subscriptions." Owing to the increasingly multidisciplinary nature of SMD programs, this E-mail 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

"NNH16ZDA001N" 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 E-mail received from "NSPIRES-help@nasaprs.com" or "nspires@nasaprs.com" are not identified by any automated E-mail filtering system as unwanted E-mail.

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. Amendments to this NRA that create new proposal opportunities will also be synopsized on Grants.gov at the time of their 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 Geospatial One Stop (http://geo.data.gov/).

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.

Michael H. Freilich
Director
Earth Science Division

Steven W. Clarke
Director
Heliophysics Division

James L. Green
Director
Planetary Science Division

Paul L. Hertz
Director
Astrophysics Division

John M. Grunsfeld
Associate Administrator
Science Mission Directorate

Table 1: Checklist for ROSES-2016 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. See Also the 2016 version of the *NASA* *Guidebook for Proposers*.		
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 instructions.		
	Team	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 Co-Is.
	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 text box in the cover pages, not main body of the proposal. It has a built in 4000-character limit
	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 required component of proposal. One page only
Scientific/Technical /Management Section		Second required 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., Planetary Major Equipment). Please read the program element and refer to the summary table of key information.
	Format	8.5" x 11.0" page size
	Format	Single spaced, single column text (unless otherwise specified).
	Format	One-inch margins on all four sides. No reviewable content in margins.
	Format	No more than 5.5 lines per inch
	Format	No more than 15 characters per inch
	Format	Times New Roman Font size 12 is always safe
	Figure Format	Text and content on/in figures must be easily legible without magnification.

Table 1 Continued: Checklist for ROSES-2016 Proposals

	Captions Format	Figure captions follow the same font restrictions as body of proposal. Don't put anything crucial only in the captions.
	Table Format	Text and content on/in Tables must be easily legible without magnification.
	Content	Discuss objectives and their significance.
	Content	Discuss perceived impact of the work.
	Content	Discuss relevance of the work to the 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 its clear what they are doing
	Content	Present a work plan, with milestones, management structure
	Content	Present a data sharing and/or archiving plan here 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 (e.g., unpublished manuscripts) unavailable to reviewers. No links to personal websites.
Biographical sketches/Curriculum Vitae (CVs): fourth component of proposal		
	Required	One for the PI and each Co-I
	Length restriction	CV for PI - two pages or fewer, unless otherwise specified, such as Early Career Fellowship, which allows three pages
	Length restriction	CVs for anyone other than the PI are limited to one page
	Not required	CVs for collaborators are typically not needed, but may be included
Summary of work effort: This is a new fifth section of the proposal. Note, location differs from and supersedes that given in *Guidebook*.		
	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.
	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 part of the proposal, not page limited.		
	Required	Required for the PI. Also required for funded team members who are proposed to devote ≥10% of their time to the proposed work.

Table 1 Continued: Checklist for ROSES-2016 Proposals

	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		
	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 proposals that were submitted via grants.gov since web confirmation is not possible
	Letter of Endorsement – only permitted under special circumstances.	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 as platforms.
	Letter of Support	A letter of support is required from the owner of any facility or resource that is not under the PI's direct control, acknowledging that the facility or resource is available for the proposed use during the proposed period. See Section 2.3.9 of the *Guidebook for Proposers*
	Letter of feasibility	A letter of feasibility from the NASA Space Station Payload Office must be included with proposals to use ISS.
	Letter of affirmation	In general, letters of affirmation are not permitted for normal research proposals, but letters from the community may be included only where explicitly allowed, e.g., for C.17 PME and E.2 TWSC.
Budget Justification: The eighth part 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 II (a)
Facilities and Equipment: The ninth part 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.

Table 1 Continued: Checklist for ROSES-2016 Proposals

[Separate Documents Section of the table was reformatted for clarity August 18, 2016]

Detailed Budget: The tenth and final part of the proposal **document**.		
	Strongly	Detailed budget, itemizing expenses.

	Recommended	
	Strongly Recommended	Separate detailed budget from each subaward organization.
	Excluded	Do not include **any values for** salary, **fringe,** or overhead. This is reported only in the cover page budget and "Total" budget.
Separate PDF documents from 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). [Added March 24, 2016]**
	HEC Appendix Document (separate PDF file **attached as document type "Appendix"**)	
	If necessary	If the Program Specific Data Question about the use of HEC was answered in the affirmative, a required appendix document must be provided. See Section I (d) for information about this new requirement

TABLE 2: SOLICITED RESEARCH PROGRAMS (IN ORDER OF PROPOSAL DUE DATES)

TABLE 3: SOLICITED RESEARCH PROGRAMS (IN ORDER OF APPENDICES A–E)

Table 2 and Table 3 of this NRA are posted as separate documents on the web and can be reached either by following the hypertext links above embedded in the electronic version of this document or by going to http://solicitation.nasaprs.com/ROSES2016 or to http://solicitation.nasaprs.com/open and selecting "NNH16ZDA001N".

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

Appendix	Program Element	NOI/Step-1 Due Date [2]	Proposal Due Date
B.4	Heliophysics Guest Investigators	03/18/2016 (Step-1)	04/22/2016 (Step-2)
D.2	Astrophysics Data Analysis	03/25/2016	05/13/2016
A.29	NASA Data for Operation and Assessment	03/15/2016	05/20/2016
E.3	Exoplanets Research Program [3]	03/29/2016 (Step-1)	05/26/2016 (Step-2)
A.11	Ocean Surface Topography Science Team	04/29/2016	05/27/2016
C.2	Emerging Worlds [3] [4]	03/31/2016 (Step-1)	06/03/2016 (Step-2)
C.6	Solar System Observations [3] [4]	04/08/2016 (Step-1)	06/10/2016 (Step-2)
A.24	Earth Surface and Interior	04/15/2016	06/15/2016
A.5	Carbon Cycle Science	04/01/2016	06/15/2016
C.10	Cassini Data Analysis Program [3]	04/06/2016 (Step-1)	06/16/2016 (Step-2)
A.13	Modeling, Analysis, and Prediction	04/15/2016	06/17/2016
C.18	Laboratory Analysis of Returned Samples [3] [4]	**05/02/2016** (Step-1)	06/24/2016 (Step-2)
A.8	Physical Oceanography	05/20/2016	06/30/2016
A.46	**Earth Science Applications: Ecological Forecasting**	**03/16/2016**	**06/30/2016**
A.17	Atmospheric Composition: Upper Atmospheric Composition Observations	N/A	07/01/2016
D.4	Astrophysics Theory	05/16/2016	07/08/2016
A.42	**Instrument Incubator Program**	**05/31/2016**	**07/11/2016**
A.21	Terrestrial Hydrology	05/13/2016	07/15/2016
C.7	Planetary Data Archiving, Restoration, and Tools	05/13/2016 (Step-1)	07/15/2016 (Step-2)
A.47	**Citizen Science for Earth Systems**	**05/27/2016**	**07/21/2016**
C.13	**Maturation of Instruments for Solar System Exploration** [3]	**05/20/2016 (Step-1)**	**07/21/2016 (Step-2)**
B.3	Heliophysics Technology and Instrument Development for Science	06/10/2016 (Step-1)	07/22/2016 (Step-2)
B.7	Heliophysics Data Environment Enhancements	05/20/2016 (Step-1)	07/22/2016 (Step-2)
C.5	Exobiology [3] [4]	05/20/2016 (Step-1)	07/22/2016 (Step-2)

A.4	**Terrestrial Ecology**	**05/16/2016**	**08/01/2016**
A.16	Studies with IceSat and CryoSat -2	N/A	08/05/2016
C.20	**Concepts for Ocean worlds Life Detection Technology**	**06/17/2016 (Step-1)**	**08/12/2016 (Step-2)**
A.48	**Space Geodesy Research Program**	**06/15/2016**	**08/15/2016**
A.19	Atmospheric Composition: Aura Science Team and Atmospheric Composition Modeling and Analysis Program	N/A	08/**19**/2016
A.27	Earth Science U.S. Participating Investigator	N/A	08/26/2016
A.37	Applied Sciences - Water Resources	05/02/2016 (Step-1)	09/01/2016 (Step-2)
B.2	Heliophysics Supporting Research	07/29/2016 (Step-1)	09/09/2016 (Step-2)
A.23	**Weather and Atmospheric Dynamics**	**07/15/2016**	**09/15/2016**
A.49	**IceBridge Science Team**	**08/01/2016**	**09/19/2016**
A.18	Cloud and Aerosol Monsoonal Processes - Philippines Experiment	N/A	09/23/2016
C.14	**Planetary Science and Technology Through Analog Research** [3] [4]	07/22/2016 (Step-1)	09/23/2016 (Step-2)
D.5	Swift Guest Investigator – Cycle 13	N/A	09/23/2016
A.26	Airborne Instrument Technology Transition	07/25/2016	09/26/2016
A.28	Interdisciplinary Science	08/01/2016	09/**30**/2016
B.10	**Heliophysics U.S. Participating Investigator**	**08/19/16 (Step-1)**	**10/14/2016 (Step-2)**
A.9	Ocean Salinity Science Team	09/30/2016	10/28/2016
C.9	Mars Data Analysis [3]	08/26/2016 (Step-1)	**10/28/2016** (Step-2)
C.22	**Dynamic Power Convertors for Radioisotope Power Systems**	**08/31/2016 (Step-1)**	**10/31/2016 (Step-2)**
C.8	Lunar Data Analysis [3]	**09/08/2016 (Step-1)**	**11/10/2016 (Step-2)**
C.12	**Planetary Instrument Concepts for the Advancement of Solar System Observations** [3]	09/14/2016 (Step-1)	11/14/2016 (Step-2)
A.10	Sea Level Change Science Team	10/14/2016	11/15/2016
D.12	**Astrophysics Probe Mission Concept Studies**	**09/16/2016**	**11/15/2016**
C.11	**Discovery Data Analysis** [3]	09/08/2016 (Step-1)	11/17/2016 (Step-2)
B.6	**Heliophysics Living With a Star Science**	10/07/2016 (Step-1)	11/18/2016 (Step-2)

Table 2

C.23	**Planetary Science Deep Space SmallSat Studies**	**09/30/2016**	**11/18/2016**
B.5	**Heliophysics Grand Challenges Research**	**10/13/2016 (Step-1)**	**11/23/2016 (Step-2)**
C.24	**Hot Operating Temperature Technology**	**09/28/2016**	**11/23/2016**
E.5	**Interdisciplinary Science For Eclipse 2017**	**10/27/2016 (Step-1)**	**11/30/2016 (Step-2)**
D.7	**K2 Guest Observer - Cycle 5**	**11/03/2016 (Step-1)**	**12/15/2016 (Step-2)**
D.13	**Astrophysics Explorers U.S. Participating Investigators**	**10/27/2016 (required)**	**12/15/2016**
B.8	**Magnetospheric Multiscale Guest Investigators**	**11/18/2016 (Step-1)**	**01/13/2017 (Step-2)**
A.31	**Utilization of Airborne Visible/Infrared Imaging Spectrometer – Next Generation Data from an Airborne Campaign in India**	**12/08/2016**	**01/17/2017**
E.4	Habitable Worlds [3] [4]	11/18/2016 (Step-1)	01/20/2017 (Step-2)
D.10	**NuSTAR Guest Observer - Cycle 3**	**N/A**	**01/27/2017**
A.41	**Advanced Information Systems Technology**	**12/21/2016**	**02/16/2017**
C.3	Solar System Workings [3] [4]	11/17/2016 (Step-1)	02/23/2017 (Step-2)
A.7	**Carbon Monitoring System**	**01/05/2017**	**02/24/2017**
D.6	**Fermi Guest Investigator - Cycle 10**	**N/A**	**02/24/2017**
A.50	**Group on Earth Observations Work Programme**	**01/13/2017**	**02/28/2017**
D.3	Astrophysics Research and Analysis	01/20/2017	03/17/2017
D.8	Strategic Astrophysics Technology	01/20/2017	03/17/2017
A.25	Rapid Response and Novel Research in Earth Science	N/A	Rollling Submissions through 03/31/2017
C.16	Fellowships for Early Career Researchers (current fellows) [3]	N/A	Rollling Submissions through 03/31/2017
E.2	Topical Workshops, Symposia, and Conferences	N/A	Rollling Submissions through 03/31/2017
C.19	**New Frontiers Data Analysis Program [3]**	**02/08/2017 (Step-1)**	**05/03/2017 (Step-2)**

Table 2

A.2	Land Cover/Land Use Change	12/01/2016 (Step-1)	06/01/2017 (Step-2)
C.16	Fellowships for Early Career Researchers (new applicants) [3]	See Program of Interest	
C.17	Planetary Major Equipment [4]	See Program of Interest	
A.3	Ocean Biology and Biogeochemistry	TBD	TBD
A.30	Remote Sensing of Water Quality	TBD	TBD
C.26	**Instruments for Gondola for High-Altitude Planetary Science**	**TBD**	**TBD**
A.6	Biodiversity	Not solicited this year	
A.12	Ocean Vector Winds Science Team	Not solicited this year	
A.14	Cryospheric Science	**Not solicited this year**	
A.15	IceBridge Observations	Not solicited this year	
A.20	Atmospheric Composition: Tropospheric Composition Program	Not solicited this year	
A.22	NASA Energy and Water Cycle	Not solicited this year	
A.32	New Investigator Program	Not solicited this year	
A.33	SUOMI National Polar-Orbiting Partnership (NPP) Science Team and Science Investigator-Led Processing Systems for Earth System Data Records from SUOMI NPP	Not solicited this year	
A.34	Science of Terra & Aqua	Not solicited this year	
A.35	Terra and Aqua Existing Algorithms	Not solicited this year	
A.36	PACE Science Team	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	Computational Modeling Algorithms and Cyberinfrastructure	Not solicited this year	
A.43	Advanced Component Technology	Not solicited this year	
A.44	In-Space Validation of Earth Science Technologies	Not solicited this year	
A.45	Sustainable Land Imaging Technology	Not solicited this year	
B.9	**Heliophysics Grand Challenges Research-Science Centers**	**Not solicited this year**	
C.15	**Planetary Protection Research [4]**	**Not solicited this year**	
C.21	**Small Innovative Missions for Planetary Exploration**	**Not solicited this year**	
C.25	**Rosetta Data Analysis Program**	**Not solicited this year**	

Table 2

D.9	Nancy Grace Roman Technology Fellowships for Early Career Researchers	Not solicited this year	
D.11	**ASTRO-H Guest Observer - Cycle 1**	**Not solicited this year**	
A.1	Earth Science Research Program Overview	N/A	N/A
B.1	Heliophysics Research Program Overview	N/A	N/A
C.1	Planetary Science Research Program Overview	N/A	N/A
D.1	Astrophysics Research Program Overview	N/A	N/A
E.1	Cross Division Research Overview	N/A	N/A

Notes:

[1] Amended due dates and new program elements will be indicated with bold red text as ROSES-2016 is amended through the 2016 calendar 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.

[3] The proposals for program element Fellowships for Early Career Researchers (C.16) may be submitted only in conjunction with program elements Emerging Worlds (Appendix C.2); Solar System Workings (Appendix C.3); Exobiology (Appendix C.5); Solar System Observations (Appendix C.6); Lunar Data Analysis (Appendix C.8), Mars Data Analysis (Appendix C.9); Cassini Data Analysis (Appendix C.10); Discovery Data Analysis (Appendix C.11), Planetary Instrument Concepts for the Advancement of Solar System Observations (Appendix C.12), Maturation of Instruments for Solar System Exploration (Appendix C.13); Planetary Science and Technology Through Analog Research (Appendix C.14); Laboratory Analysis of Returned Samples (Appendix C.18); New Frontiers Data Analysis (Appendix C.19); Exoplanet Research Program (Appendix E.3); and Habitable Worlds (Appendix E.4).

[4] The proposals for program element Planetary Major Equipment (C.17) may be submitted only in conjunction with program elements Emerging Worlds (Appendix C.2); Solar System Workings (Appendix C.3); Exobiology (Appendix C.5); Solar System Observations (Appendix C.6); Planetary Science and Technology Through Analog Research (Appendix C.14); Planetary Protection Research (Appendix C.15); Laboratory Analysis of Returned Samples (Appendix C.18); and Habitable Worlds (Appendix E.4).

ROSES 2016

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 Program Overview	N/A	N/A
A.2	Land Cover/Land Use Change	12/01/2016 (Step-1)	06/01/2017 (Step-2)
A.3	Ocean Biology and Biogeochemistry	TBD	TBD
A.4	**Terrestrial Ecology**	**05/16/2016**	**08/01/2016**
A.5	Carbon Cycle Science	04/01/2016	06/15/2016
A.6	Biodiversity	Not solicited this year	
A.7	**Carbon Monitoring System**	**01/05/2017**	**02/24/2017**
A.8	Physical Oceanography	05/20/2016	06/30/2016
A.9	Ocean Salinity Science Team	09/30/2016	10/28/2016
A.10	Sea Level Change Science Team	10/14/2016	11/15/2016
A.11	Ocean Surface Topography Science Team	04/29/2016	05/27/2016
A.12	Ocean Vector Winds Science Team	Not solicited this year	
A.13	Modeling, Analysis, and Prediction	04/15/2016	06/17/2016
A.14	Cryospheric Science	**Not solicited this year**	
A.15	IceBridge Observations	Not solicited this year	
A.16	Studies with IceSat and CryoSat -2	N/A	08/05/2016
A.17	Atmospheric Composition: Upper Atmospheric Composition Observations	N/A	07/01/2016
A.18	Cloud and Aerosol Monsoonal Processes - Philippines Experiment	N/A	09/23/2016
A.19	Atmospheric Composition: Aura Science Team and Atmospheric Composition Modeling and Analysis Program	N/A	**08/19/2016**
A.20	Atmospheric Composition: Tropospheric Composition Program	Not solicited this year	
A.21	Terrestrial Hydrology	05/13/2016	07/15/2016
A.22	NASA Energy and Water Cycle	Not solicited this year	
A.23	**Weather and Atmospheric Dynamics**	**07/15/2016**	**09/15/2016**
A.24	Earth Surface and Interior	04/15/2016	06/15/2016
A.25	Rapid Response and Novel Research in Earth Science	N/A	Rollling Submissions through 03/31/2017
A.26	Airborne Instrument Technology Transition	07/25/2016	09/26/2016
A.27	Earth Science U.S. Participating Investigator	N/A	08/26/2016

A.28	Interdisciplinary Science	08/01/2016	09/**30**/2016
A.29	NASA Data for Operation and Assessment	03/15/2016	05/20/2016
A.30	Remote Sensing of Water Quality	TBD	TBD
A.31	**Utilization of Airborne Visible/Infrared Imaging Spectrometer – Next Generation Data from an Airborne Campaign in India**	**12/08/2016**	**01/17/2017**
A.32	New Investigator Program	Not solicited this year	
A.33	SUOMI National Polar-Orbiting Partnership (NPP) Science Team and Science Investigator-Led Processing Systems for Earth System Data Records from SUOMI NPP	Not solicited this year	
A.34	Science of Terra & Aqua	Not solicited this year	
A.35	Terra and Aqua Existing Algorithms	Not solicited this year	
A.36	PACE Science Team	Not solicited this year	
A.37	Applied Sciences - Water Resources	05/02/2016 (Step-1)	09/01/2016 (Step-2)
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	Computational Modeling Algorithms and Cyberinfrastructure	Not solicited this year	
A.41	**Advanced Information Systems Technology**	**12/21/2016**	**02/16/2017**
A.42	**Instrument Incubator Program**	**05/31/2016**	**07/11/2016**
A.43	Advanced Component Technology	Not solicited this year	
A.44	In-Space Validation of Earth Science Technologies	Not solicited this year	
A.45	Sustainable Land Imaging Technology	Not solicited this year	
A.46	**Earth Science Applications: Ecological Forecasting**	**03/16/2016**	**06/30/2016**
A.47	**Citizen Science for Earth Systems**	**05/27/2016**	**07/21/2016**
A.48	**Space Geodesy Research Program**	**06/15/2016**	**08/15/2016**
A.49	**IceBridge Science Team**	**08/01/2016**	**09/19/2016**
A.50	**Group on Earth Observations Work Programme**	**01/13/2017**	**02/28/2017**
B.1	Heliophysics Research Program Overview	N/A	N/A
B.2	Heliophysics Supporting Research	07/29/2016 (Step-1)	09/09/2016 (Step-2)
B.3	Heliophysics Technology and Instrument Development for Science	06/10/2016 (Step-1)	07/22/2016 (Step-2)

Table 3

B.4	Heliophysics Guest Investigators	03/18/2016 (Step-1)	04/22/2016 (Step-2)
B.5	**Heliophysics Grand Challenges Research**	**10/13/2016 (Step-1)**	**11/23/2016 (Step-2)**
B.6	**Heliophysics Living With a Star Science**	10/07/2016 (Step-1)	11/18/2016 (Step-2)
B.7	Heliophysics Data Environment Enhancements	05/20/2016 (Step-1)	07/22/2016 (Step-2)
B.8	**Magnetospheric Multiscale Guest Investigators**	**11/18/2016 (Step-1)**	**01/13/2017 (Step-2)**
B.9	**Heliophysics Grand Challenges Research-Science Centers**	**Not solicited this year**	
B.10	**Heliophysics U.S. Participating Investigator**	**08/19/2016 (Step-1)**	**10/14/2016 (Step-2)**
B.11	**Interdisciplinary Science For Eclipse 2017**	**See E.5**	
C.1	Planetary Science Research Program Overview	N/A	N/A
C.2	Emerging Worlds [3] [4]	03/31/2016 (Step-1)	06/03/2016 (Step-2)
C.3	Solar System Workings [3] [4]	11/17/2016 (Step-1)	02/23/2017 (Step-2)
C.4	Habitable Worlds [3] [4]	See Appendix E.4	
C.5	Exobiology [3] [4]	05/20/2016 (Step-1)	07/22/2016 (Step-2)
C.6	Solar System Observations [3] [4]	04/08/2016 (Step-1)	06/10/2016 (Step-2)
C.7	Planetary Data Archiving, Restoration, and Tools	05/13/2016 (Step-1)	07/15/2016 (Step-2)
C.8	Lunar Data Analysis [3]	**09/08/2016 (Step-1)**	**11/10/2016 (Step-2)**
C.9	Mars Data Analysis [3]	08/26/2016 (Step-1)	**10/28/2016** (Step-2)
C.10	Cassini Data Analysis Program [3]	04/06/2016 (Step-1)	06/16/2016 (Step-2)
C.11	**Discovery Data Analysis** [3]	09/08/2016 (Step-1)	11/17/2016 (Step-2)
C.12	**Planetary Instrument Concepts for the Advancement of Solar System Observations** [3]	09/14/2016 (Step-1)	11/14/2016 (Step-2)
C.13	**Maturation of Instruments for Solar System Exploration** [3]	**05/20/2016 (Step-1)**	**07/21/2016 (Step-2)**

Table 3

C.14	**Planetary Science and Technology Through Analog Research** [3] [4]	07/22/2016 (Step-1)	09/23/2016 (Step-2)
C.15	**Planetary Protection Research [4]**	**Not solicited this year**	
C.16	Fellowships for Early Career Researchers (new applicants) [3]	See Program of Interest	
C.16	Fellowships for Early Career Researchers (current fellows) [3]	N/A	Rolling Submissions through 03/31/2017
C.17	Planetary Major Equipment [4]	See Program of Interest	
C.18	Laboratory Analysis of Returned Samples [3] [4]	**05/02/2016** (Step-1)	06/24/2016 (Step-2)
C.19	**New Frontiers Data Analysis Program [3]**	**02/08/2017 (Step-1)**	**05/03/2017 (Step-2)**
C.20	**Concepts for Ocean worlds Life Detection Technology**	**06/17/2016 (Step-1)**	**08/12/2016 (Step-2)**
C.21	**Small Innovative Missions for Planetary Exploration**	**Not solicited this year**	
C.22	**Dynamic Power Convertors for Radioisotope Power Systems**	**08/31/2016 (Step-1)**	**10/31/2016 (Step-2)**
C.23	**Planetary Science Deep Space SmallSat Studies**	**09/30/2016**	**11/18/2016**
C.24	**Hot Operating Temperature Technology**	**09/28/2016**	**11/23/2016**
C.25	**Rosetta Data Analysis Program**	**Not solicited this year**	
C.26	**Instruments for Gondola for High-Altitude Planetary Science**	**TBD**	**TBD**
D.1	Astrophysics Research Program Overview	N/A	N/A
D.2	Astrophysics Data Analysis	03/25/2016	05/13/2016
D.3	Astrophysics Research and Analysis	01/20/2017	03/17/2017
D.4	Astrophysics Theory	05/16/2016	07/08/2016
D.5	Swift Guest Investigator - Cycle 13	N/A	09/23/2016
D.6	**Fermi Guest Investigator - Cycle 10**	**N/A**	**02/24/2017**
D.7	**K2 Guest Observer - Cycle 5**	**11/03/2016 (Step-1)**	**12/15/2016 (Step-2)**
D.8	Strategic Astrophysics Technology	01/20/2017	03/17/2017
D.9	Nancy Grace Roman Technology Fellowships for Early Career Researchers	Not solicited this year	
D.10	**NuSTAR Guest Observer - Cycle 3**	**N/A**	**01/27/2017**
D.11	**ASTRO-H Guest Observer - Cycle 1**	**Not solicited this year**	
D.12	**Astrophysics Probe Mission Concept Studies**	**09/16/2016**	**11/15/2016**
D.13	**Astrophysics Explorers U.S. Participating Investigators**	**10/27/2016 (required)**	**12/15/2016**

Table 3

E.1	Cross Division Research Overview	N/A	N/A
E.2	Topical Workshops, Symposia, and Conferences	N/A	Rollling Submissions through 03/31/2017
E.3	Exoplanets Research Program [3]	03/29/2016 (Step-1)	05/26/2016 (Step-2)
E.4	Habitable Worlds [3] [4]	11/18/2016 (Step-1)	01/20/2017 (Step-2)
E.5	**Interdisciplinary Science For Eclipse 2017**	**10/27/2016 (Step-1)**	**11/30/2016 (Step-2)**

Notes:

[1] Amended due dates and new program elements will be indicated with bold red text as ROSES-2016 is amended through the 2016 calendar 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.

[3] The proposals for program element Fellowships for Early Career Researchers (C.16) may be submitted only in conjunction with program elements Emerging Worlds (Appendix C.2); Solar System Workings (Appendix C.3); Exobiology (Appendix C.5); Solar System Observations (Appendix C.6); Lunar Data Analysis (Appendix C.8), Mars Data Analysis (Appendix C.9); Cassini Data Analysis (Appendix C.10); Discovery Data Analysis (Appendix C.11), Planetary Instrument Concepts for the Advancement of Solar System Observations (Appendix C.12), Maturation of Instruments for Solar System Exploration (Appendix C.13); Planetary Science and Technology Through Analog Research (Appendix C.14); Laboratory Analysis of Returned Samples (Appendix C.18); New Frontiers Data Analysis (Appendix C.19); Exoplanet Research Program (Appendix E.3); and Habitable Worlds (Appendix E.4).

[4] The proposals for program element Planetary Major Equipment (C.17) may be submitted only in conjunction with program elements Emerging Worlds (Appendix C.2); Solar System Workings (Appendix C.3); Exobiology (Appendix C.5); Solar System Observations (Appendix C.6); Planetary Science and Technology Through Analog Research (Appendix C.14); Planetary Protection Research (Appendix C.15); Laboratory Analysis of Returned Samples (Appendix C.18); and Habitable Worlds (Appendix E.4).

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 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 addressing its objectives. The science carried out 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* (see http://nasascience.nasa.gov/about-us/science-strategy/)). 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 http://nasascience.nasa.gov/about-us/science-strategy/), 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 ecological and chemical 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;
- 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://nasascience.nasa.gov/about-us/science-strategy. A decadal study for the satellite component of NASA's Earth science activities has been carried out by the

National Academy of Sciences (NAS); the report *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond* is available at http://www.nap.edu/catalog.php?record_id=11820; more recently, NAS released a midterm assessment of NASA's implementation of the Decadal Survey (http://www.nap.edu/catalog.php?record_id=13405). A description of the most recent plans by the Earth Science Division to implement a series of climate-oriented missions beyond those suggested by the decadal survey (*Responding to the Challenge of Climate and Environmental Change: NASA's Plan for a Climate-Centric Architecture for Earth Observations and Applications from Space*) was released in June 2010, and may be found at http://science.nasa.gov/media/medialibrary/2010/07/01/Climate_Architecture_Final.pdf). An earlier study by the NAS documenting the advances in the study of Earth from space, which draws significantly on NASA-produced results, was also released in the same time frame as the Decadal Survey and is available at http://dels.nas.edu/Report/Earth-Observations-from-Space-First/11991.

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%E2%80%932021-strategic-plan-us-global-change). Similarly, there are interagency programs related to Oceans and the Arctic. In particular, the Implementation Plan (http://www.whitehouse.gov//sites/default/files/national_ocean_policy_implementation_plan.pdf) for the National Ocean Policy (http://www.whitehouse.gov/administration/eop/oceans), the Research Plan (http://www.whitehouse.gov/sites/default/files/microsites/ostp/2013_arctic_research_plan.pdf) for the Interagency Arctic Policy Research Council (IARPC, see http://www.nsf.gov/od/opp/arctic/iarpc/start.jsp), and the National Strategy for the Arctic Region (http://www.whitehouse.gov/sites/default/files/docs/nat_arctic_strategy.pdf) with its associated implementation plan (http://www.whitehouse.gov/sites/default/files/docs/implementation_plan_for_the_national_strategy_for_the_arctic_region_-_fi....pdf). In addition, there are several other subgroups of the Committee on the Environment, Natural Resources and Sustainability (CENRS, see http://www.whitehouse.gov/administration/eop/ostp/nstc/committees/cenrs) that serve to provide interagency coordination in areas covered by NASA's Earth Science Research Program. In addition, the NASA 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, satellite missions, applied sciences, and enabling capabilities, with the bulk of the solicited research coming in the first of these. Research and analysis (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 research and analysis area).

Most proposals to ROSES-2016 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 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.

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 that makes up a significant fraction of the planet's surface; 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 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-2016 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-2016 elements for completeness, as well as to provide potential proposers with plans about the anticipated dates of the next solicitation.

- Biodiveristy (Program Element A.6);
- Ocean Vector Winds Science Team (Program Element A.12);
- IceBridge Observations (Program Element A.15);
- Tropospheric Composition (Program Element A.20);
- NASA Energy and Water Cycle Study (Program Element A.22);
- New Investigator Program (Program Element A.32);
- Suomi-NPP Science Team (Program Element A.33);
- Science of Terra and Aqua (Program Element A.34);
- Terra and Aqua Existing Algorithms (Program Element A.35);
- PACE Science Team (Program Element A.36);
- Advancing Collaborative Connections for Earth System Science (Program Element A.38);

- Making Earth System data records for Use in Research Environments (Program Element A.39);
- Computational Modeling Algorithms and Cyberinfrastructure (Program Element A.40);
- 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-2016 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 is the basis for the food, fiber, and energy that sustain life on planet Earth. The cycling of carbon dioxide and methane into the atmosphere contributes to the planetary greenhouse effect and global climate. Ecosystems provide a wide variety of essential goods and services to humans and also affect the climate system by exchanging energy, momentum, trace gases, and aerosols with the atmosphere. Earth's carbon cycle and ecosystems are being subjected to human intervention and environmental changes on an unprecedented scale, in both rate and geographical extent. 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: (i) the distribution and cycling of carbon among the active terrestrial, oceanic, and atmospheric reservoirs and (ii) 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-2016 are:

- Land Cover and Land Use Change (Program Element A.2);
- Ocean Biology and Biogeochemistry (Program Element A.3);
- Terrestrial Ecology (Program Element A.4); and
- Carbon Cycle (Program Element A.5).

Topics relevant to the Carbon Cycle and Ecosystems Focus Area that are actively or potentially soliciting this fiscal year include the following program elements:

- Rapid Response and Novel Research in Earth Science (Program Element A.25);
- Airborne Instrument Technology Transition (Program Element A.26);
- US Participating Investigator (Program Element A.27);
- Interdisciplinary Science (Program Element A.28);
- NASA Data for Operation and Assessment (Program Element A.29);
- Remote Sensing of Water Quality (Program Element A.30);
- AVIRIS-ng India Campaign Investigation (Program Element A.31);
- Advanced Information System Technology (Program Element A.41);
- Instrument Incubator Program (Program Element A.42); and
- Earth Science Applications: Ecological Forecasting (Program Element A.46).

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-2016 are:

- Physical Oceanography (Program Element A.8);
- Ocean Salinity Science Team (Program Element A.9);
- Sea Level Change Science Team (Program Element A.10);
- Ocean Surface Topography Science Team (Program Element A.11);
- Modeling, Analysis, and Prediction (Program Element A.13);
- Cryospheric Science (Program Element A.14);
- Studies with IceSat and CryoSat-2 (Program Element A.16).

Topics relevant to the Climate Variability and Change Focus Area that are actively or potentially soliciting this fiscal year include the following program elements:

- Rapid Response and Novel Research in Earth Science (Program Element A.25);
- Airborne Instrument Technology Transition (Program Element A.26);
- U.S. Participating Investigator (Program Element A.27);
- Interdisciplinary Science (Program Element A.28);
- NASA Data for Operation and Assessment (Program Element A.29);
- AVIRIS-ng India Campaign Investigation (Program Element A.31);
- Advanced Information System Technology (Program Element A.41); and
- Instrument Incubator Program (Program Element A.42).

2.3 Atmospheric Composition

Atmospheric composition changes 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 is central to Earth system dynamics, since the atmosphere integrates surface emissions globally on time scales from weeks to years and couples several environmental issues. NASA's research for furthering our understanding of atmospheric composition is geared to providing an improved prognostic capability for such issues (e.g., the recovery of stratospheric ozone and its impacts on surface ultraviolet radiation, the evolution of greenhouse gases and their impacts on climate, and the evolution of 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 elements most closely directed towards the Atmospheric Composition Focus Area that are or may be soliciting for proposals in ROSES-2016 are:

- Upper Atmosphere Research Program Core Observations (Program Element A.17);
- Cloud-Aerosol-Monsoon Philippines Experiment (CAMP^{2}Ex) (Program Element A.18); and

- Atmospheric Chemistry Modeling and Analysis Program and Aura Science Team (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 this fiscal year include the following program elements:

- Rapid Response and Novel Research in Earth Science (Program Element A.25);
- Airborne Instrument Technology Transition (Program Element A.26);
- U.S. Participating Investigator (Program Element A.27);
- Interdisciplinary Science (Program Element A.28);
- NASA Data for Operation and Assessment (Program Element A.29);
- AVIRIS-ng India Campaign Investigation (Program Element A.31);
- Advanced Information System Technology (Program Element A.41); and
- Instrument Incubator Program (Program Element A.42).

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 and replenishing 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 are intimately entwined.

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. 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.

Additional information on the Water and Energy Cycle Focus Area can be found at http://nasa-news.org/. 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 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. High priority is placed on understanding, observing, and modeling clouds and their interaction with energy fluxes, though this is done along with activities of three other Focus Areas (Atmospheric Composition, Climate, and Weather).

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.

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

- How are global precipitation, evaporation, and the cycling of water changing?
- What are the effects of clouds and surface hydrologic processes on Earth's climate?
- How are variations in local weather, precipitation, and water resources related to global climate variation?
- What are the consequences of land cover and land use change for human societies and the sustainability of ecosystems?
- How can weather forecast duration and reliability be improved?
- How can prediction of climate variability and change be improved?
- How will water cycle dynamics change in the future?

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

The ROSES elements most closely directed towards the Water and Energy Cycle Focus Area that are or may be soliciting for proposals in ROSES-2016 are:

- Terrestrial Hydrology (Element A.21).

Topics relevant to the Water and Energy Cycle Focus Area are included in the following program elements that are actively or potentially soliciting this fiscal year include the following program elements:

- Rapid Response and Novel Research in Earth Science (Program Element A.25);
- Airborne Instrument Technology Transition (Program Element A.26);
- U.S. Participating Investigator (Program Element A.27);
- Interdisciplinary Science (Program Element A.28);
- NASA Data for Operation and Assessment (Program Element A.29);
- Remote Sensing of Water Quality (Program Element A.30);
- AVIRIS-ng India Campaign Investigation (Program Element A.31);
- Earth Science Applications: Water Resources (Program Element A.37);
- Advanced Information System Technology (Program Element A.41); and
- Instrument Incubator Program (Program Element A.42).

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) l on the Suomi National Polar-orbiting Partnership (NPP) satellite launched in October 2011.

Through collaborations in the Joint Center for Satellite Data Assimilation (JCSDA) (http://www.jcsda.noaa.gov/), 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-13 element A.33 (NASA Data for Operation and Assessment (http://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={649CE75A-9095-4146-CD72-2427D2071D10}&path=closedPast).

NASA also has a long history of conducting airborne field campaigns in support of hurricane research (http://airbornescience.nsstc.nasa.gov/field/). Most recently, the Hurricane and Severe Storm Sentinel (HS3) Mission, a five-year Earth Venture Class Suborbital mission that was awarded in 2010, has been obtaining 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 uses two Global Hawk (GH) unmanned aircraft systems (UAS) with distinct payloads to address both over-storm and near-storm environmental issues. The HS3 Mission is 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 are expected to launch 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 (Appendix 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 this fiscal year include the following program elements:

- Weather and Atmospheric Dynamics (Program Element A.23);
- Rapid Response and Novel Research in Earth Science (Program Element A.25);
- Airborne Instrument Technology Transition (Program Element A.26);
- U.S. Participating Investigator (Program Element A.27);
- Interdisciplinary Science (Program Element A.28);
- NASA Data for Operation and Assessment (Program Element A.29);
- Advanced Information System Technology (Program Element A.41); and
- Instrument Incubator Program (Program Element A.42).

2.6 Earth Surface and Interior

The Earth Surface and Interior Focus Area promotes the development and application of remote sensing to address the questions:

- How is the Earth's surface being transformed by naturally occurring tectonic and climatic processes?
- What are the motions of the Earth's interior, and how do they directly impact our environment?
- How can our knowledge of Earth surface change be used to predict and mitigate natural hazards?
- How is global sea level affected by natural variability and human induced change in the Earth System?

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 the 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.

Modeling, calibration, and validation are essential components in advancing the above solid-Earth science objectives. The Earth Surface and Interior Focus Area 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 the Earth Surface and Interior Focus Area 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 elements most closely directed towards the Earth Surface and Interior Focus Area that are or may be soliciting for proposals in ROSES-2016 are:

- Earth Surface and Interior (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);
- Airborne Instrument Technology Transition (Program Element A.26);
- U.S. Participating Investigator (Program Element A.27);
- Interdisciplinary Science (Program Element A.28);
- NASA Data for Operation and Assessment (Program Element A.29);
- AVIRIS-ng India Campaign Investigation (Program Element A.31);
- Advanced Information System Technology (Program Element A.41); and
- Instrument Incubator Program (Program Element A.42).

2.7 Cross-Cutting and Interdisciplinary

There are several cross-cutting and interdisciplinary elements in ROSES-2016, 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-2016 or are being evaluated for possible solicitation, are:

- *Rapid Response and Novel Research in Earth Science* (Program Element A.25) – This solicitation 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;
- *Airborne Instrument Technology Transition* (Program Element A.26) - This announcement seeks to upgrade mature instruments developed under NASA's Instrument Incubator Program (IIP – see Appendix A.42 for details on this program), or by similar NASA or externally-supported (e.g., corporate, other federal agency, internal institution funding) programs or activities. 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 that typically involve multiple instruments and/or platforms. The goal is to upgrade existing operating instruments to campaign-ready airborne configuration(s). 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)
- *U.S. Participating Investigator* (Program Element A.27) - 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.
- *Interdisciplinary Science* (Program Element A.28) - This solicitation is for new and successor interdisciplinary research investigations within NASA's Interdisciplinary Research in Earth Science (IDS) program. Proposed research investigations will meet the following criteria: a) offer a fundamental advance to our understanding of the Earth system; b) be based on remote sensing data, especially satellite observations, but including suborbital sensors as appropriate; c) go beyond correlation of data sets and seek to understand the underlying causality of change through determination of the specific physical, chemical, and/or biological processes involved; d) be truly interdisciplinary in scope by involving traditionally disparate disciplines of the Earth sciences; and e) address at least one of the specific themes listed in any particular IDS solicitation.
- *NASA Data for Operation and Assessment* (Program Element A.29) – This solicitation offers investigators an opportunity to increase the impact of NASA data by transitioning the data and algorithms into the operational environment in two areas: Operational weather prediction and ecological or ecosystem-climate models. In addition, because of the recent priority to further constrain the Earth system models using NASA data especially in the upcoming Coupled Model Intercomparison Project Phase 6 (CMIP6),

this solicitation offers an opportunity to research and develop data, algorithms, and methodologies for the validation, verification, and the overall assessment of the accuracy and deficiency of Earth system models. For ecosystem and ecosystem-climate models, this solicitation offers an opportunity to research and develop data, algorithms, and methodologies for the validation, verification, and the overall skill assessment of ecological or ecosystem-climate models using NASA satellite data. There is a recent priority from the GLACIER conference (http://www.state.gov/e/oes/glacier/index.htm) to address fisheries science in the Arctic ecosystem

- *Remote Sensing of Water Quality* (Program Element A.30) – This solicitation seeks proposals for studies of water quality using existing space-based remote sensing and similar approaches in development in conjunction with related data sources (e.g., airborne, *in situ*) observations and associated models. It crosses the interface between the terrestrial hydrology and ocean biology/biogeochemistry programs, and thus supports both the Carbon Cycle and Ecosystems and the Global Water and Energy Cycle focus areas.
- *AVIRIS-ng India Campaign Investigation* (Program Element A.31) - This solicitation seeks proposals for data analysis and modeling of AVIRIS-NG airborne data from the airborne campaign carried out in 2016-2017 as a partnership between NASA and the Indian Space Research Organization (ISRO) using a B-200 aircraft from ISRO's National Remote Sensing Center. Use of data from surface-based networks associated with the airborne campaign sites is welcome. Utilization of relevant data from other sources, including data from NASA satellites or those of NASA's interagency and international partners, is encouraged.

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, Weather, 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-2016 are:

- Earth Science Applications: Water Resources (Program Element A.37); and
- Earth Science Applications: Ecological Forecasting (Program Element A.46).

In addition, topics relevant to the Applied Sciences Program that are actively or potentially soliciting this fiscal year include the following program elements:

- Airborne Instrument Technology Transition (Program Element A.26);
- U.S. Participating Investigator (Program Element A.27);
- Interdisciplinary Science (Program Element A.28);
- NASA Data for Operation and Assessment (Program Element A.29);
- Remote Sensing of Water Quality (Program Element A.30);
- AVIRIS-ng India Campaign Investigation (Program Element A.31);
- Advanced Information System Technology (Program Element A.41); and
- Instrument Incubator Program (Program Element A.42).

4. 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).

4.1 Education

The Earth Science Research Program also 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 will collaborate 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.

4.2 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 (Appendix A.32), which is directed towards scientists and/or engineers within five years of their receipt of a Ph.D. degree, is solicited every two years. It is not included in ROSES-2016, but is expected to be competed again in ROSES-2017.

4.3 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) and the Making Earth System Data Records for Use in Research Environments (MEaSUREs). In ROSES-2016 neither program is being solicited.

Unless otherwise specified, any data proposed to be analyzed in response to Appendix A solicitations 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

4.4 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 is implementing a more rigorous resource allocation process. Proposals should include up to one page (not counted against the technical proposal page limit) justification 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-2016, no program elements specifically targeted towards High End Computing, Networking, and Storage will be solicited. A relevant ROSES element, Computational Modeling Algorithms and Cyberinfrastructure, was last solicited in late 2014 (see Appendix A.40). This element provides research opportunities for new or improved computational modeling algorithms; the exploitation of new computing, storage, and networking architectures; or the development of programming and analysis environments relevant to NASA's modeling and data assimilation systems.

4.5 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.

4.6 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, ER-2, P-3B, and Global Hawk, as well as several independently owned aircraft, including, but not limited to, those operated by other Federal agencies. Information regarding the utilization 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.

4.7 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* (http://nasascience.nasa.gov/about-us/science-strategy), the 2010 NASA plan for climate-centric observations: *Responding to the Challenge of Climate and Environmental Change: NASA's Plan for a Climate-Centric Architecture for Earth Observations from Space* (http://science.nasa.gov/media/medialibrary/2010/07/01/Climate_Architecture_Final.pdf), and the 2007 *Earth Science Decadal Survey: Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond* by the National Research Council (NRC) of the National Academies (http://www.nap.edu/catalog.php?record_id=11820).

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 Instrument Incubator Program and

Advanced Information Systems Technology elements will be solicited in ROSES-2016:

- AIST (Element A.41): The Advanced Information Systems Technology program advances information systems that are used to process, archive, access, visualize, and communicate science data; and
- IIP (Element A.42): 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; and

Other ESTO programs that are periodically solicited are NOT being solicited in ROSES-2016:

- ACT (Element A.43): The Advanced Component Technology program develops a broad array of components and subsystems for instruments and observing systems.
- InVEST (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.
- SLI-T (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.

A.2 LAND-COVER/LAND-USE CHANGE

NOTICE: This program element uses a two-step proposal process (see Section 4.3), with required Step-1 proposals.

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

The current solicitation consists of two elements: LCLUC in Southeast Asia and LCLUC in the Caucasus.

2.1 LCLUC in Southeast Asia

From previous LCLUC studies, we have learned that economic development and population growth in Southeast Asia are leading to significant land-cover and land-use changes associated primarily with agriculture, forestry, and urban land uses. Underlying these changes are a number of trends with respect to urban growth, rural out-migration, increased demand for natural resources, expanding transportation infrastructure, land speculation, and changes in the commodity market, etc. Countries in this region are developing rapidly so that, Indonesia, Malaysia, Thailand, Philippines, and Viet Nam are expected to be ranked with the higher income countries in Asia, such as Japan, Korea, and Singapore, within the next few decades. Efforts are underway at the national and international level to assess accurately the deforestation rates for the region, however, forest fragmentation is continuing at an alarming rate, resulting in habitat and biodiversity loss, often with negative impacts on the environment. Deforestation in the region can be attributed to agricultural expansion, timber harvest, and the increase in commercial plantations. The causative and enabling factors of land use change are complex, vary geographically, and operate at multiple scales, such as the increase in demand for palm oil and rubber, government policies and economic development initiatives, weak governance, land ownership, lack of zoning, and inappropriate land management. More than sixty percent of the land in Southeast Asia is used for agriculture. However, rapid urban expansion is replacing productive agricultural lands, rural areas are depopulating, and agricultural intensification is increasing throughout the region, with the use of chemical fertilizers, pesticides, intensive irrigation and mechanization. Thus, land-use change is a major cause for concern throughout the region. Inappropriate land-use practices can result in negative impacts on the environment such as increased erosion, degraded air quality, ground water pollution, depletion of ground water resources, and eutrophication of rivers and lakes. Further, a recent rise in the global price of commodity crops like rubber and oil palm has resulted in them replacing forest and woodlands and in some cases traditional food production, leading to increased food costs. In this context, documenting land-use transitions using satellite observations and understanding the causative factors and various impacts in the region gain significance. In addition, extreme climate events (e.g., drought, flooding) and their related environmental and humanitarian disasters have recently disrupted economic development and impacted livelihoods in several Southeast Asian countries. The degree of adaptive capacity of any region to such disasters depends on effective land use planning and resource management. In this region where rapid land-use change has such visibility, there is an opportunity for land-use science to inform land use policy.

The scope of the Southeast Asia component of the solicitation is on identifying where land-use change is presently occurring, quantifying recent rates of change, understanding the impacts of these changes on physical or social systems, understanding the process of change, addressing the trajectory of change, and assessing whether recent trends are likely to change in the near future. To understand the drivers of land-use change, the socioeconomic processes need to be considered and as such, social science needs to be an integral part of each proposal. Successful proposals should address and integrate socioeconomic dimensions of land-use/cover changes and feedbacks among them, to help answer the above questions. Studies can be 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. For example, a variety of multispectral, hyper-spectral, optical, thermal, and radar data may be integrated in the analysis, as needed. Local case studies that document LCLUC trajectories and their causative factors are welcome, however, the analysis and outputs should be scaled to larger regions. Proposals should highlight the theoretical and analytical frameworks appropriate for investigating the patterns of physical and socioeconomic 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. The Southeast Asia geographic region of interest for this solicitation extends from Burma (Myanmar) in the west to Papua in the east and from Indonesia in the south to Hong Kong in the north. The successful proposals from this round will contribute to South/Southeast Asia Regional Initiative (SARI; http://www.sari.umd.edu/)

2.2 LCLUC in the Caucasus

The Caucasus is the region in Northern Eurasia that has not received sufficient attention in the LCLUC program. However, the breakup of the Soviet Union resulted in institutional changes in the former Soviet republics that, in turn, altered land use and land management. Over 50% of the land in the Caucasus is used for agriculture and 17% is forested land. Changes in land use in the Caucasus during the last couple of decades include changes from rainfed-agriculture to tree crops, irrigated agriculture, grasslands, and open shrublands. Overgrazing and tree overharvesting for fuel wood and timber cause degradation of natural resources in the Caucasus due to mismanagement of pastures and forest land. As the system becomes more degraded, the pressures increase on pastures and forests resulting in soil erosion. The LCLUC program welcomes proposals to study changes in forest, agriculture, urban, and coastal zones, as well as impacts of LCLUC on carbon and water cycles during the last two decades in the Caucasus region. Research should highlight land-use trends that have developed since the breakup of the Soviet Union and examining the implications of the changes in terms of their impacts, for example, on the vulnerability of the associated land use or social systems and their adaptability to a changing climate. The region of interest encompasses the geographic area from the Black Sea coast (Turkey and Georgia) to the Caspian Sea coast (Azerbaijan and Iran).

Note: For regional proposals on both South/Southeast Asia and the Caucasus, 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 socieconomic 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, especially those of NASA, 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. Proposals that undertake fusion of data from various sources of Landsat- type data (e.g., Landsat, IRS, CBERS, SPOT, Sentinel-2), with coarser or higher resolution data, as well as radar observations, are welcome. This approach may provide better temporal-spatial coverage and contribute to a Land Surface Imaging constellation paradigm for future systems (http://ceos.org/). 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-I.'s or Collaborators employed by non-U.S. organizations may be identified as part of a proposal submitted by a U.S. organization, NASA funding may not normally be used to support research efforts by non-U.S. organizations at any level. Paragraph (c)(8)(iv) of Appendix B of the *NASA Guidebook for Proposers* states "NASA funding may not be used for foreign research efforts at any level, whether as a collaborator or a subcontract. The direct purchase of supplies and/or services, which do not constitute research, from non-U.S. sources by U.S. award recipients is permitted." 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 by any participant who is not employed either full-time or part-time by a U.S. organization (see Section 1.6 of the *NASA Guidebook for Proposers*; see also Appendix B, part (c)(8)(iv) of that document and Section III (c) of the *Summary of Solicitation* of this document 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. P.I.'s are expected to provide input to the program website and participate in the program webinar and outreach activities.

4.2 Funding Available for Support of Selected Proposals

Approximately $2M per year is expected to be available for new awards from proposals submitted to this program element. NASA anticipates supporting eight to ten investigations, each with annual budgets in the $200-250K range. NASA will make selections for this announcement in the fall of 2017. Anticipated starting date for selected projects is early 2018.

A budget for travel to at least one LCLUC Science Team Meeting per year is required in the proposal. In addition, international travel should be included in the proposal budget if the region of investigation is outside of the U.S. 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 the *NASA Guidebook for Proposers*, Sections 1.6 and 2.3.11(b)(vi)). 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.

Submission of a Step-1 Proposal is required in order to submit a Step-2 Proposal. Step-2 Proposals must contain the same scientific goals and Principal Investigator (PI) proposed in Step-1, but the rest of the proposal team of the Step-2 Proposal may be different from that of the Step-1 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 should:

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.

Following the submission and evaluation of a Step-1 proposal, the proposer will be notified through NSPIRES whether the Step-2 proposal is "encouraged" or "discouraged," at which point the proposer will be able to submit a Step-2 proposal.
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	~ $2M
Number of new awards pending adequate proposals of merit	8-10
Maximum duration of awards	3 years
Due date for Step-1 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for Step-2 proposals	See also Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	Early Calendar 2018
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 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	NNH16ZDA001N-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 may solicit research proposals under the Ocean Biology and Biogeochemistry program element. If research proposals are solicited, the final text for Appendix A.3 will be released as an amendment to ROSES-2016 sometime toward the end of calendar year 2016. Proposals will be due no earlier than 90 days after the release of the amendment.

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 and ecology, 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, ecological, and biogeochemical observations 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, ecology, 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 (http://nasascience.nasa.gov/earth-science/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 Focus Areas goals and objectives (http://cce.nasa.gov/cce/index.htm and http://science.nasa.gov/earth-science/focus-areas/carbon-cycle-and-ecosystems/), 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 (http://oceancolor.gsfc.nasa.gov/DOCS/OBB_Report_5.12.2008.pdf).

2. Description of Solicited Research

The subject of this solicitation may be identified in an amendment during 2016.

3. 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
National Aeronautics and Space Administration
Washington, DC 20546-0001
Telephone: (202) 358-1508
E-mail: Paula.Bontempi@nasa.gov

A.4 TERRESTRIAL ECOLOGY: AN AIRBORNE CAMPAIGN FOR THE ARCTIC-BOREAL VULNERABILITY EXPERIMENT (ABOVE)

NOTICE: April 25, 2016. The description of the airborne measurements in Section 4.2 has been clarified. "Other Airborne Measurements" includes remote sensing and/or *in-situ* measurements, such as flask sampling or direct onboard measurement of atmospheric greenhouse gas concentrations. New text is in bold.

1. Scope of NASA's Terrestrial Ecology Program

This announcement offers opportunities for terrestrial ecology research within NASA's Earth Science Division. The NASA Terrestrial Ecology Program uses airborne and space-based observations to understand how the Earth's carbon cycle and terrestrial ecosystems respond to environmental change and human intervention. The goals of NASA's Terrestrial Ecology Program are to improve understanding of the structure, function, and productivity of terrestrial ecosystems across the globe, their interactions with the atmosphere and hydrosphere, and their role in the cycling of 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 ecosystem properties. The research approach combines (i) the use of remote sensing to observe and analyze changes in terrestrial ecosystems; (ii) field campaigns and related process studies to elucidate ecosystem function at different scales; and (iii) data assimilation and modeling to analyze and predict responses of ecosystem and biogeochemical cycles 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 develops the methodologies and technical approaches to analyze and interpret such measurements. These activities provide a foundation for the development of new remote sensing capabilities for understanding and monitoring terrestrial ecosystems at regional to global scales.

2. The Arctic-Boreal Vulnerability Experiment (ABoVE)

Climate change in the high latitudes of the Arctic-Boreal Zone (ABZ) is occurring faster than anywhere else on Earth and is resulting in widespread transformations in landscape structure and ecosystem function. In addition to producing significant feedbacks to climate through changes in ecosystem processes, environmental change in this region is increasingly impacting society in many ways. For example, increased frequency and intensity of ecological disturbance can negatively impact both forest resources and air quality, thawing permafrost can negatively impact local water quality and human infrastructure, and changes to wildlife populations can negatively impact both traditional and commercial hunting. Recognizing the sensitivity, vulnerability, and global importance of this region, we now focus our scientific efforts on developing a better ability to observe, understand, and model the complex, multiscale and nonlinear processes that drive the region's natural and social systems. The NASA Terrestrial Ecology Program has led the development of the Arctic-Boreal Vulnerability Experiment (ABoVE) as a contribution to understanding this region (http://above.nasa.gov). The ABoVE

Study Area encompasses much of the boreal and tundra area of Alaska and western Canada (Figure 1). The overarching science question for ABoVE is:

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

All ABoVE research projects must address at least one of the Tier 2 Science Questions initially defined in the ABoVE Concise Experiment Plan (ACEP: 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 subsurface 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 driving these changes?

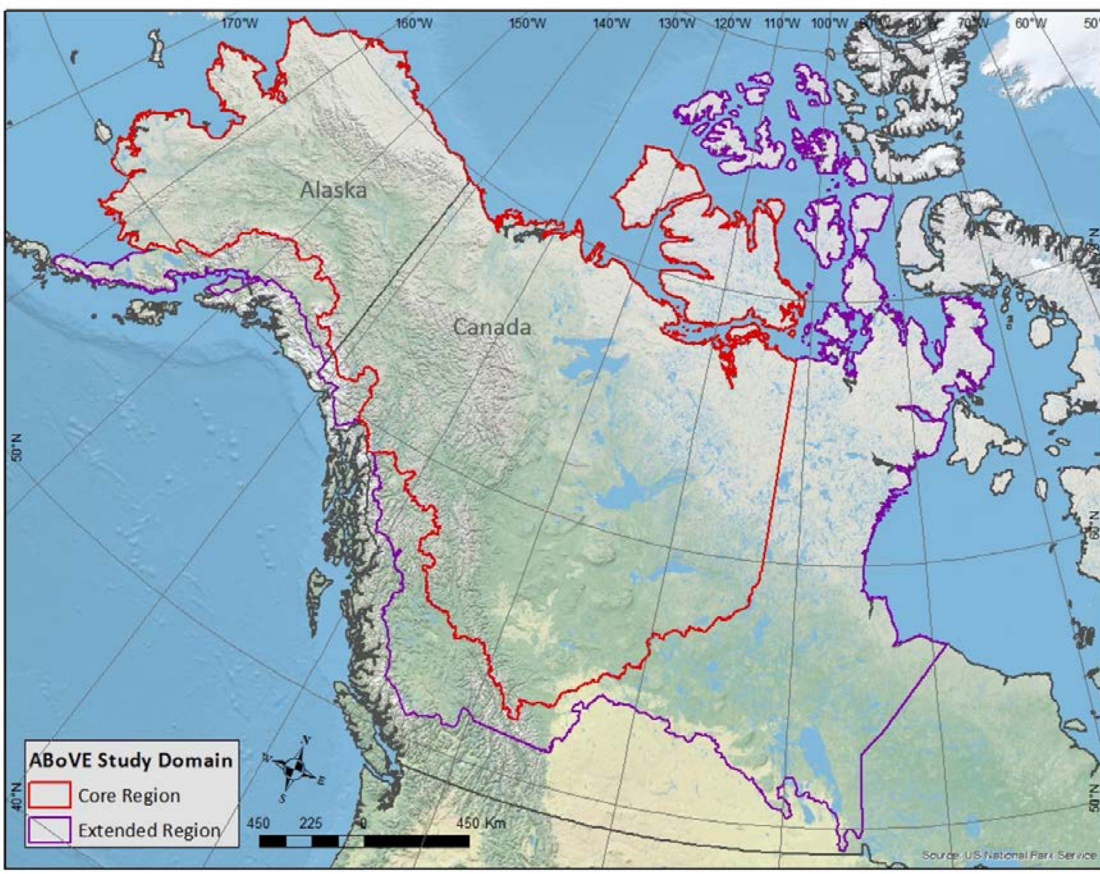

Figure 1. The ABoVE Study Area has both a Core and Extended Study Area. The core study area is 4.1 million km^2 while the extended study area encompasses an additional 2.2 million km^2. The airborne campaign that is the subject of the current solicitation will sample portions of the area.

3. Types of Proposals

The focus of this current program element is the further development of ABoVE with a focus on the initiation of the first ABoVE Airborne Campaign to be conducted in 2017. This program element aims to build on and extend the research on boreal and arctic ecosystems supported in the first phase of ABoVE in response to the 2014 call from NASA's Terrestrial Ecology Program. Based on the 2014 proposals, NASA supported 22 investigations that formed the initial stage of the ABoVE field program.

This current program element calls for research on arctic and boreal ecosystems with an emphasis on producing scientific results that are pertinent to the objectives of both the NASA Terrestrial Ecology Program and to policy and management decisions at local to global scales. We are interested in applying airborne remote sensing tools to help understand the vulnerability and resilience of northern ecosystems at regional scales within the ABoVE Study Area. Proposals to collect, analyze, and interpret airborne data sets are sought that address the ABoVE Tier 2 science questions. Integration of the airborne data into an ecosystem modeling framework is encouraged. Collection of ground data to support the analysis and interpretation of the airborne data sets may be included, but only when it is crucial to interpreting the airborne data. Airborne measurements that are pertinent to terrestrial ecosystem applications of NASA satellite missions and/or instruments either currently in development (e.g., NISAR, ICESat-2, GRACE-FO, OCO-3), preformulation (HySPIRI, PACE, ASCENDS), or operating (e.g., SMAP, OCO-2, Landsat-7/8, VIIRS, MODIS, etc.) are of particular interest. Furthermore, permafrost dynamics; responses to ecological disturbance; ecosystem physiology; biosphere-atmosphere exchange; carbon-hydrology interactions; and improved understanding of the structural and functional properties of forest, shrub, and/or herbaceous vegetation in the extensive areas of largely unmanaged forest and tundra regions of the ABoVE Study Area are subjects of interest for airborne data collection and analyses.

Proposals that do not have a strong link to the use of airborne remote sensing data will be considered nonresponsive to this call, and may be returned without review.

The ABoVE Concise Experiment Plan (ACEP) is a source of additional information about ABoVE. The ACEP outlines the conceptual basis for ABoVE and articulates a rationale of the scientific and societal importance of the study. The ACEP presents both the science questions driving ABoVE research, as well as the top-level requirements for a study design to address them. Additional information on NASA's organizational structure, management support, interagency/international partnerships, geographical focus, collaboration policies, and implementation plan is provided on the ABoVE web site landing page established to support this NRA (http://above.nasa.gov/2016_NRA.html).

NASA is interested in collaborating with other interested parties and stakeholders to advance the ABoVE research agenda through an airborne campaign that supplements the previously selected ABoVE research. Information about potential collaborating agencies can be found at http://above.nasa.gov/2016_NRA/collaborators.html. For example, NASA seeks to extend and expand existing collaborations with the Department of Energy's (DOE's) Next-Generation Ecosystem Experiment – Arctic (NGEE-Arctic), U.S. Department of Agriculture (USDA) Forest Service, U.S. Geological Survey, the Bureau of Land Management, National Park Service, Fish and Wildlife Service, and Alaskan State agencies. Proposals that can develop such collaborations are of interest. However, the absence of a collaborator/partner will not be counted against a proposal during its panel evaluation.

Collaborations with Canadian scientists and stakeholders for work conducted in Canada are also encouraged. Polar Knowledge Canada, the Canadian Forest Service, the Canada Centre for Mapping and Earth Observation (formerly Canada Centre for Remote Sensing), and the provincial governments of the Yukon and the Northwest Territories have expressed interest in fostering collaborations between Canadian and U.S. scientists working on ABoVE. While research with collaborating/partnering organizations in the ABoVE Study Area is desirable, once again, the absence of a collaborator/partner will not be counted against a proposal during its panel evaluation. It is important to note that NASA only funds research activities conducted by scientists directly affiliated with U.S. institutions.

4. Airborne Campaign

ABoVE is planning significant airborne campaigns in 2017 and 2019. However, proposals submitted to this Program Element should focus only on activities and analyses related to the 2017 airborne campaign.

NASA will use a hybrid approach to the planning and execution of the ABoVE airborne campaigns that involves (a) Foundational Airborne Measurements that will be centrally managed by ABoVE and (b) Other Airborne Measurements initiated and managed by Principal Investigators (PIs). For all supported projects, investigators should plan on Level 2 data (derived geolocated geophysical variables, such as surface reflectance) being made available to all ABoVE investigators within three to four months of data collection.

4.1. Foundational Airborne Measurements

The Foundational Airborne Measurements will be made using NASA sensors flown on NASA-provided aircraft that will fly transects across the ABoVE Core Study Area (solid black lines in Figure 2). The notional flight lines represented in Figure 2 traverse the major latitudinal and longitudinal gradients that control patterns of both precipitation and temperature in the core study area. They are designed to collect data across significant variations in both topography and soil characteristics that are controlled by a range of geomorphological processes, including the impacts of glaciation and variations in surface deposition. In turn, the variations in climate, topography, and surface geomorphology influence gradients in permafrost type, ice content, and surface hydrology, including soil moisture and surface water inundation. This results in a complex mosaic of terrestrial and freshwater ecosystems, in particular landscapes where upland vegetation (forests, shrublands, and tundra) are interspersed with wetlands, peatlands, small ponds, and lakes. Finally, the flight transects will provide the opportunity to collect airborne remote sensing data over vegetation chronosequences that are caused by disturbances (fire, permafrost, and insects), which provides the opportunity to understand how these disturbances are affecting vegetation, permafrost, and surface hydrology.

The foundational airborne campaigns are timed to facilitate research to address three major science objectives:
(a) Improve understanding of active-layer thickness and permafrost state characterization and the impacts of variations in permafrost on ecosystems at local to regional scales;
(b) Advance our ability to characterize the type, 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 impacts of variations in surface hydrology (soil moisture and inundation) at local to regional scales.

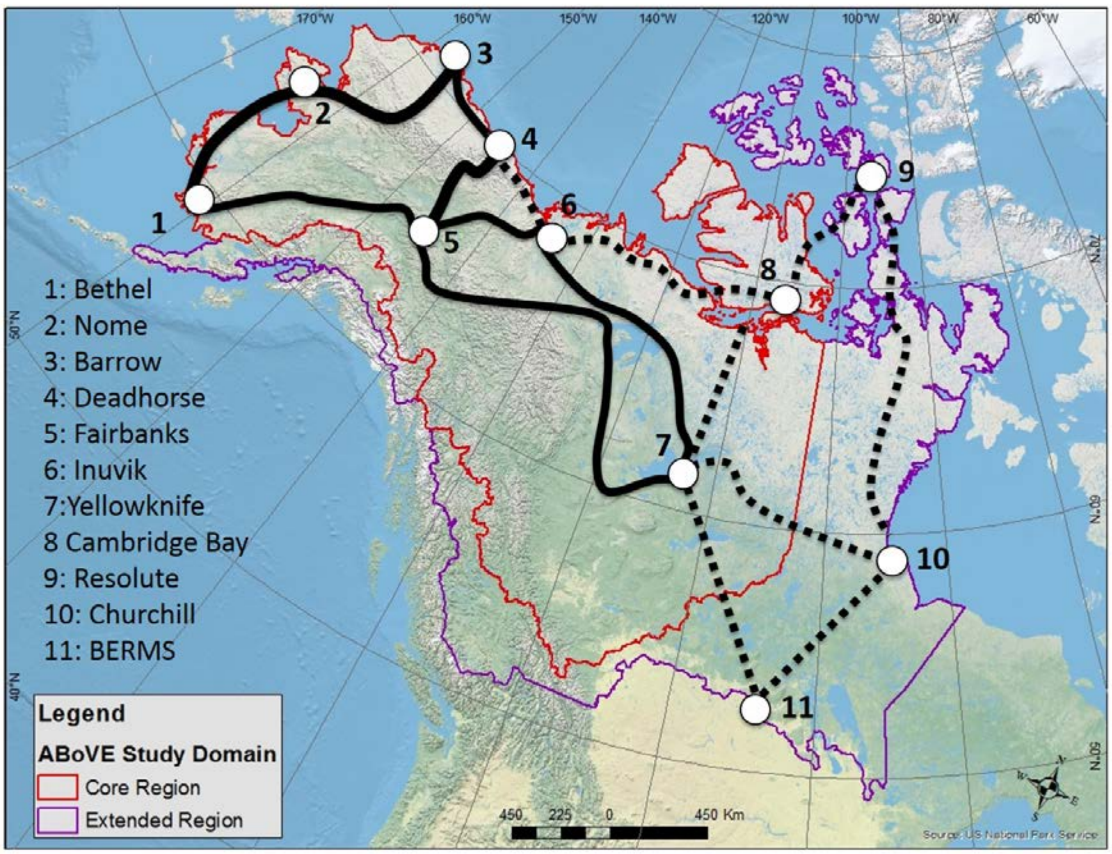

Figure 2. Flight lines for ABoVE’s Foundational Airborne Measurements (black solid lines) will sample important north-south and east-west gradients within the Core Study Area. The Alaska circuit connects points 1-2-3-4 5 and the Canada circuit connects points 5-6-7. Supplemental flight lines (black dashed lines) are not part of the Foundational Airborne Measurements, but might expand coverage into Extended Study Area and the High Arctic (points 8-11) if additional sources of funding are acquired from partner organizations.

Proposals are sought to use some or all of these ABoVE airborne data for analysis and modeling. The following NASA sensors and aircraft are under consideration for the Foundational Airborne Measurements. However, alternate payload platform combinations that deliver comparable performance may be employed to address cost or aircraft schedule constraints.

a. UAVSAR (Uninhabited Aerial Vehicle Synthetic Aperture Radar) L-band radar on the Armstrong C-20 aircraft. Two deployments – one at beginning of thaw period in spring and one at period of maximum thaw in late summer. 48 to 72 science flight hours in total. http://uavsar.jpl.nasa.gov/
b. AIRMOSS (Airborne Microwave Observatory of Subcanopy and Subsurface) P-band radar on the NASA Johnson Space Center (JSC) G-3 aircraft. Two deployments - one at beginning of thaw period in spring and one at period of maximum thaw in late summer. 48 to 72 science flight hours in total. https://airmoss.jpl.nasa.gov/
c. AVIRIS-NG or -Classic (hyperspectral) and MASTER (VIS-SWIR-TIR) on the ER-2 or B200 aircraft. One deployment in mid-growing season. Approximately 15 science flight hours. http://avirisng.jpl.nasa.gov/ and http://master.jpl.nasa.gov/
d. LVIS (waveform lidar) on an aircraft to be determined. One deployment in mid-growing season. Approximately 15 to 20 science flight hours. http://lvis.gsfc.nasa.gov/

All airborne data collections are contingent upon NASA receiving and selecting high-quality scientific proposals to make productive use of these data. These instruments will provide domain-wide sampling and coverage of many existing ABoVE field sites (Figure 2). Proposals to use these data do not need to include flight costs in their proposals nor the costs for data processing up to Level 2 as these will be provided by ABoVE.

4.2 Other Airborne Measurements

NASA is also interested in proposals (a) to fly other sensors on other aircraft, (b) to integrate other sensors onto the platforms already flying (see Section 6.1), (c) or to extend or expand the flight lines of the foundational measurements at a feasible cost. **These may include remote sensing and/or *in-situ* measurements, such as flask sampling or direct onboard measurement of atmospheric greenhouse gas concentrations. [Clarified April 25, 2016]**. In all cases, the costs of all aircraft-instrument integration, instrument operation, required flight hour costs, mission peculiar costs (e.g., per diem), and data processing must be included in the proposal budget. When NASA aircraft are the intended platform, relevant letters of support from people responsible for the NASA aircraft are required (see Section 6.1). These proposals can emphasize higher spatial or temporal coverage over specific field sites or research areas of scientific interest and should enable significant insights into the ABoVE Tier 2 science questions. Analyses of these airborne measurements can be combined with the Foundational Measurements.

The ABoVE airborne strategy is also open to leveraging complementary NASA activities, such as ICEBridge (https://www.nasa.gov/mission_pages/icebridge). Coordination with ongoing or planned Canadian airborne remote sensing activities is also of interest.

4.3 Additional Details on Airborne Transects

The Foundational Airborne Measurements will be collected along the Alaskan and Canadian regional circuits described below and presented in Figure 2. The speed and endurance of the aircraft should make it possible to sample one complete circuit on each flight day. The foundational flight lines consist of a series of north-south and east-west transects that may be executed in two basic flight patterns. Both circuits can base out of Fairbanks, simplifying operations and logistics. The Alaskan circuit features two north-south transects: the Western North Slope – Bering Tundra/Seward Peninsula – Bering Taiga/Yukon-Kuskokwim Delta transect (points 3-2-1) and the Dalton Highway transect (points 4-5). These are connected via east-west transects that cover the transition from the boreal interior to the Bering taiga (points 5-1) and sampling across the North Slope Arctic coastal plain (points 4-5).

The Canadian circuit features extended east-west transects cutting across the Alaskan boreal interior to the taiga plain near the Mackenzie Delta (points 5-6), then follows the northern treeline along the tundra/taiga ecotone (points 6-7) before returning across the Upper Mackenzie River taiga plains and across the boreal cordillera to Fairbanks (points 7-5).

Supplemental flight lines (the dashed lines in Figure 2) are not part of the Foundational Airborne Measurements, but offer the potential to expand these foundational measurements into the Extended Study Area and possibly the High Arctic. However, proposers need to be aware that transect flights in the Extended Study Area will require a supplementary source of funding from partner organizations or from another NASA program beyond the planned Terrestrial Ecology program funding. For these types of proposals, the nature and status of the expected contributions from the other funding sources should be clearly explained.

5. Background on ABoVE Organization and Management

In the first phase of ABoVE, twenty-two proposals were selected for funding (http://above.nasa.gov/cgi-bin/above/pi_list.pl) and field work is ongoing. Many aspects of NASA's organizational structure and management support for ABoVE have already been established. The section below provides important information for proposers regarding unique aspects of the ABoVE organization and management structure.

5.1 Carbon Cycle and Ecosystems Office and Field Operations Support

NASA has established an ABoVE Science Support Group within the Carbon Cycle and Ecosystems Office (CCEO) at the NASA Goddard Space Flight Center (GSFC). Field activities and operations to be conducted within the ABoVE Study Area will be coordinated through the CCEO. Important aspects include coordination and support for field operations and logistics, safety and risk management, and interactions with local and regional stakeholders. The CCEO will provide cyberinfrastructure for data analysis and management (e.g., the ABoVE Science Cloud, see Section 5.2). The CCEO will assist Science Team members with permit applications to appropriate authorities. The CCEO will help coordinate the ABoVE airborne campaigns.

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

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

5.2 The ABoVE Science Cloud (ASC)

The NASA Center for Climate Simulation (NCCS) at GSFC has 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 large-scale modeling, analysis of remote sensing data, copious disk storage with integrated data management, and integration of core variable data from *in situ* networks. The ASC will:

- Provide a shared set of computational and data resources to the ABoVE Science Team,
- Enable access to large, common data sets (both observation and model) that are relevant to ABoVE research,
- Provide a system by which results may be quickly and readily shared with the ABoVE research community,
- Enable researchers to propose larger problems and more scientific analyses than they would typically be able to leverage on their desktop computers, and
- Provide tailored computational, analysis, and data management environments to meet the needs of the individual science investigations.

Investigators will be able to request assistance from the CCEO for: use of the ASC, provisioning of key data products needed in 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. More information about the ASC, its capabilities, and potential use for ABoVE research is available on the ABoVE website (see http://above.nasa.gov/science_cloud.html) and will be updated periodically.

5.3 Data and Publication Policies

The ABoVE ST will be 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 as described below. The CCEO and ABoVE Science Leads (ASL), in consultation with the NASA Headquarters Program Manager and ABoVE partner organizations, will develop and coordinate the implementation of ABoVE data and publication policies.

All data collected and science data products (including important model products) produced under NASA sponsorship will be managed in accordance with the NASA Earth Science Data and

Information Policy specified at http://science.nasa.gov/earth-science/earth-science-data/data-information-policy/. Public release of all data shall conform to the NASA Earth Science Data and Information Policy, and there can be no significant period of exclusive access to the data or data products by either an individual scientist or a science team. A short period of time 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 or confidential human-subjects data).

Researchers will be expected to share their data using ABoVE's cyberinfrastructure (see Sections 2.2 and 2.4) and/or partnering data system capabilities as guided by the CCEO. For ABoVE investigations supported by NASA, a tailored, alternate Data Rights section will be applied to the award document, under which scientific data and scientific software will be exchanged without restriction as to its disclosure, use, or duplication.

5.4 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. 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 of ABoVE partner organizations. NASA managers and the CCEO will assist each investigator in identifying the appropriate archive for their data and products.

The following apply to data and products to be archived:

- The science data product formats from awarded projects shall conform to Earth Science Division (ESD) approved data system standards for data and metadata published at https://earthdata.nasa.gov/data/standards-and-references .
- Prior to the end of the project, awarded projects will be required to deliver all data products, along with the scientific algorithm software, coefficients, and ancillary data used to generate these products, to the DAAC in keeping with the need to ensure long-term stewardship of the data. The requirement to archive supporting algorithm software, coefficients, and ancillary data is applied primarily to satellite and airborne data products. However, it is not usually applied to other types of data to be archived, such as the wide diversity of field data, process data, and social science data that will be produced during ABoVE.
- All terms and conditions of the transfer of data products and associated information to the archive will need to be documented in the Data Management Plan (see Section 6.4.3).

6. Required Elements for Proposals

For proposals to this program element, the Scientific/Technical/Management section of the proposal will be replaced with a separate Scientific/Technical section and six separate management-related sections (see Section 6.4 below). In addition, all proposals must respond to the requirements detailed in Sections 6.1 to 6.3 below.

6.1. Requirements for Proposals to Acquire New Airborne Data

Proposals requiring data from airborne sensors that are not part of the Foundational Airborne Measurements must detail in their cost plan all costs for acquiring the new data sets, including aircraft hours, deployment costs, mission peculiar costs, data processing costs, and other costs associated with deploying the sensors and aircraft (this includes NASA sensors and platforms, as well as non-NASA sensors and platforms). In addition, for any proposed activities requiring NASA aircraft or NASA facility sensors that are not part of the foundational measurements, proposers should submit a Flight Request through the Airborne Science Flight Request system at http://airbornescience.nasa.gov (and then click on "FLIGHT REQUEST"). Questions regarding the flight request system or process should be addressed to Marilyn Vasques, Flight Request Manager (Marilyn.Vasques@nasa.gov or 650-604-6120). If the instrument or aircraft platform 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.

Proposals must provide a summary of the separate costs of the (1) airborne data collection, (2) Level 2 data processing, and (3) field work and all other scientific analyses. Optimization of the use of airborne platforms by NASA to accommodate selected proposals may be necessary.

6.2. Requirement to Address Errors and Uncertainties

All proposals submitted in response to this program element must include (1) a discussion in the Scientific/Technical section describing how errors and uncertainties will be addressed and (2) a description in the Data Management Plan (see Section 6.4.3 below) of how they will be reported with the data and products to be shared and archived. The research supported will be expected to characterize uncertainties and quantify errors associated with data, analytical approaches, model results, and scientific interpretations.

6.3 Requirement to Attend ABoVE Science Team Meetings and Workshops and TE 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 and collaborators will be welcome to participate in all meetings – as are student researchers. Support for all such travel must be included in the proposal budget and it will be up to the PI to determine who attends.

Proposers should budget for one three-day ABoVE ST meeting per year for all three years and for additional travel to one workshop per year. Proposers should assume a mix of ABoVE ST meeting locations to include some in Alaska or western Canada and some in the conterminous U.S. Workshop activity is intended to allow for more specialized ABoVE ST coordination activities and/or for subgroups of the ABoVE ST to meet; the purposes and locations will be determined by the ABoVE ST. Finally, each project should plan to send one representative to a NASA Terrestrial Ecology (TE) Science Meeting planned for late 2017 or early 2018.

6.4 Required Plans and Statements

All proposals for participation in ABoVE must include the plans detailed below in Sections 6.4.1 to 6.4.6, and these plans must be presented as separate sections of the proposal to follow the References and Citations section. Proposals lacking these required plans will not be considered for selection and will be returned without review. All of these plans are in addition to the Scientific/Technical Plan and are not included in its 15-page limit.

6.4.1 Project Management Plan (PMP)

Proposals must include a separate Project Management Plan (PMP) that presents a management structure describing how the proposed research activities will be organized, who will be doing what work, and what procedures will be followed to ensure that work is safely and responsibly conducted. The Project Management Plan section should be inserted after the References and Citations section in the proposal and does not have a page limit (in most cases, two to three pages are likely to be adequate for the Project Management Plan).

6.4.1.1 PMP: Roles and Responsibilities of all Investigators

The Project Management Plan must present a management structure describing roles and responsibilities for the Principal Investigator and all Co-Investigators and Collaborators and how the research activities will be coordinated and integrated. If students and postdoctoral scientists are involved, their roles should be described in this plan. Consistent with this section, the proposal budget section and proposal cover page must include budgetary information for all co-investigators to receive funding.

6.4.1.2 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 in an appendix to the proposal. The generic statement of commitment provided in Section 2.3.10 of the NRA/CAN Proposers Guidebook does not provide an acceptable level of detail for this program element, and should not be utilized. Note that these letters of commitment for collaborations are separate from the individual team member commitment that is completed via NSPIRES.

The summary of institutional collaboration(s) element of the Project Management Plan is required, but, while collaborations of all types are encouraged and will be viewed favorably, collaborations are not required. An acceptable summary of institutional collaboration(s) may simply state: "No institutional collaborations are proposed."

6.4.1.3 PMP: Safety and Risk Management

For efforts involving field operations, the investigator's Project Management Plan should address risk management under applicable institutional, state, and national requirements, with respect to insuring that team participants are aware of hazards related to either airborne 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 a Web-based hazard analysis and 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 their budget plan.

6.4.2. Resource Needs and Utilization Plan

The CCEO provides some logistical support to the ABoVE ST and will work to efficiently arrange for field infrastructure and seek economies of scale that will minimize costs and maximize utilization. Special support for individual investigations will be provided when it is most efficient and cost effective to do so. Selected scientists should expect a dialog with the CCEO, the ABoVE Science Leads, and NASA Headquarters, to ensure that their infrastructural and logistical needs are met adequately and in a cost-effective manner – either through the efforts of the CCEO or through their own funding award.

Proposals must include a separate Resource Needs and Utilization Plan that details the research infrastructure and logistical support needed for the investigation. Requirements for *in situ* observations, logistical support, NASA computer use, etc., must be detailed. Special support required that is likely to be unique to an individual investigation must be described. Proposers are urged to delineate such needs specifically in their budget or budget justification, item by item, if at all possible. Proposers should clearly state what support exists within their funded investigation, and what they expect the CCEO or other investigators to provide. Proposers must be aware that CCEO support is limited and should not make unreasonable assumptions about the level of available resources.

All use of the ABoVE Science Cloud (ASC) for analysis and collaborative sharing of data and results should be detailed in the Resource Needs and Utilization Plan section of ABoVE proposals. While use of the ASC for data analysis and modeling will not be required of ABoVE researchers, proposers are encouraged to request use of the ASC when existing computational resources are not available to them. NASA will not view favorably requests for purchase of new computational equipment or time on other systems without a compelling rationale for why the ASC would be unsuitable for meeting the needs of the research investigation.

Consistent with the Resource Needs and Utilization Plan, costs for all logistical and infrastructural support items must be included in the budget presented in the proposal. However, proposers are advised that some or all of these costs may be pulled out postselection 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 (see Section 5.1).

The Resource Needs and Utilization Plan section should be inserted after the Project Management Plan section of the proposal and does not have a page limit (in most cases, two to three pages are likely to be adequate for the Resource Needs and Utilization Plan).

6.4.3. Data Management Plan

Proposals must include a Data Management Plan that addresses the dissemination and sharing of research results and compliance with the NASA Earth Science data policy (http://science.nasa.gov/earth-science/earth-science-data/data-information-policy/). The Data Management Plan should include, when relevant to the type of study being proposed, the existing data and data products or other materials to be utilized or produced in the course of the project, the 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 special 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 should describe how errors and uncertainties will be reported with the data and products to be shared and archived.

The Data Management Plan will be evaluated as part of Merit, see Section 7.3.

An outline describing in greater detail desired content for the Data Management Plan is available on the ABoVE Web site (http://above.nasa.gov/2016_NRA/data_management_plan.html) and additional information about data management is available at the ORNL DAAC Web site (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 for the Data Management Plan to become a living document; successful proposers will be requested to update their Data Management Plan annually as to the status of and schedule for data set 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 presented in the proposal. The Data Management Plan section should be inserted after the Resource Needs and Utilization Plan section of the proposal and does not have a page limit (in most cases, two to three pages are likely to be adequate for the Data Management Plan).

6.4.4. Training and Communications Plan

Proposals must include a separate Training and Communications Plan that details any training and knowledge transfer to be undertaken as part of the proposed investigation. The proposal should acknowledge that the investigators are willing to provide input to ABoVE management for centralized public communications efforts and that the investigators will make their best effort to participate in such events. If there are some dissemination activities that are likely to be best addressed by individual investigators, then a description and budget for such 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 U.S. institutions may be supported by project funds. As well, travel support, including per diem for scientific exchanges (e.g., internships) between U.S. and Canadian institutions is also possible, when scientifically justified.

Airborne campaigns provide abundant opportunities to train a next generation of researchers, as well as to conduct professional development activities with a wide variety of groups, including educators, applied scientists with partnering organizations, field workers and technicians, and local stakeholders. To the extent possible, training of technicians, undergraduate and graduate students and postdoctoral fellows should be directly incorporated into ABoVE investigator studies. In addition to being directly involved in research, students and postdoctoralss should be encouraged to participate in the annual ABoVE ST meetings.

Opportunities for capacity building and public outreach abound across the ABoVE Study Area, including communications activities that are necessary to inform and fully engage important stakeholders at all 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 that the CCEO will be available to coordinate these activities.

The Training and Communications Plan section should be inserted after the Data Management Plan section of the proposal and does not have a page limit (in most cases, one-half page is likely to be adequate for the Training and Communications Plan).

6.4.5. 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 acknowledgement – 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.

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

Proposals must include a separate Stakeholder Engagement and Interactions Plan that simply describes how they plan to interact with and/or develop partnerships with stakeholders pertinent to their investigation. Such 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.

The Stakeholder Engagement and Interactions Plan section should be inserted after the Training and Communications Plan section of the proposal and does not have a page limit (in most cases, one-half to one page is likely adequate for the Stakeholder Engagement and Interactions Plan).

6.4.6. Statement of Science Team Member Commitment

Proposals must include a brief Statement of Team Member Commitment describing the proposing team's understanding of and qualifications for the role(s) they will play as members of the ABoVE ST. Many of the commitments to be made as ABoVE ST members are covered in the required plans called for in Sections 6.4.1-6.4.5 of this solicitation and need not be repeated in this statement. What is desired here is a statement of the team's commitment to becoming active, productive, and constructive members of the ABoVE ST and a description of any specific, special contributions to ST activities that individual team members plan to provide. 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 should be inserted after the Stakeholder Engagement and Interactions Plan section of the proposal and does not have a page limit (in most cases, one-half to one page is likely to be adequate for the Statement of Team Member Commitment).

7. Programmatic Information

7.1 Eligibility

This solicitation is open to all categories of institutions interested in conducting ABoVE research. Proposals from non-U.S. organizations may propose to participate on a no-exchange-of-funds basis (see Section 1.6 of the NRA/CAN Proposers Guidebook). Collaborations between researchers at U.S. and non-U.S. organizations are welcome, but the portion of the work to be conducted by the non-U.S. institution must be funded through other sources to comply with NASA's no-exchange of funds policy.

7.2 Available Funds, Budget Profiles, and Periods of Performance

Funding available for this solicitation is approximately \$3.5M in FY 2017 and \$2.5M in FY 2018 and FY 2019. This does not include the funding to support the Foundational Airborne Measurements of \$1.5 to \$2.0 M. NASA will fund three-year research projects.

7.3 Proposal Evaluation Criteria

Proposals will be evaluated according to the criteria in Section VI. (a) of the *ROSES Summary of Solicitation*. In addition to those factors, the determination of a proposal's intrinsic merit shall include:

- The quality and completeness of the following required plans: Project Management Plan, Resource Needs and Utilization Plan, Data Management Plan, Training and Communications Plan, and Stakeholder Engagement and Interactions Plan, and

- The proposer’s ability to serve as a constructive, productive team member as demonstrated in the proposal, Statement of Science Team Member Commitment, and related and relevant projects.

In addition to the proposal’s responsiveness to the goals, objectives, and requirements described in this program element, the determination of a proposal’s relevance shall take into account the following considerations:

- 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
- The quality and desirability of any collaborations with potential partner organizations, including the reasonableness and desirability of any cost-sharing arrangements (while appropriate collaborations will be viewed favorably, a lack of collaborations will not be viewed unfavorably).

8. Summary of Key Information

Expected program budget for first year of new awards	~ $3.5M (not including Foundational Airborne Measurements)
Number of new awards pending adequate proposals of merit	~ 10 to 20
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	May 16, 2016
Due date for proposals	August 1, 2016
Planning date for start of investigation	Three to four months after proposal due date or after airborne data collection, as appropriate to the study.
Page limit for the central Science-Technical section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers.* Management section requirements are given in Sections 6.4.1-6.4.6 above (additional pages are permitted for the Management section).
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 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	NNH16ZDA001N-TE
NASA point of contact concerning this program	Hank Margolis Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-4760 E-mail hank.a.margolis@nasa.gov

A.5 Carbon Cycle Science

NOTICE: Corrected February 24, 2016. Throughout the document USDA has been updated to refer to "USDA-NIFA" and a paragraph has been added to Section 2.2 referring to NIFA's strategic goal 1 and sub-goal 1.2

1. Scope of Program

This announcement offers opportunities for Carbon Cycle Science investigations within the NASA Earth Science Program, the U.S. Department of Agriculture (USDA), National Institute of Food and Agriculture (NIFA), Agriculture and Food Research Initiative Competitive Grants Program (AFRI), the U.S. Department of Energy (DOE) Terrestrial Ecosystem Science Program, and the National Oceanic and Atmospheric Administration (NOAA) Ocean Acidification Program. NASA, USDA**-NIFA**, DOE, and NOAA seek proposals to improve understanding of changes in the distribution and cycling of carbon among the active land, ocean, coastal, and atmospheric reservoirs and how that understanding can be used to establish a scientific foundation for societal responses to global environmental change.

2. Background

Priorities for new carbon cycle science research continue to derive from the research agenda of the U.S. Global Change Research Program (USGCRP) (http://www.globalchange.gov/), and, specifically, its U.S. Carbon Cycle Science Program (http://www.carboncyclescience.us/), as well as the goals and objectives of the individual agencies supporting the research.

In 2011, the U.S. carbon cycle science community completed a new plan for carbon cycle research. This reassessment of U.S. carbon cycle science priorities was conducted by the USGCRP Carbon Cycle Interagency Working Group's (CCIWG) Carbon Cycle Science Steering Group (CCSSG). The planning process culminated in the publication of *A U.S. Carbon Cycle Science Plan* (https://downloads.globalchange.gov/carbon-cycle/us-carbon-cycle-science-plan.pdf). This community plan informs U.S. research efforts on the global carbon cycle for the next decade. It is organized around three overarching questions:

- How do natural processes and human actions affect the carbon cycle on land, in the atmosphere, and in the ocean?
- How do policy and management decisions affect the levels of the primary carbon-containing gases, carbon dioxide, and methane in the atmosphere?
- How are ecosystems, species, and natural resources impacted by increasing greenhouse gas concentrations, the associated changes in climate, and by carbon management decisions?

2.1 NASA Carbon Cycle Science

The overall goals for NASA's Earth Science program are documented in NASA's Strategic Plan (http://nasascience.nasa.gov/about-us/science-strategy). Carbon Cycle Science research is supported by many different research and applied science programs at NASA, including, but not limited to, NASA's Carbon Cycle and Ecosystem focus area (http://science.nasa.gov/earth-science/focus-areas/carbon-cycle-and-ecosystems/), as well as the programs that support it (http://cce.nasa.gov/cce/index.htm). 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 events. 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 pervades carbon cycle research by NASA and is a basis for partnerships with other U.S. Government agencies and institutions. NASA carbon cycle research contributes toward the goals of major 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/, http://www.carboncyclescience.us/, http://www.nacarbon.org/nacp/, and http://www.us-ocb.org/about/projects.html), as well as the goals and objectives of the Ocean Carbon and Biogeochemistry program supported by the National Science Foundation and NASA (http://www.us-ocb.org). NASA carbon cycle research also contributes toward the goals of the National Ocean Council's National Ocean Policy planning documents (http://www.whitehouse.gov/administration/eop/oceans/policy).

2.2 USDA-**NIFA** Carbon Cycle Science

The USDA-NIFA mission is to advance knowledge for agriculture, the environment, human health and well-being, and communities. The purpose of the AFRI is to support research, education, and extension grants that address key problems of national, regional, and multistate importance in sustaining all components of agriculture. USDA-**NIFA** research seeks to determine the significance of agricultural systems (including farm, crop, forest, and range lands) in the global carbon cycle, including carbon consequences of adaptation strategies within these systems, and to identify agricultural and forestry activities that can contribute toward reducing atmospheric concentrations of greenhouse gases. This carbon cycle science program falls within the USDA-NIFA'S Agriculture and Natural Resources Science for Climate Variability and Change program which seeks both fundamental and applied interdisciplinary research on impacts and feedbacks to global change and potential adaptation and mitigation strategies, as well as discovery and demonstration of decision support tools for land, ecosystem and water resource managers to mitigate carbon and greenhouse gas emissions (i.e., increase carbon uptake and sequestration and/or reduce emissions) while maintaining or enhancing productivity and associated ecosystem products, services, and structure; identify vulnerable ecosystems (including production and management systems) and their thresholds; and adapt to global change and its drivers. USDA-**NIFA** carbon cycle research contributes toward the goals of major USGCRP activities, including the Carbon Cycle Science Program's U.S. NACP. In addition USDA-NIFA encourages international coordination in the area of agricultural greenhouse gases via the Global Research Alliance (http://www.globalresearchalliance.org/).

This program addresses NIFA's strategic goal 1: Catalyze exemplary and relevant research, education and extension programs. Specifically it addresses sub-goal 1.2: Advance the development and delivery of science for agricultural, forest, and range systems adapted to climate variability and to mitigate climate impacts. See http://nifa.USDA.gov/strategic-plan. [Added February 24, 2016]

The objectives of this program address the USDA Strategic Plan for 2010-2015 under Strategic Goal 2, Objective 2.2: Lead Efforts to Mitigate and Adapt to Climate Change, in particular the strategy to "Develop models, national observing and monitoring systems, decision support tools, and new technology and adaptation strategies for communities, agriculture producers, and natural resource managers;" and "Encourage the adoption of reasonable, transparent, and science-based programs to adapt to, or mitigate the effects of, climate change on agriculture and forestry." They also support the USDA Research, Education, and Economics (REE) Action Plan (http://www.ree.USDA.gov/ree/news/USDA_2014_REE_Action_Plan_08-2014_Final.pdf Goal 2: Responding to Climate and Energy Needs, Subgoal 2A: Responding to Climate Variability, with direct reference to the identified REE role to "develop and deliver science-based knowledge that empowers farmers, foresters, ranchers, land owners, resource managers, policymakers, and Federal agencies to manage the risks, challenges, and opportunities of climate variability, and position decision makers to reduce emissions of atmospheric greenhouse gases and enhance carbon sequestration."

2.3 DOE Carbon Cycle Science

Within DOE's Office of Science, the Climate and Environmental Sciences Division (CESD) seeks to advance a robust predictive understanding of Earth’s climate and environmental systems and to inform the development of sustainable solutions to the nation’s energy and environmental challenges (http://science.energy.gov/~/media/ber/pdf/CESD-StratPlan-2012.pdf). Among CESD's goals, the following three pertain to the Terrestrial Ecosystems Science (TES) program and to this solicitation:

- Develop, test, and simulate process-level understanding of terrestrial ecosystems.
- Advance fundamental understanding of coupled biogeochemical processes in complex subsurface environments to enable systems-level environmental prediction and decision support.
- Synthesize new process knowledge to advance next-generation, integrated models of the human-Earth system.

TES seeks to improve the representation of terrestrial ecosystem processes that in turn can be incorporated into the land component of Earth system models, thereby improving the quality of climate model projections and providing the scientific foundation needed to inform DOE’s energy decisions. TES seeks to focus its research on ecosystems that are globally important, climatically sensitive, and comparatively understudied or underrepresented in Earth system models.

TES uses a systems approach to understand ecosystems over multiple scales that can be represented in models. This emphasis on the incorporation of improved scientific understanding of ecosystems in models has two goals. First, it seeks to improve the representation of specific processes so that an analysis of scale aware interactions and interdependencies can be conducted with a systems approach. Second, it seeks to exercise models and compare projections and simulations against observations or other data sets to inform future research directions.

2.4 NOAA Carbon Cycle Science

The focus of NOAA carbon cycle science research is to better quantify the information on atmospheric composition, its influence on the energy budget, and feedbacks that contribute to changes in Earth's climate. Specifically, NOAA seeks to provide the understanding needed to link emissions of climate-relevant compounds to the radiative forcing of climate change for science-based decision support (see http://www.nrc.noaa.gov/plans.html)

NOAA is providing research 1) to understand oceanic and atmospheric processes, both natural and human-related, that affect carbon dioxide (CO_2) trends, 2) to quantify the climate roles of the radiatively important trace atmospheric species such as fine particles (aerosols), ozone, and chemically active greenhouse gases, and 3) to understand and assess stratospheric ozone depletion.

Research activities 1) may be directly applied to climate projection and to policy decisions regarding carbon management that are related to limiting unwanted effects of future climate change and 2) provide timely and adequate information needed to broaden the suite of noncarbon options for addressing changes in climate forcing, especially in the next few decades.

NOAA's carbon cycle research supports both national and international assessments of the climate system, e.g., the synthesis and assessment products of the USGCRP, the assessment reports of the IPCC, and the reports to the U.N. Montreal Protocol on the ozone layer. Such science-based assessments and scenarios provide (1) tools for better management of carbon- and noncarbon-based climate-forcing emissions, (2) a suite of choices for both air quality and the alteration of climate forcing in the near term, and (3) longer-term assessments of strategies for managing climate-forcing emissions over the longer term.

In addition, related to carbon in the ocean, SEC. 12406. of the Federal Ocean Acidification and Monitoring Act (FOARAM, 2009) requires that NOAA oversee and coordinate a diverse research and monitoring portfolio consistent with the *Strategic Plan for Federal Research and Monitoring of Ocean Acidification* developed by the Interagency Working Group on Ocean Acidification (IWGOA). In support of these requirements, NOAA supports research and monitoring on ocean acidification that contributes towards an assessment of the impacts of ocean acidification on marine ecosystems and promotes development of adaption and mitigation strategies to better conserve ocean acidification (OA) impacted marine systems on which human communities depend. Carbon exchange between the oceanic, atmospheric, and terrestrial reservoirs is a primary factor controlling both long-term and episodic acidification events (e.g. concomitant decrease in both pH and carbonate ion concentration). The complex biogeochemistry within shallow or coastal environments can significantly challenge the predictive capacity of continued OA on marine ecosystems and dependent human societies. NOAA's ocean acidification research works to better inform fisheries, marine resource managers, and policy makers of OA implications for the nation.

3. Carbon Cycle Research Solicited

In this solicitation, NASA, USDA-**NIFA**, DOE, and NOAA request proposals for research and/or applied science investigations aimed at addressing the three overarching U.S. carbon cycle science questions and conducting research focused on integrated scientific-societal issues. Proposals within five specific research themes are requested. Each agency participating in this solicitation will be able to support research only in a subset of these themes, and the participating agencies are noted in parentheses for each theme listed below. The five research themes solicited are:

1. Carbon research in critical regions, specifically: tropical terrestrial ecosystems, Arctic-boreal terrestrial ecosystems, North American continental margins (NASA, DOE, USDA-**NIFA**);
2. Blue Carbon and Carbon in Associated Ecosystems (USDA-**NIFA**, NASA) ;
3. Carbon dynamics across managed landscapes, specifically: urban-rural, forested-agricultural and terrestrial-aquatic (USDA-**NIFA**, NASA);
4. The Impact of Rising CO_2 on Ocean Ecology (NASA, NOAA); and
5. Carbon cycle science synthesis research (NASA, USDA-**NIFA**)

A further description of the types of research solicited under each of these themes is provided in the sections that follow.

3.1 Theme 1: Carbon Research in Critical Regions (NASA, DOE, USDA-**NIFA**)

Many Earth system research programs have focused on temperate systems due to proximity and ease of access. However, many extra-temperate systems are increasingly recognized for their importance in critical Earth processes, particularly biogeochemical cycles associated with carbon and macronutrients. Tropical and Arctic ecosystems sequester massive quantities of carbon in soil, vegetation, and permafrost, and are directly responsible for important feedbacks to the global climate system. Recent reports have identified gaps in our knowledge of the quantity and scales of carbon cycled in and around the North American continental margins. Wetlands, peatlands, and coastal ecosystems also sequester large quantities of carbon through processes at risk of disturbance from changing climate, land use change, and rising sea levels. However, our understanding of these systems, e.g., their characteristics and dynamical behaviors, are poorly understood, thus limiting our ability to adequately predict their long-term behavior. Research is solicited for the following three critical regions.

3.1.1 *Carbon Dynamics in Tropical Terrestrial Ecosystems (moist forests and, woodlands/savannas) (NASA)*

The tropics cover approximately 40% of Earth's land surface area and critically regulate many Earth system processes. Tropical terrestrial ecosystems contain great stores of biomass, and they represent a major reservoir of the planet's terrestrial carbon. These ecosystems also cycle more carbon dioxide (CO_2) and water than other biomes and play important roles in determining Earth's energy balance, which drives global systems of temperature and precipitation. Large-scale changes in tropical terrestrial ecosystems have the potential to change global patterns of temperature and precipitation. Tropical ecosystems are under significant stress from a changing climate and from anthropogenic land use changes. While generally accepted as a critical global system, tropical ecosystems are poorly understood, causing corresponding limitations to their representation in ecosystem and global-scale carbon cycle and climate system models. Social, economic, and behavioral processes can interact strongly with these processes, such that incorporation of these processes into models and projections is needed to more fully understand how many of these ecosystems have evolved and can change in the future. Important questions from microscale (microbial processes, soil and biogeochemical processes), to macroscale (plants and plant systems), to landscape and watershed scale remain unanswered regarding carbon dynamics in tropical systems.

Proposals should address improved understanding of widespread, critical tropical ecosystems. Particular emphasis is placed on research that combines measurements and/or experiments with modeling to provide improved quantitative and predictive understanding of the coupled biological, chemical, and physical processes that represent potentially strong carbon cycle feedbacks from tropical terrestrial ecosystems in a changing climate. Processes of particular interest include those that are needed to explain the impacts on ecosystems caused by drought, temperature, and changes in hydrology, as well as improved understanding of soil biogeochemistry and methane dynamics. Preference will be given to projects that demonstrate strong potential feedbacks and wide geographic applicability.

3.1.2 *Carbon Dynamics in Arctic/Boreal Terrestrial Ecosystems (NASA, DOE)*

Arctic tundra, boreal systems, and the transitions in between represent a vast expanse of northern land mass and contain one of the largest volumes of carbon stored in the biosphere. As a consequence of a warming climate, the region may be approaching a potential tipping point with regard to the release of this stored carbon. Climate warming could trigger large-scale releases of CO_2 and CH_4 from thawing Arctic/boreal soils into the atmosphere. On the other hand, warming may induce perturbations to local hydrology of land surfaces that in turn could increase plant production and either decrease methane production or increase methane consumption, and thus potentially reduce carbon emissions to the atmosphere. These and other processes that can influence carbon dynamics and climate feedbacks are also influenced by social and economic factors and other human decisions and disturbances. Although it is widely accepted that this region is critically important to our understanding and modeling of climate change, our understanding of key processes, impacts, and feedbacks are far from robust. There are currently large uncertainties in the direction and strength of the positive and negative feedbacks and what is likely to occur in the region in response to continued climate change. These ecosystems are remote and measurements and observations that are widespread and common in temperate ecosystems are rare or absent in many of these northern ecosystems.

Therefore, this theme solicits fundamental research to advance our understanding of the function of widespread, critical northern terrestrial ecosystems, particularly in ways that influence carbon cycle feedbacks to the climate system. Particular emphasis is placed on research that combines measurements and/or experiments with modeling to provide improved quantitative and predictive understanding of the coupled biological, chemical, and physical processes that represent potentially strong carbon cycle feedbacks to climate from northern terrestrial ecosystems in a changing climate. Preference will be given to projects that focus on strong potential feedbacks and have wide geographic applicability.

3.1.3 *North American Continental Margins (NASA,* USDA-**NIFA***)*

Relative to their surface area, continental margins represent some of the largest carbon fluxes in the global ocean, but sparse sampling in space and time makes these systems difficult to characterize, quantify, and model. Recognizing the importance of continental margins to the overall North American carbon budget, specifically as acknowledged by the North American Carbon Program (http://www.nacarbon.org/nacp/index.html), terrestrial and marine carbon cycle scientists have collaborated on a series of synthesis, carbon budgeting, and modeling exercises for coastal regions of North America, which include the Gulf of Mexico, the Laurentian Great Lakes (LGL), and the coastal waters of the Atlantic, Pacific, and Arctic Oceans.

The Coastal CARbon Synthesis (CCARS) workshops and research activities have been conducted since 2007 as a partner activity between the Ocean Carbon and Biogeochemistry (OCB) Program and the North American Carbon Program (NACP) to synthesize existing data and improve quantitative assessments of the North American carbon budget. Out of this effort has come a draft science plan for carbon cycle research in North American coastal waters that specifically identifies areas ripe for research and modeling investment, particularly focused on gaps in our knowledge of the North American continental margins' carbon cycle. One of the plan's key goals is to synthesize existing data and improve quantitative assessments of the North American carbon budget. This program element welcomes research activities to support the key findings and recommendations of the CCARS report entitled "An Interdisciplinary Science Plan for Research in North American Continental Margin Systems" that can be found on the OCB website at http://www.us-ocb.org/CCARS_Sci_Plan_DRAFT.pdf. NASA welcomes proposals to conduct research to address the goals and objectives of the CCARS Report and its implementation. This subelement solicits fundamental research to address the gaps and needs in research in the aforementioned geographical areas of focus to address the preliminary recommendations and key findings of the coastal carbon data synthesis activities articulated in the report. One example of this might be to increase the use of satellite products and development of algorithms for key carbon flux estimates. Particular emphasis is placed on research that combines measurements and/or experiments with modeling to provide improved quantitative and predictive understanding of the coupled biological, chemical, and physical processes of carbon cycling along the North American Continental Margins. The proposed work plan's relationship and direct link to the CCARS report and it's research goals and objectives must be explicitly justified within the proposal.

Also within this subelement, USDA-**NIFA** has particular interest in projects that would include assessments of projected changes in and vulnerability of coastal ecosystems such as coastal wetland forests and marshes, including both below- and above-ground processes, due to both climate change and sea level rise, and associated changes in hydrology, water tables, salinity, and frequency and intensity of disturbance. Integration of social, behavioral, and/or economic sciences is strongly encouraged.

3.2 Theme 2: Blue Carbon and Carbon in Associated Ecosystems (NASA, USDA-**NIFA**)

"Blue carbon" refers to carbon in coastal and marine ecosystems. This theme specifically focuses on wetlands, peatlands, mangroves, seagrasses, tidal marshes, coastal forests, and estuary systems across the globe. These areas are subject to environmental and climate variability and change, typically removing some fraction of carbon from the atmosphere and ocean and storing it in plants and the sediment. Once these regions are impacted by environmental or climate change, restoration and adaptation become a challenge. Additionally, research has pointed to a release of carbon dioxide from the blue carbon ecosystems as a result of environmental and climate change impacts. The destruction of these areas can also have large effects on local economics. For example, in addition to providing protection to coastal communities and nurseries for many fish species, the aforementioned coastal ecosystems are highly productive, storing large quantities of carbon.

NASA and USDA-**NIFA** are interested in the research and modeling studies that underpin the approaches to the aforementioned "blue carbon" regions' conservation and management, bringing in how processes and human actions in these areas and beyond are affecting these ecosystems. Climate change is affecting these ecosystems that are important for the global carbon balance via numerous direct and indirect mechanisms and their interactions with human decisions, policies (such as national accounting), resource management and socioeconomics and behavior.

This theme calls for research in the following topical areas:

a) using historical or existing remotely sensed and *in situ* data and/or proposing new remotely sensed and *in situ* observations to map the aforementioned blue carbon geographical areas (e.g., seagrasses); this effort must be linked to research that attempts to quantify the carbon stored in these systems,

b) understanding historical and future carbon fluxes in to and out of the aforementioned blue carbon areas due to projected changes in climate, environmental change or disturbance, and/or human actions, including but not limited to: management/decision making, urbanization, before and after land use change, sea level rise, etc., and

c) understanding the potential feedback(s) of naturally or anthropogenically-driven change in an aforementioned blue carbon system (e.g., mangroves) to the climate system and the impact of this change on key carbon cycle processes (in both natural and managed systems).

Projects should integrate process research with modeling and should span different temporal or spatial scales (e.g., proposals may include the role of the microbial community in the blue carbon area under study). Geographic study regions may span regional or watershed to continental, but the compelling reason that geographic area is worthy of scientific study must be justified and should be placed in a global context. Proposers to USDA-**NIFA** can include below-ground/sediment level processes. Projects that integrate human dimensions into the research, models, and analyses are strongly encouraged.

For proposals requesting NASA support: Unless otherwise specified above, proposed investigations must utilize remotely sensed (e.g., MODIS) observations as a primary research tool, but may also seek to improve existing satellite observations or explore the development of new algorithms for new carbon cycle properties from space-based assets (beyond traditional observations) in support of the project objectives. Coordinated or individual efforts may be linked with other projects or proposals and these linkages must clearly and explicitly be called out by all involved proposals and investigators. Project planning to propose any new data collection are strongly encouraged to speak with the cognizant program manager prior to submitting the proposal to ensure the scope of the planned proposed effort are appropriate to the solicitation.

Investigators should make clear any special requirements or platform needs, i.e., ship modifications, additional boats, specific sampling requirements in a separate section. Information about high-end computing requirements will be collected using a question on the NSPIRES cover pages and a required appendix to the proposal document (see Section I(d) of the *ROSES Summary of Solicitation* for details of this requirement and information about the template to be used for the appendix). For example, 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 sensors and platforms as well as non-NASA sensors and platforms). In addition, for any proposed activities requiring NASA aircraft or NASA facility sensors, proposers should submit a Flight Request to the Airborne Science Flight Request system at http://airbornescience.nasa.gov (and then click on "FLIGHT REQUEST"). Questions regarding the flight request system or process should be addressed to Marilyn Vasques, Flight Request Manager (Marilyn.Vasques@nasa.gov or 650-604-6120). If the instrument or aircraft platform 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. Proposers should include any required supporting paperwork that provides insight in to costs or requests in support of the use of the vessel. Proposers must take responsibility for making all arrangements to secure the availability of the needed sensors and vessel and explain these plans in the proposal.

All data collected will be subject to the standard NASA Earth Science data policy (http://nasascience.nasa.gov/earth-science/earth-science-data/data-information-policy/). Proposals seeking NASA funding and planning to collect field data should contain a table that, to the extent possible, details what data will be collected, on what cruise or field visit, and when, and provide a detailed plan for submission to a NASA data center, such as the SeaWiFS Bio-optical Archive and Storage System (SeaBASS - http://seabass.gsfc.nasa.gov), within one year of collection. All proposals submitted in response to this solicitation must include a section in the statement of work describing how errors and uncertainties will be addressed. The research supported will be expected to characterize uncertainties and quantify errors associated with data, analytical approaches, model results, and scientific interpretations. This work must be described in the proposal. Proposals must include a data management plan of no more than two pages that addresses the dissemination and sharing of 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 should include, when relevant to the type of study being proposed, the types of data and data products or other materials to be produced in the course of the project, the standards to be used for data and metadata formats and plans for providing access to and/or archiving the data and other research products. The data sharing plan called for in section 2.3.5 of the *Guidebook for Proposers* may be included in the data management plan. The data management plan must be included within the 15-page limit for the Scientific/Technical/Management section of the proposal. A valid data management plan may include only the statement that no detailed plan is needed, as long as a clear justification is provided.

For proposals requesting USDA-**NIFA** support:
It is expected that many proposals in response to this theme may be appropriate for both NASA and USDA-**NIFA** funding. Thus, just as for proposals requesting NASA support, all proposals must include a data management plan that assures preservation of and ready access to information and data outputs from the project. Data management plans developed according to NASA requirements are acceptable to USDA-**NIFA**; otherwise USDA-**NIFA** suggests that the data management plans include or address following:

- Describe types of data, metadata, and other generated materials, formats, and standards used, and whether it will change or be updated. Indicate if data is sensitive or proprietary;
- Detail planned policies for access and sharing data, including provisions for appropriate protections of security, confidentiality and intellectual property, and mechanisms for obtaining access;
- Address provisions for reuse, redistribution and production of derivatives, and plans for archiving data and other products for preservation of access.
- Submission to an appropriate data center or archive is required, but it need not be a NASA data center.

3.3 Theme 3: Carbon Dynamics Across Managed Landscapes (USDA-**NIFA**, NASA)

Land use and resource management decisions generate complex patterns of native vegetation, managed forests, agricultural systems, and urban and suburban landscapes. This mosaic of land use and land cover (LULC) has significant spatial and temporal variation in terrestrial carbon stocks, rates of carbon exchange, and potentials for carbon sequestration. Urban, suburban, and adjacent/supporting agricultural and forest regions are becoming increasingly important in the global carbon cycle. For example, as of the 2010 Census, more than 80% of the population of the U.S. now lives in cities and their suburbs, while more than 50% of the land area is under agricultural management. More than 90% of global anthropogenic greenhouse gas emissions are attributable (directly or indirectly) to cities, and urban populations drive to a large extent many of the activities of the rural and forested areas due to their demand for food and fiber, resources, and recreational areas. In recognition of their contributions to global greenhouse gas emissions, a number of cities, regions, and nations have issued bold goals for greenhouse gas emission reductions. Effective actions to quantify the effects of such actions will depend, however, on understanding the processes controlling the uptake, storage, and release of greenhouse gases along urban to rural gradients and the social, behavioral, and economic drivers and influences on these processes. In many tropical areas for example, forest and peat land clearing through fires for industrial oil palm plantations results in significant carbon loss hence increased greenhouse gas emissions, and this decision is driven by many factors, including demands for these resources/products through a global economy.

Development choices pay a central role in determining local, regional, and global carbon emissions through such factors as energy consumption, transportation, and construction, as well as management for terrestrial carbon sinks via vegetation carbon uptake and storage. However, there are very few data available to systematically evaluate how alternative patterns of urban and regional development and LULC change interact with ecosystem processes and atmospheric carbon dynamics. Studies of the processes and mechanisms controlling carbon cycling in urban and surrounding regions can provide a useful test-bed for developing carbon cycle information that can provide a sound basis for carbon management at local and regional scales.

Land-use changes of interest across the range of urban-suburban-forested-agricultural systems include, for example, deforestation, reforestation and afforestation, urban encroachment, land conversions to and from agricultural and forestry uses, changes related to renewable energy production, changes in crop, range, pasture, or forest management systems, and fragmentation of land-cover types. Also of importance are the interactions at the intersections of different land uses/land cover - how does one land use affect the adjacent land use or land cover and what is the resulting net impact on carbon fluxes and stores. This could also include consideration of the tradeoffs between carbon sequestration or greenhouse gas reductions and other goods and services needed by society and of the natural and socioeconomic drivers of these land changes and decisions. Changes and disturbances of interest include, for example, changing precipitation patterns, altered fire regimes, increasing temperatures and/or concentrations of CO_2, CH_4, and other greenhouse gases, extreme events, nitrogen deposition, agricultural management decisions, and biotic or socioeconomic disruptions.

To better guide and strengthen the development of models of the processes dominating terrestrial (both above- and below-ground) and atmospheric carbon dynamics, effective use of advanced measurement and observational capabilities is needed. Integration of a broader range of data and information will also, in time, lead to improved predictive model capabilities. For example, structural information retrieved from radar data can provide additional information on the above-ground biomass useful for carbon assessments. Carbon cycle research under this theme is, therefore, expected to help quantify the carbon signatures (spatial and temporal changes in fluxes) of ecosystems across a range of human influence and control, requiring measurements, modeling and analysis. Projects that can capitalize on ongoing activities, and/or projects that investigate systems of high potential carbon flux (both emissions and sequestration) or climate feedback are encouraged.

3.4 Theme 4: The Impact of Rising CO_2 on Ocean Ecology (NASA, NOAA)

Recent planning documents for carbon cycle science, including the 2011 *A U.S. Carbon Cycle Science Plan* (https://downloads.globalchange.gov/carbon-cycle/us-carbon-cycle-science-plan.pdf), point to large unknowns in global carbon dynamics, including a need to determine the synergistic effects of rising CO_2 on ecosystems in the presence of altered patterns of climate and associated changes in weather, hydrology, sea level, and ocean circulation. Concurrently, the United States Ocean Carbon and Biogeochemistry program (www.us-ocb.org) points to two overarching research priorities: oceanic uptake and release of atmospheric CO_2 and other greenhouse gases and environmental sensitivities of biogeochemical cycles, marine ecosystems, and interactions between the two. With these overarching goals in mind, this program element solicits proposals that seek to address one aspect of these scientific issues: to delineate, understand, and quantify the impact of rising atmospheric CO_2 on aquatic ecology.

This subelement solicits fundamental research to advance our understanding of the impacts of rising atmospheric CO_2 on aquatic ecosystems, including, but by no means limited to, ocean acidification and the resulting impacts of aquatic uptake or release of carbon dioxide on aquatic organisms and ecosystems. Higher atmospheric CO_2 levels are likely to change the competitive balance among ecosystem dynamics, functional groups, and biodiversity (e.g., dramatic shifts in species). Efforts will be needed to determine the combined effects of rising CO_2 and altered patterns of climate on ecosystem structure and function in aquatic habitats. Additionally, linkages between land and ocean ecosystems represent an area that is sensitive to changes in carbon cycling, particularly the rise in CO_2 concentrations resulting from environmental change, and that has important significance for functional groups, ecosystems, and for society. These land-ocean linkages are only beginning to be examined in the context of carbon export to the coastal oceans and the impact of this export on diverse end points such as coastal ocean acidification and fisheries. Therein, particular emphasis is placed on research that combines measurements and/or experiments with modeling to provide improved quantitative and predictive understanding of the coupled biological, chemical, and physical processes that represent potentially strong carbon cycle and ecosystem feedbacks under changing environmental and climatic conditions. Preference will be given to projects that focus on strong potential feedbacks and have wide geographic applicability, as well as emphasis on human influences in the proposed research. Proposals must include substantive use of NASA satellite data for consideration by NASA. No such requirement is necessary for consideration by NOAA's Ocean Acidification Program.

3.5 Theme 5: Carbon Cycle Science Synthesis Research (NASA, USDA-**NIFA**)

Recent research investments in synthesis research under the North American Carbon Program (NACP) have been highly productive, producing, in addition to their scientific findings, new and valuable information regarding how carbon measurements can be used, the capabilities of carbon cycle models, and uncertainties and errors in these measurements and models. However, it seems clear that there is still more that could be learned in the coastal carbon synthesis effort, and, at least in the case of the NACP midcontinent study, more data to be analyzed. Therefore, focused, follow-on research that extends and/or completes NACP synthesis research is solicited.

Also, the agencies believe that additional relevant carbon cycle science programs, projects, and topic areas would benefit from new synthesis studies addressing the important science questions of this solicitation. Candidate programs, projects, and topics include, but are not limited to Free Air Carbon Dioxide Enrichment (FACE), Greenhouse Gas Reduction through Agricultural Carbon Enhancement Network (GRACENet), AmeriFlux, Consortium for Agricultural Soils Mitigation of Greenhouse Gases (CASMGS), Rapid Soil Carbon Assessment, International Soil Carbon Network, ocean acidification trends and impacts by region, ocean biogeochemistry, disturbance, mortality, and ecosystem fluxes. New synthesis studies must be directed toward addressing the scientific topics outlined in Themes 1-4 in Sections 3.1-3.4 above.

Model-measurement intercomparisons and model-model intercomparisons that include measurements or observations represent approaches with focused scientific objectives that are of interest for synthesis research. Activities and infrastructure essential to the support of synthesis research, including data preparation, management, and distribution may be proposed as part of a scientific synthesis study. Proposers are encouraged to make use of existing infrastructure and/or partner with established data centers whenever possible. Proposals offering support infrastructure only, with no scientific synthesis research, will be considered nonresponsive to this program element.

3.6 Cross-cutting research Topics

3.6.1 *Human Activities*

It is recognized that human activities are the major cause of increasing atmospheric greenhouse gases. In addition, as indicated in all three questions guiding the 2011 publication *A U.S. Carbon Cycle Science Plan*, human activities and decisions, as well as societal and economic forces, strongly affect the Earth's carbon cycle dynamics, both directly and indirectly. Thus, the agencies participating in this solicitation strongly encourage proposers to consider offering research investigations that address human activities, including impacts on coupled human-biogeophysical systems and societal responses involving adaptation, mitigation, and/or integrated, adaptive management of carbon in the environment.

3.6.2 *Space-based Atmospheric Carbon Observations*

Past solicitations for interagency carbon cycle science research encouraged studies using space-based atmospheric carbon observations to be better prepared for upcoming observations from the Orbiting Carbon Observatory-2 (OCO-2) and Greenhouse Gases Observing Satellite (GOSAT) missions. Because other solicitations from NASA have called for similar studies, and because the GOSAT data are now becoming mature and used, this solicitation is not calling explicitly for such studies. Instead, studies are encouraged that use and/or combine existing space-based CO_2 and/or CH_4 observations (with or without other types of observations) to concentrate on the topics covered within Sections 3.1 through 3.5 of this solicitation. In particular, Sections 3.1, 3.2, and 3.4 are all quite relevant for the use of these atmospheric carbon observations. Also, validation of satellite atmospheric carbon data products remains a strong interest in support of the use of these observations and research to support surface remote sensing observations and infrastructure to evaluate current CO_2 and CH_4 data products would be welcome.

3.6.3 *Research Approaches and Analysis Tools*

The agencies value certain research approaches and analysis tools and believe they have much to offer in advancing current understanding of the global carbon cycle. Proposers are strongly encouraged to consider including one or more of the approaches described below in this section in their research plans.

3.6.3.1 *Improved Observations*

Scientific understanding of the carbon cycle can be limited by the amount and quality of relevant observations and studies that offer improvements in observations are of interest when they focus on improving the observations necessary to achieve a particular carbon cycle science goal during the course of the study. However, proposers should note that this solicitation is not an appropriate vehicle for proposing technology development or instrument development work; any such proposals will be considered nonresponsive. However, studies which involve improved measurement of the carbonic acid system within poikilohaline environments may be considered, if proposed as a means to improving quantification of coastal carbon fluxes and achieving better constraint of coastal acidification processes.

3.6.3.2 *Modeling*

Modeling approaches are of great interest and essential for developing predictive capacity for carbon cycling. The agencies are interested in all types of models that address carbon cycle dynamics (budgets and/or fluxes), including: data assimilation modeling, atmospheric transport and inversion modeling, ecosystem component modeling, socioeconomic modeling, model improvement through incorporation of new/better data and process information, analysis of model outputs, modeling at global and regional scales, models at the scale of key processes, and model intercomparison studies (including the data preparation and management activities necessary to support them). Utilization of, or explicit links to, widely used, open source models is encouraged, where appropriate.

3.6.3.3 *Coordination with other Federal Research Projects*

The U.S. Carbon Cycle Science Program coordinates the carbon cycle research of ten Federal agencies. Some of these agencies direct or compete their carbon cycle research in ways not compatible with an interagency solicitation of this nature at this time. Thus, it is imperative that efforts be made to coordinate and encourage synergies across all contributions to the U.S. Carbon Cycle Science Program. Proposers to this solicitation are, therefore, strongly encouraged to offer studies that collaborate with, leverage, complement, or build upon existing carbon cycle science or related projects of other U.S. agencies (e.g., NSF, USGS, other elements of USDA or NOAA). Explicit evidence of these interagency collaborations, if the proposed study is dependent on them, must be provided in the proposal.

3.7 Additional Requirements for All Proposals

Proposers are advised to take great care to match their proposed activities to the research themes solicited (see Section 3) and the scientific goals (see Section 2) and programmatic considerations (see Sections 3.6.5 and 4.3-4.6) of each agency. Proposers are encouraged to contact the relevant agency point of contact listed in Section 5 if they have any questions regarding the appropriateness of or requirements for a particular type of study.

In addition to the requirements specified under each research theme in Sections 3.1-3.5 and the cross-cutting activities in Section 3.6 above, all proposals must adhere to the requirements detailed below.

3.7.1 *Error and Uncertainty*

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

3.7.2 *Project Management Plan*

Proposals must include a project management plan that presents a management structure describing roles and responsibilities for all Co-Investigators and Collaborators and how the research activities will be coordinated and integrated. The proposal budget section and proposal cover page must include budgetary information for all funded Co-Investigators. Involvement of students and postdoctoral scientists, where possible, is encouraged. The project management plan section should be inserted after the science and technical section of the proposal and does not have a page limit.

3.7.3 *Data Management Plan*

Research data obtained through public funding are a public trust. These data must be publicly accessible to be in compliance with the data policy of the U.S. Global Change Research Program of full and open access to global change research data (see http://www.usglobec.org/reports/datapol/datapol.usgcrp.html). Proposals submitted in response to this solicitation must include a data management plan describing the researcher's data sharing plan, if the proposed research involves the acquisition of data. This includes data from measurements, observations, and experiments and from model simulations that would be costly to duplicate. The description must include plans for sharing and disseminating the data that are to be acquired in the course of the proposed research, particularly how the acquired data will be preserved, documented, quality assured, and archived for access by others. It is not necessary to identify the archive in the proposal, but a process for determining the archive should be described. The data management plan must include, when relevant to the type of study being proposed, the types of data and data products or other materials to be produced in the course of the project and the standards to be used for data and metadata formats. The data sharing plan called for in section 2.3.5 of the NASA *Guidebook for Proposers* should be included in the data management plan. The data management plan section should be inserted after the Project Management Plan section of the proposal and does not have a page limit, unless otherwise specified within the program subelement.

Selected investigations also will be expected to comply with the data policy of the agency funding their study. The relevant agency data policies and archive descriptions that are now available online can be found at the following Web links:

NASA: http://science.nasa.gov/earth-science/earth-science-data/data-information-policy/ and http://earthdata.nasa.gov/data/data-centers
USDA-**NIFA**: http://nifa.USDA.gov/resource/data-management-plan-nifa-funded-research-projects
DOE: http://science.energy.gov/ber/funding-opportunities/digital-data-management/, http://cdiac.ornl.gov/, http://www-pcmdi.llnl.gov/ipcc/about_ipcc.php and http://ameriflux.lbl.gov/data/data-policy/

3.7.4 *Principal Investigator Meeting Attendance Required*

All Principal Investigators (PI) of proposals funded under this solicitation will be required to attend the PI meetings of the agency funding their project or another PI meeting designated by that agency. Travel funds should be budgeted to allow at least the lead PI to attend one PI meeting during each year of the project.

3.7.5 *Agency-Specific Requirements and Opportunities*

3.7.5.1 *NASA Requirements and Opportunities*

To be eligible for NASA funding, the proposed research must make substantial use of remotely sensed data from satellites or airborne platforms.

3.7.5.2 *USDA-**NIFA** Requirements and Opportunities*

3.7.5.2.1 USDA-**NIFA** International Partnerships

To be eligible for USDA-NIFA funding, projects must show relevance to U.S. agriculture and forestry. However, joint multilateral approaches can maximize the effectiveness of national efforts, develop the much needed expertise on mitigation for agricultural systems, and spread the knowledge gained and improved technologies resulting from international research cooperation and investment in mitigation practices and technologies. Thus, to attain USDA-**NIFA**'s goals for agriculture and forestry, applicants may include international partnerships and activities, as long as they clearly describe how the international activities proposed contribute to and support advances in the viability and sustainability of U.S. agriculture and forestry.

3.7.5.2.2 USDA-**NIFA** Restrictions on Indirect Costs

In addition, budgets for all USDA-NIFA funded projects must comply with USDA-NIFA restrictions on indirect costs and allowable expenses (see Section 4.3.3) or be willing to adjust budgets to comply with these restrictions upon being recommended for an award. Additional information can be found at http://nifa.USDA.gov/indirect-costs. Proposals funded by USDA-NIFA must show relevance to U.S. agriculture, including rangelands, forestry, food systems, or rural communities. Subcontracts to foreign institutions are allowed by USDA-NIFA, but cannot include salaries for regular employees of non-U.S. institutions.

3.7.5.2.3 USDA-**NIFA** Requirements for Responsible and Ethical Conduct of Research

In accordance with sections 2, 3, and 8 of 2 CFR Part 422, institutions that conduct USDA-**NIFA**-funded extramural research must foster an atmosphere conducive to research integrity, bear primary responsibility for prevention and detection of research misconduct, and maintain and effectively communicate and train their staff regarding policies and procedures. In the event an application to NIFA results in an award, the Authorized Representative (AR) assures, through acceptance of the award that the institution will comply with the above requirements. Award recipients shall, upon request, make available to NIFA the policies, procedures, and documentation to support the conduct of the training. See http://nifa.USDA.gov/responsible-and-ethical-conduct-research for more information.

3.7.5.2.4 USDA-**NIFA** Reporting Requirements

Grantees are to submit initial project information and annual summary reports to NIFA's electronic, web-based inventory system (see http://nifa.USDA.gov/tool/reeport) that facilitates both grantee submissions of project outcomes and public access to information on Federally funded projects. The details of these reporting requirements are included in the award terms and conditions.

3.7.5.3 *DOE Requirements and Opportunities*

Proposers should be aware that DOE is looking for proposals that pose their research goals, objectives, and approach in the context of representing terrestrial ecosystem processes in Earth system models. The emphasis on applicability to models can be accomplished through process research that specifies mechanisms for the incorporation of results into state-of-the-art process, ecosystem or Earth system models, by proposing direct improvements to such models or through synthesis activities that draw on existing data sets. This is not necessarily guidance to include modeling in every application, but rather to pose the questions in the context of identified (or previously unrecognized) needs for Earth system models as well as to propose a clear mechanism whereby the results of the proposed research would be made available to the modeling community.

3.7.5.4 *NOAA Requirements and Opportunities*

Projects in collaboration with NOAA scientists are highly encouraged.

NOAA seeks to fund studies only focused on U.S. landscapes and seascapes, with priority regions within the U.S. Exclusive Economic Zone (EEZ) up to and including polyhaline coastal environments.

4. Programmatic Information

All proposals will be submitted to a NASA-led peer review process in accordance with the guidelines provided in this solicitation and the *NASA Guidebook for Proposers*. NASA, USDA-**NIFA**, DOE, and NOAA will collaborate in the planning and conduct of the peer review. This peer review will be followed by a programmatic review in which NASA, USDA-**NIFA**, DOE, and NOAA program officers will assess program balance across the highly rated proposals and evaluate any logistical, implementation, cost, or management concerns. The NASA, USDA-**NIFA**, DOE, and NOAA program officers will recommend for selection the proposals that best address the objectives of this solicitation within resource constraints. The program officers will also recommend the division of funding responsibilities between the agencies consistent with each agency's mission (see Section 2 and the evaluation criteria in Section 4.2.2 below). Co-funding is possible, and NASA, USDA-**NIFA**, and DOE reserve the option of funding Co-Investigator institutions either as subawards of the Principal Investigator institution's award or as separate awards directly to the Co-Investigator institutions. The funding recommendations will be forwarded to each participating agency's Selection Official for confirmation. The Selection Official for NASA will be the Associate Director for Research, Earth Science Division. The Selection Official for USDA-**NIFA** will be the Assistant Director, Institute of Bioenergy Climate and Environment at the National Institute of Food and Agriculture. The Selection Official for DOE will be the Director, Climate and Environmental Sciences Division. The Selection Official for NOAA will be the Chief, Research Programs Division. NASA will announce the official selection of proposals for award, recognizing the agency or agencies that have agreed to be responsible for funding.

Proposals that USDA-**NIFA**, DOE, or NOAA have agreed to be responsible for will be forwarded to the appropriate agency for final negotiations and implementation of awards. Respondents selected for funding by USDA-**NIFA**, DOE, or NOAA will be required to submit additional documentation. Further information will be provided to applicants selected for funding by those agencies.

4.1 Evaluation Criteria

Proposals will be evaluated according to the criteria specified in Section C.2 of the NASA Guidebook for Proposers. In addition to the factors given there, the evaluation of intrinsic merit for a proposal shall consider the experience of the offeror (investigators and their institutions) in engaging in data sharing and providing timely access to data and research products on related and relevant projects.

The evaluation criteria (of approximately equal weight) that will be considered in evaluating a proposal are its relevance to NASA's, USDA-**NIFA's**, DOE's or NOAA's objectives; intrinsic merit; and cost reasonableness with respect to both time allocated for personnel as well as overall financial request. The failure of a proposal to be rated highly in any one of these elements is sufficient cause for the proposal to not be selected.

Also, the following factors will be applied:

4.1.1 *Relevance*

Evaluation of a proposal's relevance includes the consideration of all of the following factors:

(i) The potential contribution of the effort to NASA's, USDA-**NIFA**'s, DOE's or NOAA's mission as expressed in their most recent strategy documents and Section 2 of this solicitation.

(ii) The specific objectives and goals given in Section 3 of this solicitation.
(iii) The quality and completeness of the project management plan.
(iv) The quality and completeness of the data management plan.

4.1.2 *Merit*

Evaluation of intrinsic merit includes consideration of all of the following factors:

(i) Overall scientific or technical merit of the proposal. This includes the unique and innovative methods, approaches, or concepts, demonstrated by the proposal; the appropriateness and feasibility of the proposed methods or approaches; the clarity and delineation of objectives; the probability of success and risk-reward balance for the project; and the quality and appropriateness of the approach to characterizing uncertainties and quantifying errors.
(ii) Offeror's (i.e., proposing institution's) capabilities, related experience, facilities, techniques, or unique combination of these which are integral factors for achieving the proposal's objectives.
(iii) The qualifications, capabilities, and experience of the proposed Principal Investigator, team leader, or key personnel critical in achieving the proposal objectives.
(iv) Evaluation against the state-of-the-art. (Review panels are instructed not to compare proposals to each other; all comparative evaluations are conducted by agency program personnel.)

4.1.3 *Cost*

Evaluation of the cost of a proposed effort shall include the realism and reasonableness of the proposed cost, and the comparison of that proposed cost to available funds. Low cost, while desirable, does not offset the importance of realism and reasonableness of the proposed budget. Review panels evaluate cost realism and reasonableness; however, comparison of the proposed cost to available funds is performed by agency program personnel.

4.2 Programmatic Information Specific to NASA

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

NASA encourages use of the new NASA Earth Exchange (NEX) collaboration facility for large-scale global high resolution carbon cycle data analysis and modeling projects. Proposers should refer to Appendix A.1, Section 4.4, for additional information about NEX and the resources it offers. Proposals should include a section that justifies the need for using NEX, specifies the data storage and processing needs, and includes NEX in its data management plan. NEX resource availability will be considered during the proposal review and selection process. Additional constraints and requirements for proposals to use NEX are available at https://c3.nasa.gov/nex/resource_updates.

4.3 Programmatic Information Specific to USDA-**NIFA**

4.3.1 *Legislative Authority and Background*

Section 7406 of the Food, Conservation, and Energy Act of 2008 (FCEA) (Pub. L. 110-246) amends section 2(b) of the Competitive, Special, and Facilities Research Grant Act (7 U.S.C. 450i(b)) to authorize the Secretary of Agriculture to establish the Agriculture and Food Research Initiative (AFRI); a competitive grant program to provide funding for fundamental and applied research, education, and extension to address food and agricultural sciences. Grants shall be awarded to address priorities in United States agriculture in the following areas:

1. Plant health and production and plant products;
2. Animal health and production and animal products;
3. Food safety, nutrition, and health;
4. Renewable energy, natural resources, and environment;
5. Agriculture systems and technology; and
6. Agriculture economics and rural communities.

To the maximum extent practicable, the National Institute of Food and Agriculture (NIFA), in coordination with the Under Secretary for Research, Education, and Economics (REE), will make grants for high priority research, education, and extension, taking into consideration, when available, the determinations made by the National Agricultural Research, Extension, Education, and Economics Advisory Board (NAREEEAB) pursuant to section 2(b)(10) of the Competitive, Special, and Facilities Research Grant Act (7 U.S.C. 450i(b)(10)), as amended. The authority to carry out this program has been delegated to NIFA through the Under Secretary for REE.

AFRI encourages projects that coordinate with the USDA Climate Hubs (http://www.climatehubs.oce.USDA.gov/). The mission of the Climate Hubs is to develop and deliver science-based, region-specific information and technologies, with USDA agencies and partners, to agricultural and natural resource managers that enable climate-informed decision-making, and to provide access to assistance to implement those decisions. This is in alignment with the USDA mission to provide leadership on food, agriculture, natural resources, rural development, nutrition, and related issues based on sound public policy, the best available science, and efficient management.

AFRI encourages projects that develop content and programs suitable for delivery through the Cooperative Extension System's eXtension Initiative. Funds may be used to contribute to existing Communities of Practice (CoP) such as the Climate Forests and Woodlands Community of Practice, or to form a new CoP focused on content relevant to sustainable bioenergy systems and water resource management. Projects that choose to include the delivery of products through eXtension must align with the eXtension vision, mission, and values, and a letter of acknowledgement from eXtension is required. In addition, a letter of support may be required from one or more of the Communities of Practice. For detailed guidance on how to partner with eXtension, go to http://create.extension.org/node/2057.

4.3.2 *Eligible Applicants for USDA-NIFA Awards*

Eligible applicants for the program implemented under this subpart include: 1) State Agricultural Experiment Stations; 2) colleges and universities (including junior colleges offering associate degrees or higher); 3) university research foundations; 4) other research institutions and organizations; 5) Federal agencies, 6) national laboratories; 7) private organizations or corporations; 8) individuals who are U.S. citizens, nationals, or permanent residents; and (9) any group consisting of 2 or more entities identified in 1) through 8). Eligible institutions do not include foreign and international organizations. For questions regarding USDA **NIFA** eligibility, please contact the USDA-NIFA point of contact listed in Part 5.

4.3.3 *Funding Restrictions for USDA-NIFA Awards*

Allowable indirect costs are not to exceed 30% of Federal Funds awarded, equivalent to a maximum of 42.86% of total direct costs. For FY 2013 and 2014 appropriated funds, see Section 720 of the Agriculture, Rural Development, Food and Drug Administration, and Related Agencies Appropriations Act, 2012 (Division A of Pub. L. 112-55).

Funds made available for grants under the AFRI program shall not be used for the construction of a new building or facility or the acquisition, expansion, remodeling, or alteration of an existing building or facility (including site grading and improvement, and architect fees).

4.4 Programmatic Information Specific to DOE

4.4.1 *Eligibility*

All types of entities are eligible to apply for funding from DOE, except Federally Funded Research and Development Center (FFRDC) Contractors, and nonprofit organizations described in section 501(c)(4) of the Internal Revenue Code of 1986 that engaged in lobbying activities after December 31, 1995.

4.4.2 *Collaborations*

Multidisciplinary and inter-institutional collaborations are strongly encouraged to enhance and strengthen research capabilities as needed. Collaboration could include institutions such as universities, industry, nonprofit organizations, Federal agencies, and Federally Funded Research and Development Centers (FFRDCs), which include the DOE National Laboratories. Collaborations involving the DOE National Laboratories are permitted; however, the efforts must reflect specific and unique capabilities/expertise at the collaborating DOE National Laboratory. These financial collaborations should show clear scientific leadership from the submitting institution and reflect an appropriate level of effort from the DOE National Laboratory and should not exceed 10% of the budget except for pay-for-use situations (i.e., sample analysis).

4.5 Programmatic Information Specific to NOAA

Eligible applications for the program implemented under this subpart (NOAA Ocean Acidification Awards) should be responsive to the research goals detailed within the *Strategic Plan for Federal Research and Monitoring of Ocean Acidification* that are consistent with the priorities of the USGCRP detailed in Part 2. These goals include but are not limited to: the development of comprehensive models to predict changes in the ocean carbon cycle, oceanic carbonate-buffer systems, and impacts on marine ecosystems, ensure the ability to measure all required carbonic acid system parameters with adequate data quality, improve interdisciplinary monitoring or both the chemical changes and biological impacts resulting from ocean acidification, and examine species-specific and multi-species physiological responses including behavioral and evolutionary adaptive capacities.

5. Summary of Key Information

Expected program budget for first year of new awards	NASA: $6.3 M; USDA-**NIFA**: $1.67 M; DOE: $1 M; NOAA: $0.2M
Number of new awards pending adequate proposals of merit	NASA: 15-25; USDA-**NIFA**: 5-7; DOE: 2-3; NOAA: 1-2
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI) proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for Proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	January 1, 2017
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, USDA-**NIFA**, DOE, and/or NOAA	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. Proposals for other agency funding must address one or more of the agency-specific objectives listed in Section 2 of this Appendix.
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 Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.

Web site for submission 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	NNH16ZDA001N-CARBON
NASA point of contact concerning this program	Paula Bontempi Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1508 E-mail: paula.s.bontempi@nasa.gov
USDA-**NIFA** point of contact concerning this program	Nancy Cavallaro Global Climate Change Program National Institute of Food and Agriculture U.S. Department of Agriculture Washington, DC 20250-2241 Telephone: (202) 401-5176 E-mail: ncavallaro@nifa.USDA.gov
DOE point of contact concerning this program	Dan Stover Terrestrial Ecosystem Sciences Office of Science/Biological and Environmental Sciences U.S. Department of Energy Washington, DC Telephone: (301-903-0289) E-mail: daniel.stover@science.doe.gov
NOAA point of contact concerning this program	Dwight Gledhill Ocean Acidification Program National Oceanic and Atmospheric Administration 1315 East-West Highway, SSMC3 11355 Silver Spring, MD 20910 Telephone: (301) 734-1288 E-mail: dwight.gledhill@noaa.gov

A.6 BIODIVERSITY

NOTICE: NASA will not solicit research proposals under the Biodiversity program element in ROSES-2016. All currently available funds are committed to the support of awards selected through previous Biodiversity announcements.

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 how it is changing over 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* surveys, 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. Description of Solicited Research

There are no plans to solicit proposals under this program element in ROSES 2016.

3. 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
E-mail: woody.turner@nasa.gov

A.7 CARBON MONITORING SYSTEM: CONTINUING PROTOTYPE PRODUCT DEVELOPMENT, RESEARCH, AND SCOPING

NOTICE: November 18, 2016. This amendment adds a new opportunity for the Carbon Monitoring System program element, which had previously been designated as "TBD" in ROSES-2016. Notices of Intent to propose are requested by January 5, 2017, and proposals are due February 24, 2017. Proposers to this program element do not need to submit a data management plan via the NSPIRES cover pages, because the data management plan is part of the proposal and is included in the evaluation of Merit, see Sections 2.2.8 and 3.2.

1. Scope of Program

The NASA Carbon Monitoring System (CMS) is designed to make significant contributions in characterizing, quantifying, understanding, and predicting the evolution of global carbon sources and sinks through improved monitoring of carbon stocks and fluxes.

NASA's approach toward its contribution to a carbon monitoring system emphasizes exploitation of current and future satellite remote sensing resources, computational capabilities, integrated ecosystem and atmospheric modeling, scientific knowledge, airborne science capabilities, and end-to-end system expertise that are major strengths of the NASA Earth Science program. The emphasis has been on regional, national, and global satellite-based carbon monitoring products relevant to national needs for completely transparent carbon and biomass inventory processes that provide a robust statistical framework for reporting precision and accuracy in a geospatially explicit manner. Significant effort is being devoted to rigorous evaluation of the carbon monitoring products being produced, as well as to the characterization and quantification of errors and uncertainties in those products.

NASA's approach takes into account data and expertise that are the domain of other U.S. Government agencies and anticipates continuing close communications and/or partnerships with those agencies and their scientific and technical experts as U.S. national efforts toward integrated carbon monitoring mature, especially as coordinated through the Carbon Cycle Interagency Working Group of the U.S. Global Change Research Program (https://www.carboncyclescience.us/). NASA also recognizes a need for complementary local-scale (airborne and *in situ*) information to demonstrate quantitative remote sensing methods; to aid in scaling up from project, county, and/or state levels; and for essential evaluation of regional-, national-, and global-scale products. Such work is critically important for advancing Monitoring Reporting and Verification (MRV) system capabilities in support of Reducing Emissions from Deforestation and Forest Degradation (REDD, REDD+) in developing nations.

The current CMS activities take advantage of currently available space-based remote sensing observations like from the MODerate-resolution Imaging Spectroradiometer (MODIS) on Terra and Aqua, Landsat, and Orbiting Carbon Observatory-2 (OCO-2). Additionally, the current approach lays the groundwork for CMS-related applications of future NASA satellite sensors now in development (i.e., Global Ecosystem Dynamics Investigation (GEDI), Orbiting Carbon

Observatory-3 (OCO-3), Ice, Cloud, and Land Elevation Satellite-2 (ICESat-2), and the NISAR (NASA-Indian Space Research Organization L- and S-band synthetic aperture radars)).

In a first phase of activities, NASA initiated two CMS pilot studies and several scoping efforts focused on end-user utilization of satellite data:

- A Biomass and Carbon Storage Pilot Product
- An Integrated Emission/Uptake ("Flux") Pilot Product
- Scoping studies and research to understand the needs of end users and scope potential new carbon monitoring products

Since that time, multiple solicitations have been released to continue these activities. These solicitations can be found at:

ROSES-2011 CMS call at
https://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={DDC97177-454E-5B99-5CA9-EC6290FA6D52}&path=closedPast
ROSES-2013 CMS call at
https://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={3026BD1C-F069-382C-6FCE-A3A3BB156454}&path=closedPast
ROSES-2014 CMS call at
https://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={41E74515-E19D-72E5-3111-41FE7A816E29}&path=closedPast
ROSES-2015 CMS call at
https://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={596D5BFF-421D-5E5B-2B9C-C191EDCB0AFC}&path=closedPast

A NASA Carbon Monitoring System Science Team (CMS ST) has been established to 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 returns for science, management, and policy and providing scientific, technical, and policy-relevant inputs to help set priorities and directions for future NASA CMS activities, see Section 2.2.2.

Additional information on these initial activities, progress reports, the CMS ST, and links to available data and data products are provided at http://carbon.nasa.gov. The work conducted in this prototyping effort to date has leveraged the much larger investment currently made by NASA in remote sensing observations of carbon-related properties of the Earth system that are pertinent to understanding carbon stocks and fluxes, as well as to carbon cycle science and carbon management research.

2. Research Solicited

NASA requests proposals for investigations to advance the development of a carbon monitoring system. Emphasis is to be directed toward continued development of the established CMS pilot studies, acquisition, field sampling, quantification and development of prototype Monitoring Reporting and Verification (MRV; aka Measurement, Reporting and Verification) system capabilities which can provide transparent data products achieving levels of precision and accuracy required by current carbon trading protocols. NASA is also looking to advance previously initiated CMS work that will substantially contribute to the above activity. Successful applicants will become members of the NASA CMS ST.

2.1 Research Topics

NASA is interested in receiving proposals for the following types of prototyping, research, and scoping activities for carbon monitoring:

- Studies to produce and evaluate prototype monitoring, reporting and verification system approaches and/or calibration and validation data sets for future NASA missions, including, but not limited to, MRV work in support of REDD, REDD+, or SilvaCarbon projects.
- Studies that address research needs to advance remote sensing-based approaches to monitoring, reporting, and verification (e.g., quantification of forest degradation; independent assessment of the accuracy of airborne remote sensing observations of biomass and carbon stocks; use of airborne flux observations and satellite remote sensing, as alternative methods for quantifying net carbon emissions/storage).
- Studies that build upon, extend, and/or improve the existing CMS products for biomass and flux resulting from NASA's first phases of CMS pilot studies; such studies may include, for example, product improvements, refined characterization and quantification of errors and uncertainties, and/or preparation and delivery of a mature product for long-term archive at an established NASA DAAC or equivalent data center.
- Studies that can evaluate and enhance national reported carbon emissions inventories from bottom-up estimates from various sectors of emissions within the United States, and have the potential to be applied to reported national inventories from other nations.

Data from airborne and/or spaceborne remote sensing must be an essential element in all proposed investigations. All sources of remotely sensed data to be used must be justified in terms of their importance and appropriateness for the work to be conducted.

Proposals must explain the societal relevance of the proposed carbon monitoring activities 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 are strongly encouraged to address stakeholder interests in their studies and to contribute to CMS ST activities to understand and engage the user community for carbon monitoring products.

Many of the studies funded through the ROSES-2014 CMS solicitation (see above) will be expiring, while all the investigations funded in the ROSES-2015 solicitation (A.7; see above) have two more years until completion. Therefore, for this present solicitation, proposals to further develop or expand upon the funded ROSES-2015 activities are not as high a priority as the research topics listed above.

2.2 Additional Proposal Requirements

2.2.1 *Requirements Regarding the Duration of Award*

The scientific tasks of the ST members will be of no more than three years duration and proposers may not propose for 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 proposed ST member activities and contributions for one or more of the following:

- Representing concerns of the broad carbon monitoring community with respect to the nature, quality, and utility of NASA CMS products;
- Coordinating the proposal's CMS activities to ensure maximum returns and to 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 international organizations; and/or
- Providing scientific, technical, and policy-relevant inputs to help set priorities and directions for future NASA CMS activities.

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

2.2.3 *Carbon Monitoring System Science Team Leader*

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

Team Leader proposals should include a separate section of up to three additional pages in the Scientific/Technical/Management section that describes only the activities to be undertaken as CMS ST Leader and addresses the following aspects of team leadership:

- The carbon science, carbon management, and/or carbon policy qualifications and leadership skills of the proposing Team Leader;
- A clear articulation of the proposed Team Leader's vision for the NASA CMS and its contribution to science and society;

- The ability of the proposing Team Leader to represent CMS's overall goals and objectives to the broader community and to decision makers in need of carbon monitoring information; and
- A management plan that describes the approach to science team leadership, how interactions with the ST and NASA management will be conducted, and how science team business and meetings will be organized and conducted.

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

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

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

2.2.4 *Requirements for the Cost Plan*

Given the differing 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 may 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 annual budgets, even for the most ambitious of investigations, to exceed $500,000.

All proposals must include in their cost plans resources for activities to be 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 lasting three days each. For planning purposes, proposers should budget each year for one meeting in the western U.S. and one meeting in the Washington, D.C. area.

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

New proposals requiring data from airborne sensors must detail in their cost plan all costs for acquiring any new data sets, including costs for aircraft hours, deployment costs, mission peculiar costs, data processing costs, 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 are not NASA assets, 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 (click on "FLIGHT REQUEST"). This is required whether or not the request involves NASA sensors, platforms, and personnel because the flight request is used to help NASA to understand and track all of the airborne science it supports. Questions regarding the flight request system or process should be addressed to Marilyn Vasques, Flight Request Manager (Marilyn.Vasques@nasa.gov or 650-604-6120).

Since this solicitation allows the use of commercial airborne sensors and platforms, it is important to note that all such activities must be conducted according to NASA policies and procedures. All aircraft operations, including operations of commercially acquired aircraft, will be reviewed in accordance with NPR 7900.3 (http://nodis3.gsfc.nasa.gov/displayDir.cfm?t=NPR&c=7900&s=3C). At a minimum, this will include meeting NASA safety requirements.

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

CMS activities proposing airborne and *in situ* data acquisitions outside the U.S. (e.g., for REDD, REDD+, or SilvaCarbon projects) and/or cooperation with foreign institutions 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 or NASA sensors and/or involving NASA personnel in international work will be required to follow all NASA policies and procedures regarding such activities. In some cases, it may either be required or preferable that NASA take the lead in securing some or all of the 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.

Non-U.S. organizations participate in NASA funded research on a no-exchange-of-funds basis; NASA funds research at U.S. institutions and foreign agencies pay for research at foreign institutions. Proposers are advised to consult Section 1.6 of the NASA Research Announcement or Cooperative Agreement Notice Proposers' Guidebook for details (http://www.hq.nasa.gov/office/procurement/nraguidebook/).

2.2.7 *Requirements to Address Errors, Uncertainties, and Instrument Calibration*

Given the importance of MRV 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, as well as with analytical approaches, model results, and/or scientific interpretations. It is equally important that instrument calibration be documented and traceable so that different types of data and data products can be intercompared with a high degree of confidence. Therefore, all proposals submitted in response to this solicitation must describe how errors and uncertainties will be addressed within their research project, including, if relevant to their study, those 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 must describe their calibration, accuracy, and traceability.

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/). 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. The data management plan should 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. This data management plan also satisfies the Guidebook requirement for a "data-sharing plan." For new data products proposed, 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 2017 funding provided for continuing CMS efforts, $6.3M is committed to ongoing competitive research commitments from prior years. Therefore, $3.7M in FY 2017 is available to support new research under this solicitation.

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 take into account the following additional considerations:

- 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 evaluated relative to the text in this program element, especially Sections 1 and 2.1. This includes the relative priority of the activities proposed for support of carbon monitoring-related decision making, including societal relevance.

4. Summary of Key Information

Expected program budget for first year of new awards	$3.7M

Number of new awards pending adequate proposals of merit	~10-15
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*
Due date for Proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*
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 pp; 3 extra pages are permitted for team leader proposals. 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 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	NNH16ZDA001N-CMS

NASA points of contact concerning this program	Kenneth W. Jucks Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Tel: 202-358-0476 Email: Kenneth.W.Jucks@nasa.gov Hank Margolis Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-4760 E-mail: Hank.A.Margolis@nasa.gov Kathleen Hibbard Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0245 E-mail: Kathleen.A.Hibbard@nasa.gov

A.8 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.

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. Here NASA is looking for work that cuts across multiple variables and focuses on the ocean's role in climate.

An emerging area of increased emphasis in NASA's Physical Oceanography program is research on the coastal ocean. While NASA's focus will remain 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.

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

- Analysis and interpretation of the ocean circulation using satellite and *in situ* data. NASA will support modest proposals undertaking analysis of satellite altimetry, surface wind stress, and other relevant data in support of the U.S. CLIVAR Program (http://www.usclivar.org). 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. Also, since 2016 is the first year of a new multiyear International Indian Ocean Expedition-2 (IIOE-2; http://scor-int.org/IIOE-2/IIOE2.htm) NASA will take the opportunity to encourage some proposals that may contribute satellite data analysis expertise to IIOE-2.

- Development of new 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.

2. Programmatic Information

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

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 by NASA's Global Modeling and Analysis Program (Program Element A.13 of ROSES-2016) thus NOT considered a priority for Physical Oceanography Program funding.

Based on the quality of proposals received, awards will be distributed across the two 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 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	1 January 2017
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 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	NNH16ZDA001N-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 E-mail: eric.j.lindstrom@nasa.gov

A.9 OCEAN SALINITY SCIENCE TEAM

1. Scope of Program

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.

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's Aquarius satellite (http://aquarius.nasa.gov) completed a nearly four-year mission (June 2011-June 2015), providing global measurements of sea surface salinity (SSS). SSS are also being retrieved from NASA's Soil Moisture Active-Passive (SMAP) satellite (http://smap.jpl.nasa.gov/; launched in January 2015) to provide continuity of NASA's SSS measurements. Version 1 of the SMAP SSS product is slated for public release in January 2016. These data products are complemented by SSS measurements from the European Space Agency's Soil Moisture and Ocean Salinity (SMOS) mission and by *in situ* salinity measurements (e.g., from the Argo array of profiling floats). NASA has also supported two major SSS process studies under the name of Salinity Processes in Upper Ocean Regional Studies (SPURS; http://spurs.jpl.nasa.gov/). SPURS investigators and science are also part of the Ocean Salinity Science Team.

Previous announcements for the OSST (in 2009, 2012, and 2013) have emphasized the calibration/validation and production of SSS products from Aquarius, as well as applications of Aquarius SSS products for ocean science investigations. The current announcement solicits proposals that address the following topics.

1. Exploitation of NASA satellite SSS measurements to investigate SSS variability, its influence on ocean circulation, and the linkage with climate and water cycle.
2. Synergistic use of NASA SSS measurements with other satellite and *in situ* measurements (including salinity measurements from SMOS and Argo, as well as satellite measurements of other oceanic parameters) for the aforementioned science investigations.
3. Evaluation and improvement of Aquarius and SMAP SSS products. The Aquarius Project is working to produce Version 5.0 of mission data set by 2017. There is still much to be learned and improved in the Aquarius retrievals. Likewise, salinity retrievals from SMAP are scheduled for initial public release in early 2016, and much work will be required to evaluate and improve these products. Also, work to assure the continuity and consistency of the SSS products across the two missions is a high priority.
4. Near-surface salinity stratification (in the upper few meters) and the underlying physical processes continue to need attention. *In situ* upper ocean salinity measurements and remote sensing of sea surface salinity sample different levels of the water column.

Precipitation and evaporation drive near surface salinity signals. Assimilation of SSS data into global models remains a challenge because of unresolved physics in the near surface layer.

2. Programmatic Information

Total funds available for work selected under this solicitation are approximately $2M per year for three years.

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. It is expected that all proposals will use satellite SSS in a fundamental way (so that it is not perceived to be peripheral to the proposed work).

Based on the quality of proposals received, awards will be distributed across the four 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	~ $2.0M
Number of new awards pending adequate proposals of merit	~ 10-15
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	1 April 2017
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 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	NNH16ZDA001N-OSST
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 E-mail: eric.j.lindstrom@nasa.gov

A.10 SEA LEVEL CHANGE SCIENCE TEAM

1.0 Background

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. 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.

Changes in sea level already impact coastal communities through erosion, storm surge, saltwater intrusion, and other effects. Projections of future rise have even more dramatic implications, with relatively small rises potentially displacing millions of people. Though the sources of sea level rise are generally known, the specific details of steric and nonsteric contributions are poorly constrained, as is the regional variability that is subject to a myriad of influences, such as ocean currents, lithospheric motions, and global gravitational effects.

The processes involved are difficult to observe, dynamic, and nonlinear with lengthy lags between forcing and response, and involve all of the major components of the Earth system. Satellite records offer important observations of many aspects of these systems. Radar altimetry has been used to measure rise directly and characterize its spatial variability. Gravitational measurements have been used to measure mass change in the ice sheets and oceans. Laser altimetry, Interferometric-Synthetic Aperture Radar (InSAR,) and the Global Positioning Satellite (GPS) have been used to characterize dynamic aspects of ice loss. As well, NASA's data, modeling and research programs have all contributed to various aspects of this research including programs in Interdisciplinary Sciences; Making Earth System Data Records for Use in Research Environments (MEaSUREs), Advancing Collaborative Connections for Earth System Science (ACCESS), Modeling and Assimilation, geodesy, Earth Surface and Interior, Physical Oceanography and Cryospheric Sciences.

Interpreting both the current rise and projecting the future rise relies on the results of active research that is undergoing rapid development, and there is a critical need for an updated set of best estimates of rise and other relevant information.

2.0 Scope of Program

This program is intended to integrate research results, data sets, and model output 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 the general public.

It is focused on the following objectives. These objectives were chosen as areas critical to improved understanding of sea level change, but lacking adequate support:

1. Characterizing current changes in sea level: Global and regional sea level projections that extrapolate from satellite and contemporary observations
2. Characterizing underlying processes and improving predictions of regional variations in sea level

3. Improving knowledge of ice mass change that specifically improves estimates of current and future sea level rise
4. Integrating these results into better forecasts of sea level rise.

NASA would like to receive proposals of an interdisciplinary nature addressing some or all of these objectives.

Improving our understanding of regional fluctuations in sea level requires the inclusion of regional tectonic, geodynamic, oceanographic, hydrologic, and cryospheric processes that affect sea level. Advances in monitoring and projecting sea level rise are closely coupled to improving determinations of geoid changes to 0.05–0.1 mm/yr and changes in the position of the solid-Earth's surface to 0.5–1.0 mm/yr. This call seeks to improve the spatial resolution in our sea level models, coupled to these underlying improvements in constraining ice mass change, sea-surface heights, and vertical deformation. Regional differences in sea level rise depend on the local coastal geomorphology, bathymetry, ocean currents, regional climate and weather, as well as global and regional geoid changes. To understand the impact of sea level change on coastal habitats and populations, it is imperative to understand the local, regional, and global drivers of change. Sea level change models with regional resolution can serve as guides for the development of public policy and investments in regional adaptation. However, the driving processes and impacts of regional sea level change remain in development. Measurements indicate that global sea level rise is accelerating, and, therefore, we must strive to develop reliable models with regional resolution to estimate the impact of future inundation upon our populations. This announcement seeks to develop more accurate regional sea level rise predictions. These models should also provide probabilistic estimates of accuracy so as to properly present this information to the public and decision-makers.

For objective 3, current interpretations of ice mass change indicate that ice-ocean interaction and ice surface mass balance are important factors controlling contributions to eustatic sea level rise. Proposals are encouraged that couple work on these topics with atmospheric and oceanographic models. Such work should be framed to offer new constraints of global relevance that allow remote sensing data to be used to estimate and project current and future sea level rise. Proposals regarding mountain glaciers and smaller ice caps, as well as the ice sheets of Antarctica and Greenland, will all be considered, but must be framed to be of significance to sea level rise.

High-quality science information on global and regional sea level rise is increasingly becoming important for scientists, policy makers and to inform the general public. NASA will support the continued operation and maintenance of the sea level rise web portal (https://sealevel.earthdata.nasa.gov/) to support these communities with engaging tools and science content. Current capabilities for presenting information on sea level rise will be improved by integration of new scientific results into existing online analysis tools and other services. Proposals to this solicitation must include a plan to present their work and results via NASA's sea level change portal.

2.1 Coordination and Team Composition

The Sea Level Change Team is imagined to consist of four to five interdisciplinary research teams and a web portal science coordination team selected through this announcement.

The web portal science coordination team will work across all program elements to convey the results of research and create tools that interact directly with data and model output. This interdisciplinary team will be responsible for working closely with other program elements, NASA supported scientists and external organizations. The team will also work closely with the Earth Science Data and Information Systems (ESDIS) Project at NASA Goddard Space Flight Center (GSFC). The ESDIS Project will operate and maintain the previously developed Sea Level Change Team web portal at https://sealevel.nasa.gov. New tools and content developed by the web portal science coordination team will be compatible with the existing sea level rise portal. The ESDIS project will provide support to the portal coordination team for integrating new portal capabilities into the existing system, see https://earthdata.nasa.gov/files/EarthdataIntegrationQuickReference_v1-2_Final .docx

It is envisioned that an overall Team Leader for the entire Sea Level Change team will be selected from among the selected investigators. The leader's primary role will be to foster integration of results and organize annual meetings of the team. Proposers interested in being considered as the Team Leader must indicate their candidacy by answering the relevant cover sheet question and including a separate Team Leader section within their proposal (no more than two extra pages) and budget.

3.0 Proposal Details, Review and Award Information

3.1 Specific Information required in the proposal

This solicitation has a number of specific requirements that must be addressed, as follows:

3.1.1 *Addressing Objectives*

Proposed activities must address two or more of the objectives listed in Section 2, the scope of program. The proposal summary must discuss the objectives to be addressed. Proposal that do not specifically address two or more of these areas will be considered non-responsive.

3.1.2 *Communication of results via the portal*

Proposers are expected to work closely with the portal team to ensure results can be effectively communicated and integrated into the Sea Level Rise web portal. Proposers will be responsible for providing updates to the portal team on research progress, relevance, and results. Each proposal must present a plan for interacting with the portal team, including a schedule of deliverables. The portal team must present a plan for how it will work with other program elements, including the ESDIS project.

3.1.3 *Major fieldwork strongly discouraged*

Proposals involving major fieldwork are strongly discouraged. However, innovative approaches based on remote sensing that require small field programs will be considered. For minor amounts of fieldwork relevant to remote sensing work in Greenland or Antarctica, obtain a cost estimate for your fieldwork via the mechanisms described in the National Science Foundation's Division of Polar Program's research solicitations (http://www.usap.gov/proposalInformation/) or NASA's Airborne Sciences Program (https://airbornescience.nasa.gov/program/research-opportunities). A copy of the summary costs must be included with your proposal.

3.1.4 *Data and Information*

Data, model results and other information created for this proposal 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. Data and model results will be archived at a NASA Distributed Active Archive Center (DAAC) in formats that can be readily used for a range of research needs and ingested into ice sheet, climate, and other models in gridded formats. Metadata standards for products submitted to DAACs are located with the portal information page https://earthdata.nasa.gov/user-resources/standards-and-references.

All software along with source code for the web portal development element will be released to the Earth Science Decadal Survey (ESDS) code repository (https://ecc.earthdata.nasa.gov/) and is subject to the NASA Earth Science Alternate Data Rights language to be included into Cooperative Agreements for Projects selected (http://science.nasa.gov/earth-science/earth-science-data/data-information-policy/data-rights-related-issues/).

3.2 Proposal Evaluation

Proposed research investigations must also meet all of the following criteria, and each of these should be specifically addressed in the proposal:

- Work be based on remote sensing data, especially satellite observations but including sub-orbital sensors as appropriate;
- Investigation-wide plan to communicate results via the portal.
- Management plans and milestones that are appropriate to the investigation. Proposals developing significant new datasets must include a data management plan.

NASA expects to have a unified peer review. Most favorable consideration will be given those proposals that can integrate work on the objectives and interact constructively with the web portal.

3.3 Award Type and Funding

The vehicles for projects selected through this solicitation will be a combination of grants, contracts and Cooperative Agreements (CA) depending on the nature of the project. Most awards to nongovernmental organizations will be grants or cooperative agreements. Proposers who are seeking contracts should see Appendix D of the *NASA Guidebook for Proposers* and Section 3 "Choice of Award Instrument" of the *Grant and Cooperative Agreement Manual* for guidance.

It is anticipated that one portal maintenance project will be selected and all projects will be expected to work with that project.

4. Programmatic Information

Results from investigations supported under this ROSES element are expected to advance the goals that are articulated in NASA's Science Strategy (http://science.nasa.gov/about-us/science-strategy/), as well as a number of Presidential Mandates and associated Federal research objectives, such as the National Ocean Policy (http://www.whitehouse.gov/administration/eop/oceans/policy) emphasis on Arctic change and the U.S. Global Change Research Program (http://www.globalchange.gov/) and both its strategic plan (http://globalchange.gov/what-we-do/strategic-planning), which address aspects on understanding the role of glaciers, ice sheets and sea ice within the Earth system, and Climate "tool kit" (http://toolkit.climate.gov/), which makes specific reference to sea level and sea level rise.

5. Summary of Key Information

Expected program budget for first year of new awards	~ $3M
Number of new awards pending adequate proposals of merit	~ 5-6
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	1 May 2017
Page limit for the central Science/Technical/Management section of proposal	15 pp; See also Chapter 2 of the *NASA Guidebook for Proposers*. 2 additional pages for team lead proposals. See the last bullet of Section 2.1
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 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	NNH16ZDA001N-SLCT
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 E-mail: eric.j.lindstrom@nasa.gov

A.11 OCEAN SURFACE TOPOGRAPHY SCIENCE TEAM

NOTICE: March 24, 2016. The summary table of key information has been changed to indicate that the maximum duration of awards is four years, consistent with the text. The due dates remain unchanged.

1. Scope of Program

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 for Jason-3, a cooperative mission between NASA, CNES, NOAA, and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT). Preparations are also underway to support the follow-on for Jason-3 – the Jason-CS missions, where the European Space Agency (ESA) will join as a partner and the Jason-series will become part of the Sentinel-series of environmental monitoring satellites. Jason-CS will also be known as Sentinel-6.

Eight research topics solicited for the 2017-2020 funding cycle include:

- To support studies in physical oceanography utilizing Jason-series mission data, as well as the combined ~20-year TP/Jason/Jason-2/Jason-3 data, preferably jointly with other satellite and *in situ* data and/or models, in support of both basic research and operational applications. Analyses of the full altimetric time series (from 1992) are now capable of resolving the large-scale redistribution of heat and mass in the upper ocean, and exchanges with the atmosphere and cryosphere can be explored in combination with other data sets. Such projects may cover a wide range of studies of coastal, open ocean, and polar processes, including intraseasonal-to-interannual variability, global mean and regional sea level variations, ocean circulation, low-frequency tides, gravity waves, wind/wave generation, etc. (NASA, NOAA)

- To support studies of high-resolution merged altimetric data sets (including, but not limited to, the Jason-series, as well as other altimetry missions, such as ESA's Environmental Satellite (ENVISAT), Cryosat-2, Satellite with ARgos and ALtiKa (SARAL), Haiyang-2A, Sentinel-3, and Jason-CS/Sentinel-6 noting however that data access for those missions has to be secured by the investigators directly with the space agencies in charge of those programs). Such projects may examine the roles of mesoscale eddies and western boundary currents in the general circulation of the ocean, and Arctic Ocean circulation, among other topics. It is expected that such studies will be pathfinders in preparing for scientific analysis of next-generation, wide-swath altimetric measurements such as the NASA/CNES Surface Water Ocean Toppgraphy Mission and delay-Doppler SAR measurements from Sentinel-3 and Jason-CS. (NASA, NOAA)

- To complete comparison studies between and among Jason-series missions. This includes details on the Precise Orbit Determination (POD) assessment, role of the water vapor correction as provided by the passive microwave radiometers (including assessment of cold-sky pitch calibrations), the influence of other corrections (ionosphere, sea-state bias, barotropic effect), and a precise and comprehensive characterization of the errors involved in Jason altimeter measurement, including those that affect estimates of global mean sea level. This also includes development and assessment of new geophysical algorithms and/or models likely to improve the quality of the data. The error budget for Jason-3 must be completed relative to our updated knowledge of Jason and OSTM/Jason-2, based upon a comprehensive analysis of all of the intercalibration/validation measurements during the coincident orbit phase and after. This error evaluation will also serve in the analysis of the respective data streams of the mission. Both follow-on studies and new proposals that identify needed error analyses are anticipated in this category. (NASA)

- To explore operational applications of satellite altimetry for near real-time to interannual weather warnings and forecasts. These include but are not limited to hurricane intensity forecasting, wind/wave monitoring, coastal inundation/storm surge, search and rescue, tracking harmful algal blooms, oil exploration and operations, oil spill mitigation, coastal currents, fisheries, as well as seasonal-to-interannual prediction, including ENSO. (NOAA)

- To investigate the use of gravity mission data together with altimeter data for improving the understanding of the mean ocean circulation and barotropic variability. (NASA)

- To contributed scientific expertise to the calibration and validation of the baseline measurement of the Jason-3 mission, to develop and assess dedicated techniques, in particular taking advantage of the possible overlap of Jason-2 and Jason-3 or by proposing palliative methods if there is no overlap, including comparisons with other altimeter missions and tide gauges. (NASA)

- To support complementary studies on extreme sea level and coastal inundation, ice sheet and sea ice monitoring, lake and inland water studies, large river mouth survey, marine geoid and bathymetric studies. Such studies can use altimetry, but also additional data including the accurate geodesic point positioning provided by the highly performing POD systems (Doris, GPS, laser) on T/P, Jason-1, -2, and -3. (NASA, NOAA)

- To contribute scientific analysis and expertise to the preparation of future altimetry missions, particularly Jason-CS/Sentinel-6. (NASA)

2. Programmatic Information

All proposals will be submitted to a NASA-led peer review process in accordance with the guidelines provided in this solicitation and the *NASA Guidebook for Proposers*. NASA and NOAA will collaborate in the planning and conduct of the peer review. This peer review will be followed by a programmatic review in which NASA and NOAA program officers will assess program balance across the highly rated proposals and evaluate any logistical, implementation, cost, or management concerns. The NASA and NOAA program officers will recommend for selection the proposals that best address the objectives of this solicitation within resource constraints. The program officers will also recommend the division of funding responsibilities between the agencies consistent with each agency's mission. The funding recommendations will be forwarded to each participating agency's Selection Official for confirmation. The Selection Official for NASA will be the Associate Director for Research, Earth Science Division. The Selection Official for NOAA will be the Director of the NESDIS Center for Satellite Applications and Research (STAR). NASA will announce the official selection of proposals for award, recognizing the agency or agencies that have agreed to be responsible for funding.

Proposals that NOAA has agreed to be responsible for will be forwarded to NOAA for final negotiations and implementation of awards. Respondents selected for funding by NOAA will be required to submit additional documentation. Further information will be provided to applicants selected by NOAA.

Total funds available for work selected under this solicitation are approximately $4.0M per year for four years.

Based on the quality of proposals received, awards will be distributed across the 8 research themes identified in Section 1. Proposals outside these research themes may be considered but must be highly meritorious.

3. <u>Summary of Key Information</u>

Expected program budget for first year of new awards	NASA: ~ $3.5M; NOAA: ~$0.5M
Number of new awards pending adequate proposals of merit	NASA: ~ 15-20; NOAA: ~3
Maximum duration of awards	~~3~~ **4** years **[Corrected March 24, 2016]**
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	January 1, 2017
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 and NOAA	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. Proposals for NOAA funding must address one or more of the agency-specific objectives listed in NOAA's Next Generation Strategic Plan (http://www.noaa.gov/ngsp).
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 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	NNH16ZDA001N-OSTST
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 E-mail: 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 E-mail: laury.miller@noaa.gov

A.12 OCEAN VECTOR WINDS SCIENCE TEAM

NOTICE: Ocean Vector Winds Science Team (OVWST) will not be competed in ROSES-2016. The OVWST is tentatively scheduled to next solicit proposals in ROSES-2017.

The Ocean Vector Wind 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. This element was last competed in 2013 and is anticipated to be open again in ROSES-2017.

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

For information on this program, contact:

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A.13 Modeling, Analysis, and Prediction

1. Overview

NASA's Science Mission Directorate (SMD) supports a broad portfolio of research in the Earth Science Research Program. Key questions that drive the core research efforts of the Earth Science Division within SMD include:

- How is the Earth system changing?
- What are the sources of change in the Earth system and their magnitudes and trends?
- How will the Earth system change in the future?
- How can Earth system science improve mitigation of and adaptation to global change?

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.

2 Background

MAP funds two primary projects and/or functional organizations that comprise the core activities of the program. These efforts are:

NASA Goddard Institute for Space Studies (GISS http://www.giss.nasa.gov/projects/gcm/). GISS engages in research on global Earth system change occurring on the decadal to centennial timescales. GISS makes use of analyses of comprehensive global datasets and develops and utilizes integrated global models of the Earth system. The research includes the study of paleoclimate and the study of other planets as an aid to prediction of future evolution of Earth on a planetary scale. GISS has a long-term involvement in the Coupled Model Intercomparison Project (CMIP) that forms the basis of International Panel on Climate Change (IPCC) assessments of climate change. The primary GISS modeling tool supported by the MAP program is the GISS Model E (http://www.giss.nasa.gov/tools/modelE/), a coupled atmosphere-ocean Earth system model (ESM).

NASA Goddard Global Modeling and Assimilation Office (GMAO: http://gmao.gsfc.nasa.gov). GMAO addresses the optimal use of satellite and *in situ* observations to generate research quality data sets for analyses and reanalyses, and also for weather, climate, and air quality forecasts. The modeling and assimilation research includes coupling to and assimilation of atmospheric aerosols and chemistry and ocean biology and carbon. GMAO focuses on developing and maintaining world-class data assimilation systems in order to maximize satellite data utility and serve as a centralized resource for testing and validating as wide a range of modeling and observational efforts as possible. The goal is to undertake modeling and assimilation as components of an end-to-end process, from defining an instrument, characterizing its in-flight performance, through to the development of algorithms and forward models for data assimilation, integrating the data into assimilation products, and finally assessing the impact of the data on the products of the assimilation system. GMAO is supported by MAP to develop and utilize the Goddard Earth Observing System, version 5 (GEOS 5). GEOS 5 includes both a coupled atmosphere-ocean GCM and a data assimilation system (DAS). More information is available at: http://gmao.gsfc.nasa.gov/systems/geos5/.

MAP also funds several smaller but still substantial projects that further core program interests. These efforts include:

NASA Global Modeling Initiative (GMI: http://gmi.gsfc.nasa.gov/). GMI develops, maintains, and utilizes a state-of-the-art modular global 3D chemistry and transport model (CTM) that includes full chemistry for both the troposphere and stratosphere, as well as a coupled representation of stratospheric aerosols. The GMI model serves as a testbed for different meteorological fields, emissions, chemical mechanisms, deposition schemes, and other processes determining atmospheric composition, both gas-phase and aerosols. In this role, GMI seeks to understand and constrain the uncertainties in model results through intercomparison of simulations and testing with observations. Since many of these processes are included in general circulation models (GCMs), GMI is also a tool to expand the parameter space in sensitivity studies and test the parameterizations in GCMs with measurements of atmospheric composition.

NASA Unified Weather Research Forecast Model (NU-WRF: http://nuwrf.gsfc.nasa.gov). The NU-WRF model is an effort to unify the Weather Research and Forecasting (WRF) model, a next-generation multiagency supported mesoscale NWP system, with NASA's existing weather models and assimilation systems, such as GEOS-5 and the Land Information System (LIS). Several parameterizations of physical processes developed by NASA scientists have been implemented into NU-WRF to better represent/simulate cloud/aerosol/precipitation/land surface processes. The goals for this effort are to robustly connect the global scale to the regional and mesoscale, while maintaining the focus on comprehensive Earth system modeling, as well as the use of NASA high-resolution satellite data for research into short-term climate, weather, and integrated Earth system processes.

3 Modeling, Analysis, and Prediction Research Themes

The specific research themes included in this Modeling, Analysis, and Prediction (MAP) solicitation are listed here, to be addressed using available and anticipated observations as discussed in section 4 below. . The approximate number of proposals MAP expects to fund in each area are listed in parenthesis.

- Clouds in Earth System Models: Representations of clouds and cloud systems in Earth system models (ESMs), particularly global ESMs, remain a large source of uncertainty. This situation is exacerbated by efforts to increase resolution in models toward the cloud-permitting regime, where parameterized and explicitly represented cloud processes can coexist. Proposals addressing cloud processes and their representation in ESMs are requested. Topics of special interest include proposals to improve the representation of low clouds in ESMs, which are important to climate sensitivity, and deep convective clouds and their role in the water cycle. MAP also seeks proposals to investigate the role played by clouds in driving atmospheric circulation patterns, connecting across length scales from local to regional to global. Studies which outline a path to implementable improvements in current model representations of clouds and cloud-related processes or new parameterizations are requested, including the cloud-permitting length scales and nonhydrostatic assumptions. (~6 proposals)
- Advanced Methods for Model Evaluation: Evaluation of ESMs is complicated by the fact that simple comparisons of model variables to corresponding observations often do not identify the specific model process or processes that govern model/measurement discrepancies. Advanced diagnostic methods are needed and requested here which can identify deficiencies in specific processes and suggest a path for improved representation. Also, it is often the case that changes to modeled processes which improve the agreement between a modeled variable and a corresponding observation degrade the agreement in other situations and for other variables. Therefore, evaluation procedures which more comprehensively evaluate the representativeness of a model and can foster a more sophisticated and systematic approach to model improvements are requested. It is preferred that the diagnostics developed here be applied to NASA supported models or model output, including the Modern Era Retrospective-Analysis for Research and Applications 2 (MERRA2) reanalysis products. Preference will also be given to advanced diagnostics developed in support of the upcoming sixth Coupled Model Intercomparison Project (CMIP) exercise. Please also note the existence of a related element in appendix A.29, "NASA Data for Operation and Assessment," section 2.3.2, "Methodologies for Climate Model Improvement." (~3 proposals)
- Extremes in the Earth System: Extreme events such as hurricanes and other intense storms, floods and droughts, heat waves and outbreaks of intense cold can cause great damage and are the subject of much concern in the context of climate change. Key questions are whether these extreme events are represented well in Earth system models, in terms of structure, intensity and frequency of occurrence. Proposals are solicited to evaluate the degree to which these phenomena and their impacts are properly represented in Earth system models and understand the interconnections in the Earth system which result in the extreme behavior. (~4 proposals)
- Constituents in the Climate System: Constituents in the atmosphere (aerosols and chemical species) will respond to climate change, and changes in constituent concentrations can have climatic consequences as well. A MAP program goal is to expand our understanding of the role of atmospheric constituents (aerosols and chemical species) in the context of the climate system, as well as utilization of constituent observations to better understand global

processes and their model representation. Proposals are sought to understand the role of climate change on atmospheric constituent distributions, and the influences of constituent change on climate. This area includes proposals that address emissions parameterizations, specifically the development and implementation of physically-based interactive emissions parameterizations which can respond to climate change and other sources of variability in the Earth system. (~6 proposals)

- Coupling in the Earth System: A long-standing goal of the MAP program is developing an understanding of the Earth as a complete, dynamic system. Such an understanding would be reflected in Earth system models that accurately capture the couplings between its different interacting components. Therefore, investigations are solicited which lead to an improved understanding and representation of the interactions between different Earth system components - such as land-atmosphere, ocean-atmosphere, or the interaction of the cryosphere with other components. An additional important component of the MAP program related to coupling includes interaction of processes across spatial scales from local to global or short and long time scales. Proposals that address scale interactions are also solicited here. (~5 proposals)
- Assimilation: A long-term goal of the MAP program is the development of an Integrated Earth System Analysis (IESA) capability. IESA is the process of consistently combining all available observations of the Earth System (atmosphere, ocean, land surface, sea-ice, and biogeochemistry) at some time with a model of the Earth System in such a way to produce a best estimate of the state of the Earth System at that time. This capability is not currently available given the start-of-the-art in modeling the global Earth System and the high computational requirements necessary for such a task. This solicitation seeks proposals that are directed at addressing outstanding assimilation issues and methods for assimilating new NASA observations that are not currently assimilated in NASA data assimilation systems. (~4 proposals)
- Predictability in the Earth System: The MAP program has an interest in understanding the behavior and evolution of the Earth system on timescales spanning the weather timescale of hours to days up to multidecadal time periods. Prediction over these timescales switches from an initial value problem at the short time scales to a boundary value problem at the long end. Consequently, NASA currently is a partner in a multiagency activity with a stated goal of developing an "Earth System Prediction Capability" (ESPC), to improve our national capability for Earth system prediction (http://espc.oar.noaa.gov). Proposals specifically addressing prediction and predictability, preferrably at subseasonal to interannual time scales, are requested in support of developing the ESPC. (~3 proposals)

4. Programmatic Priorities

Characterizing the limits of validity of models and model components and identifying the sources of uncertainties is important to realizing the goal of enabling whole Earth system models. Therefore, preference will be given to proposals that: 1) characterize and/or help reduce uncertainties in the models and products; 2) extend the range of model or product validity by using new components; 3) exploit these products to address NASA Earth Science Division (ESD) research questions; 4) are in alignment with the goals and objectives of the core MAP elements described above; and 5) enable independent community validation and characterization of the core MAP elements leading to improvement of the models or products. Proposals must explicitly discuss the observations that will either be used in the proposed investigation (including the manner of their use), or whose use will be facilitated by the proposed investigation. Preference will be given to proposals utilizing or enabling analysis of NASA satellite and suborbital observations. A discussion of how the proposed investigation will interact with or inform the core modeling efforts discussed in Section 2 is also required.

Note also that programmatic balance is an important consideration. Approximate numbers of proposals that are expected to be selected in each area are shown in Section 3. To achieve this balance, it may be the case that some high-ranking proposals may not be selected in areas that are significantly overweighted. However, even though approximate numbers of proposals for each area are given as a guide in Section 3, this solicitation does not guarantee the selection of at least one proposal for every topic (in the case that there are no proposals of sufficient merit for that topic), nor does it guarantee that any of the topics will be limited by the number shown.

New model components that are proposed shall be Earth System Modeling Framework (ESMF) compliant and make use of ESMF utilities where appropriate. A discussion of the software engineering aspects of the proposed work should be included in the proposal. Components shall be "seamless" in the sense that they are capable of spanning the weather to climate continuum of time scales. Proposals to develop and implement new parameterizations in MAP-supported models should demonstrate awareness of the parameterization to be replaced (if there is one), the code that implements it, and how it interacts with other parts of the model. They should discuss why the new parameterization is expected to improve model simulations relative to the existing parameterization, include an implementation plan, and propose observationally-based metrics based on NASA data that will diagnose the improvement. They should discuss the nature and extent of the interaction with the core model team. Proposals for new model component capabilities must include an evaluation activity that characterizes its limits of validity by comparing to observational data. In all cases, the proposer must explain how the validation methodology will help identify the source of uncertainty within the model or analysis product. Proposals for new or improved model components for NASA MAP supported models and proposals that utilize NASA MAP-supported models or model output will be preferred over those that do not. Proposed evaluations of the MAP-supported models mentioned in Section 2 should consider the use of appropriate existing simulations, including those contained in the CMIP (Coupled Model Intercomparison Project) archives or simulations that have already been conducted by the NASA modeling teams. If new simulations are required, resources to support those simulations should be included in the proposal, as well as the agreement of the modeling team to provide the needed simulations (if the proposing team is unwilling or unable to conduct the simulations themselves).

5. MAP Infrastructure

As mentioned above, a MAP program goal is a set of models and model components that are well documented, thoroughly evaluated, interoperable, robust, and consistent with current coding standards and practices. Therefore, code development proposals should adhere to the multiagency Earth System Modeling Framework (https://www.earthsystemcog.org/projects/esmf), which provides a robust software infrastructure for coupling model elements. Proposals should identify resources to provide software engineering and interface support necessary to assure that the final product meets ESMF standards and investigator verification that the ESMF-compatible product yields desired results.

High-end computing (HEC) support is available from the NASA Center for Computational Sciences (NCCS, https://nccs.nasa.gov/) and the NASA Advanced Supercomputing facility (NAS, http://www.nas.nasa.gov/) (see Section I(d) of the ROSES *Summary of Solicitation*). Proposers who require computing time at NCCS or NAS must provide an accurate estimate (including the basis of the estimate) of the number of node-hours required each year of the proposal by completing the HEC template and answering the NSPIRES cover page question. See Section I(d) of the ROSES-2016 *Summary of Solicitation* for instructions. Note that the availability of computing resources will be considered in the evaluation process.

6. Summary of Key Information

Expected program budget for first year of new awards	~ $7M
Number of new awards pending adequate proposals of merit	~31; See parentheticals in Section 3.
Maximum duration of awards	4 years
Due date for Notice of Intent	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for Proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	January 1, 2017
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 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	NNH16ZDA001N-MAP
NASA point of contact concerning this program	David B. Considine Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Tel: 202-358-2277 Email : david.b.considine@nasa.gov

A.14 CRYOSPHERIC SCIENCE

NOTICE: Amended June 20, 2016. NASA does not intend to solicit research proposals under the Cryospheric Science program element in ROSES-2016. However, on or about June 20, 2016 a new opportunity will be added in program element A.49, IceBridge Science Team.

1. Program Overview

1.1 Background

NASA's Cryospheric Sciences Program supports basic research on the Earth's sea- and land-based ice to understand its connections to the global system. Recent satellite observations show dramatic changes in the Greenland and Antarctic ice sheets, including thinning of their outlet glaciers, as well as in the thickness and extent of Arctic and Antarctic sea ice. Given the tremendous areas that must be studied to characterize these changes, space-based and airborne remote-sensing techniques are required.

Overall, the program seeks to understand the mechanisms of change in ice in the polar regions and their implications for global climate, sea level and the polar environment. To accomplish this, supported studies use space-based and aircraft-based remote-sensing techniques to understand the factors controlling the retreat and growth of the world's sea ice and major land-based ice sheets, and their interactions with the ocean, atmosphere, solid Earth and solar radiation.

1.2 Scope of Program

Broadly, this program emphasizes investigations that use remote-sensing techniques to study (a)-the Greenland and Antarctic ice sheets to understand the controls on their mass balance, and (b) the ice-covered oceans of the northern and southern hemispheres to determine their response to climate change. Field studies are supported only if closely tied to remote-sensing efforts, and the development of numerical models must use remote-sensing data sets in their formulation or validation.

Specifically, the program seeks to:

- Determine the mechanisms controlling sea-ice cover, including quantification of the connections between sea ice and the ocean and atmosphere;
- Use remote sensing to validate and improve predictive models of changes in sea-ice cover, especially on decadal timescales and 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 ice flow, ice shelves, grounding lines, bed, melt water formation and role, and connections to the ocean, sea-ice cover and atmosphere;
- Use remote-sensing data to validate and improve predictive models of the contribution of land-based ice to sea-level change, especially in the coming century.

In addition, studies of polar and nonpolar mountain glaciers and small ice caps are supported if they cover broad geographical areas and are of consequence to understanding systemic impacts of global climate change and sea-level change, or help elucidate fundamental processes that control glacier dynamics with application to polar ice sheets. Similarly, studies aimed at improving records of snow cover are supported if specifically tied to questions of ice sheet mass balance, sea-ice thickness, or improvement of regional climate and precipitation models.

Furthermore, NASA expects synergy among observations, modeling, and field campaigns, and strongly encourages all projects to incorporate recommendations identified by 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* 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* from the National Research Council, available at http://www.nap.edu/catalog.php?record_id=13515
- *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

Finally, use of the extensive data sets collected by NASA (and other) satellite and airborne remote-sensing campaigns is required, and projects are especially encouraged to make use of the data collected under NASA's Operation IceBridge mission (http://www.nasa.gov/mission_pages/icebridge/index.html), an airborne remote-sensing mission collecting altimetry, radar, gravity and other data in both polar regions. Data are available at the National Snow and Ice Data Center (NSIDC; http://nsidc.org/data/icebridge/).

1.3 Arctic Studies

For Arctic sea ice, the program's focus is to understand the observed changes – in extent, concentration, thickness, and dynamics – in the context of ocean and atmospheric circulation and northern hemisphere climate. Understanding the feedback mechanisms associated with sea-ice cover and the surrounding land, ocean, atmosphere, and incident sunlight is intended to improve predictive models for the Arctic and establish links between high-latitude and low-latitude climates. Among the data sets available to support such efforts are those stored at the Distributed Active Archive Center (DAAC) at the National Snow and Ice Data Center (http://nsidc.org/), such as those for NASA's ICESat and Operation IceBridge missions.

For Arctic land ice, characterizing changes in the mass balance of the Greenland ice sheet, and other northern hemisphere glaciers, is essential to understanding and modeling their 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 to support overall ice sheet 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 Sciences research solicitation (http://www.nsf.gov/div/index.jsp?div=ARC).

1.4 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, sub-ice-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."

2. Point of Contact

For further information on this program, contact:

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A.15 ICEBRIDGE RESEARCH

NOTICE: The IceBridge Research program will not solicit proposals in ROSES-2016. NASA expects to continue to solicit related research through its core and other research and analysis programs, in particular, Studies with ICESat and CryoSat-2 in ROSES-2016. Please consult these other program elements for potential funding opportunities.

1. Background

IceBridge (http://www.nasa.gov/mission_pages/icebridge/) is a NASA airborne mission making altimetry, radar, and other geophysical measurements to monitor and characterize the Earth's cryosphere. Its primary goal is to extend the record of ice altimetry begun by ICESat. The IceBridge mission began operation in 2009 and will continue until the launch of ICESat-2 in 2017. The Earth's cryosphere is in a period of rapid change. Data collected through the IceBridge program improves our knowledge of the contribution of the world's major ice sheets and glaciers to current and future sea level rise. It also makes fundamental contributions to understanding changes occurring in the extent and thickness of sea ice in the Arctic and Southern Oceans. Research using these datasets improves knowledge of the connections of the polar regions to the global system and its change.

Details on the IceBridge campaigns and datasets can be seen at http://nsidc.org/data/icebridge/campaign_data_summary.html.

In general, IceBridge surveys various areas in the Arctic and Antarctic each year prior to the onset of melting. Specific flight lines are selected based on detailed planning by the IceBridge project and science team to meet the mission goals. In the Arctic, the coverage includes: Greenland, Arctic Sea Ice, and select Alaskan glaciers and Canadian ice caps. In the Antarctic, the coverage includes: the Antarctic peninsula and nearby sea ice, the Amundsen sea embayment, and select areas of both West and East Antarctica, including both the interior and outlet glaciers. In 2013, the mission undertook its first set of postmelt season altimetry measurements in the Arctic, and this program may continue.

The instrument suite varies by campaign, but generally includes some or all of the following: lidar, ice and snow penetrating radar, gravimeter, magnetometer, and other instruments.

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A.16 STUDIES WITH ICESAT AND CRYOSAT-2

1. Background

NASA solicits investigations to derive geophysical information from NASA's Ice, Cloud, and land Elevation Satellite (ICESat) and the European Space Agency's CryoSat-2, and link these records with the initial data stream from ICESat-2, scheduled for launch in FY 2018. These altimetry missions were optimized to characterize changes in the continental ice sheets of Antarctica and Greenland and the sea ice of the Arctic and Southern Oceans. The missions' primary goals are to understand the contributions of polar ice to current and future sea level rise and the coupling of changes in polar sea ice cover to the Earth system. Investigations are encouraged that:

- create long term, integrated records of change in the polar ice sheets;
- characterize processes of change in polar ice, especially couplings to climate forcings and insight into physical processes that improves predictive models; and
- as a lower priority, any other innovative investigations using ICESat and CryoSat-2 observations for Earth science research, such as studies of ecosystem structure and biomass, inland and ocean water heights, and clouds.

1.1. ICESat, ICESat-2, and IceBridge

The NASA Ice, Cloud, and land Elevation Satellite (ICESat) was launched in January 2003 and ceased operations in 2009. The instrument on ICESat was the Geoscience Laser Altimeter System (GLAS) with precise ranging capability. With an orbital inclination of 94 degrees, ICESat observations provided critical insight into the thinning of the Arctic sea ice cover, the ice loss from the continental ice sheets of Greenland and Antarctica, and the global distribution of above-ground biomass. Limitations of the laser lifetime led to a revised measurement strategy from the intended continuous operation in a 91-day repeat orbit to a set of discrete campaigns. These campaigns were based on a 33-day near-repeat subcycle of the 91-day orbit that was surveyed twice a year at six-month intervals. Details of the mission are available at http://icesat.gsfc.nasa.gov/. Data can be accessed from the NASA Distributed Active Archive Center (DAAC) at the National Snow and Ice Data Center through http://nsidc.org/data/icesat/.

ICESat's planned successor is ICESat-2, which is currently under development and expected to be on orbit and providing data in 2018. Details of the mission are available at http://icesat.gsfc.nasa.gov/icesat2/. ICESat-2 will be in a near-polar orbit and have a multibeam, photon counting instrument. It makes measurements at higher resolution and over broader swaths that enable direct measurement of both surface elevation and slope.

The gap in space-based laser altimetry observations is being bridged by NASA's IceBridge Mission (http://www.nasa.gov/mission_pages/icebridge/index.html), a series of aircraft campaigns over land and sea ice in both polar regions. The instrument suite and flights plans are based on lidar measurements that extend the record of ICESat and offer calibration and validation of CryoSat-2. The aircraft also have radars for mapping snow cover and the underlying bed, as well as gravimeters and other instruments. Data and instrument descriptions can be accessed from http://nsidc.org/data/icebridge/.

1.2. CryoSat-2

CryoSat-2, launched in April 2010, is a radar altimetry mission of the European Space Agency (ESA). It is designed primarily to measure sea ice thickness with sophisticated radar processing techniques. Its measurements of sea ice freeboard complement those of ICESat and have been validated with IceBridge observations. CryoSat-2 also has the potential to measure ice sheet elevation and make other geophysical measurements. Details on the Cryosat-2 mission are at http://www.esa.int/esaMI/Operations/SEM36Z8L6VE_0.html.

1.3. Scope of Program

The primary goal of this program is to continue the use of satellite altimetry for the study of polar ice sheets.

These measurements are expected to improve knowledge of the contribution of Greenland and Antarctica's ice sheets to current and future sea level rise and to determine the coupling of changes in polar sea ice to the Earth system. Investigations must be based on observations made by ICESat, CryoSat-2, and ICESat-2 as well as exploit the complementary nature of these missions to produce extended records. Proposers are also encouraged to use IceBridge measurements to connect and fill gaps between ICESat and CryoSat-2 and establish pathways to link these time series to ICESat-2.

Scientific studies based on ICESat, CryoSat-2, and ICESat-2 observations outside of the polar ice sheets are encouraged, but will also be considered at a lower priority.

Specific goals of the program are as follows:

For the Greenland and Antarctic ice sheets, the program seeks to:

- Measure and understand elevation change in the context of improved mass balance to understand couplings to the Earth system and contributions to sea level rise
- Gain insight into the surface mass balance, especially to improve models of polar precipitation and surface melting
- Characterize the dynamic processes controlling ice flow and related changes in ice sheet elevation and mass balance, especially to improve ice sheet models useful for prediction of sea level rise
- Use satellite altimetry to determine any other properties of the ice sheets critical to improved models of their contributions to current and future sea level rise.

For the sea ice of the Arctic and Southern oceans, the program seeks to:

- Measure and understand changes in the thickness of sea ice cover as derived from measurements of sea ice freeboard
- Characterize the physical processes controlling Arctic sea ice loss and Antarctic sea ice expansion, especially to improve sea ice models for hind and forecasting

- Gain insight into surface melting, snow accumulation, age and flooding of sea ice, especially to improve models of polar precipitation and surface melting
- Use satellite altimetry to determine any properties of polar sea ice to understand the physical processes that control their growth and retreat, especially their connections to climate forcings and couplings to the Earth system.

Other areas of research based on ICESat, CryoSat-2, and ICESat-2 satellite altimetry will also be considered at a lower priority. Proposals are welcome on any topic, but studies should make a specific effort at improving understanding of the Earth system and prepare for integration with ICESat-2 data when it becomes available. Potential topics include, but are not limited to the following:

- Ecosystem structure and estimation of biomass
- Change in the major glacial systems of the Alaska, Canada, and High Mountain Asia to understand their contributions to global sea level rise and or couplings to the Earth system
- Atmospheric processes, especially precipitation and cloud properties relevant to interpretation of polar processes and affecting interpretation of ICESat and ICESat-2 observations
- Land surface studies, snow volume estimates, and hydrologic information derived from water surface heights.

2. Programmatic Information

Results from investigations supported under this ROSES element are expected to advance the Earth Science goals articulated in the 2014 Science Mission Directorate Science Plan available at http://science.nasa.gov/about-us/science-strategy/, as well as a number of Presidential Mandates and associated Federal research objectives; such as the National Ocean Policy (http://www.whitehouse.gov/administration/eop/oceans/policy) emphasis on Arctic change, the U.S. Global Change Research Program (http://www.globalchange.gov/) and its strategic plan (http://globalchange.gov/what-we-do/strategic-planning), and the Interagency Arctic Research Policy Science Plan (https://www.nsf.gov/geo/plr/arctic/iarpc/arc_res_plan_index.jsp) which addresses the role of glaciers, ice sheets and sea ice within the Arctic and Earth systems.

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	~ 10-12
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.

Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page length for the Science/Technical/Management section of proposal	15 pages; 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 Guideline 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 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	NNH16ZDA001N-ICESAT2
NASA point of contact concerning this program	Thomas Wagner Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-4682 E-mail: thomas.wagner@nasa.gov

A.17 ATMOSPHERIC COMPOSITION: UPPER ATMOSPHERIC COMPOSITION OBSERVATIONS

1. Scope of Program

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

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

NASA expects to provide the necessary monitoring and evaluation tools to assess the effects of climate change on ozone recovery and future atmospheric composition, improved climate forecasts based on our understanding of the forcings of global environmental change, and air quality forecasts that take into account the feedbacks between regional air quality and global climate change. Achievements in these areas via advances in observations, data assimilation, and modeling enable improved predictive capabilities for describing how future changes in atmospheric composition affect ozone, climate, and air quality. Drawing on global observations from space, augmented by suborbital and ground-based measurements, NASA is uniquely poised to address these issues. This integrated observational strategy is furthered via studies of atmospheric processes using unique suborbital platform-sensor combinations to investigate, for example: (1) the processes responsible for the emission, uptake, transport, and chemical transformation of ozone and precursor molecules associated with its production in the troposphere and its destruction in the stratosphere and (2) the formation, properties, and transport of aerosols in the Earth's troposphere and stratosphere. NASA's research strategy for atmospheric composition encompasses an end-to-end approach for instrument design, data collection, analysis, interpretation, and prognostic studies.

2. Upper Atmosphere Research Observational support

The principal area of research solicited through this section is for operational support of atmospheric field measurement systems that monitor trace gas composition in the stratosphere and tropical upper troposphere from the ground, aircraft, and balloons. These types of measurements include those associated with (i) the long term monitoring of ozone and ozone- and climate-related trace gases via remote sensing techniques, and (ii) support of key observational field missions designed to address chemical and dynamical processes that influence upper tropospheric and stratospheric composition. In this solicitation section, NASA is not seeking proposals for instrumentation designed to make atmospheric boundary layer measurements or measurements of cloud/aerosol radiative or microphysical properties. Proposed investigations may include, but are not limited to:

- Long term ground-based remote sensing network observations of atmospheric trace gas composition, such as those prioritized under the Network for the Detection of Atmospheric Composition Change (http://www.ndacc.org/);
- Airborne *in situ* and remote sensing observations of the tropical upper troposphere and stratosphere that are key to current and potential future airborne campaigns; or
- Small and large balloon observations of atmospheric composition for maintaining continuity of satellite calibration/validation capabilities.

With respect to the balloon-borne measurements, high-altitude/heavy-lift research balloons have been an important component of the Aura validation program over the last few years. Future balloon measurements should focus on validation and collaborative observations for the SAGE-III instrument on the International Space Station after 2016 and the continued ozone mapping and profiler suite (OMPS)-Limb observations on S-NPP and JPSS-2 to ensure continuity from Aura. We anticipate that this need can be addressed at a reduced scope and level of effort. Priority will be given to proposals that directly address the science priorities of NASA's atmospheric composition focus area, have the potential to be used in a yet to be planned future airborne field campaigns in the tropical upper troposphere and lower stratosphere that can key open questions as defined in the Atmospheric Composition community white paper available at https://espo.nasa.gov/home/content/NASA_SMD_Workshop, and can be used to enhance data products from EOS Aura, SAGE-III, and OMPS-Limb. Due to budget limitations, proposals that enhance and maintain the abilities of existing established measurement techniques and recent observations will be given priority over those proposing development and construction of new instruments and technology or data sets that have not been obtained over the past 3 years. For proposals to support airborne instrument activity, proposals should include activity and budgets to support the personnel for maintenance of the instruments and data analysis of past campaigns. Funds to support participation in future campaigns will be made available separately in future solicitations.

3. Summary of Key Information

Expected annual program budget for first year of new awards	~ $6.0 M
Number of new awards pending adequate proposals of merit	~ 15 – 20
Maximum duration of awards	4 years
Due date for Notice of Intent to propose (NOI)	Not requested.

Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
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 *2008 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	NNH16ZDA001N-UACO
NASA point of contact concerning this program	Kenneth W. Jucks Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0476 E-mail: Kenneth.W.Jucks@nasa.gov

A.18 CLOUD AND AEROSOL MONSOONAL PROCESSES-PHILIPPINES EXPERIMENT

1. Scope of Program

Atmospheric composition changes affect air quality, weather, climate, and critical constituents, such as ozone. Atmosphere-biosphere exchange links terrestrial and oceanic pools within the carbon cycle and other biogeochemical cycles. Solar radiation affects atmospheric chemistry and is thus a critical factor in atmospheric composition. Atmospheric composition is central to Earth system dynamics, since the atmosphere integrates surface emissions globally on time scales from weeks to years and couples many 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 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 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, as well as aerosol interaction with clouds. NASA's research strategy for atmospheric composition encompasses an end-to-end approach for instrument design, data collection, analysis, interpretation, and prognostic studies.

2. Description of Solicited Research

The Radiation Sciences Program is soliciting proposals for participation in an airborne campaign to be conducted in the vicinity of the Philippines during July, August, and into early September of 2018 to investigate aerosol particle, cloud, meteorology/climate interactions. A single comprehensively instrumented research aircraft is required to accomplish this research. In this airborne campaign, the NASA P-3B will provide observations from near surface to ~9.7 km.

Aircraft measurements of atmospheric cloud and aerosol particle properties, radiation, and meteorology parameters provide a comprehensive suite of observations to understand these processes during the focused experiment period. They are also useful for calibration and validation of the longer-term observations of Earth observing satellite sensors and the retrieved data products generated from those observations. In particular, these measurements will be useful in the calibration and validation of the more mature A-Train and Terra satellites and S-NPP and GPM observatories. The measurements made during this campaign will also be useful in the planning of future satellite missions, especially the Aerosol, Cloud, and Ecosystems (ACE) mission.

2.1 Cloud and Aerosol Monsoonal Processes-Philippines Experiment

The Cloud and Aerosol Monsoonal Processes-Philippines Experiment (CAMP^{2}Ex) will address key questions regarding the interactions among clouds, aerosols, and meteorology, as driven by solar radiation and radiation emitted from the Earth's surface. The field campaign will take place in the vicinity of the Philippines and will focus on the influences of aerosol particles from biomass burning and anthropogenic particle emissions. Primary observations will include cloud properties, aerosol particle properties, meteorological parameters, as well as solar radiation and radiation emitted from the Earth's surface. The CAMP^{2}Ex campaign will take place during the period from July to early September 2018 to investigate the impact of biomass burning and pollution aerosol particles during the Southwest Monsoon.

A CAMP^{2}Ex white paper, which describes the scientific background, science questions and experimental approach, can be found at: https://espo.nasa.gov/CAMP2Ex_White_Paper. CAMP^{2}Ex primary observations will emphasize measurements of cloud properties, aerosol particle properties, and meteorological parameters, as well as solar radiation and radiation emitted from the Earth's surface. The primary goals of CAMP^{2}Ex are to provide key calibration and validation data for satellite observations in the Maritime Continent in the vicinity of the Philippines and to address the following scientific goal, objective, and specific questions.

The overall scientific goal of CAMP^{2}Ex is to characterize the role of anthropogenic and natural aerosol particles in modulating the frequency and amount of warm and mixed phase precipitation in the vicinity of the Philippines during the Southwest Monsoon.

The central objective of CAMP^{2}Ex will be to provide a comprehensive 4-D observational view of the environment of the Philippines and its neighboring waters in terms of microphysical, hydrological, dynamical, thermodynamical, and radiative properties of the environment, targeting the environment of shallow cumulus and cumulus congestus clouds.

Aerosol and Cloud Microphysics Questions:

(a) How do the composition and concentrations of aerosol particles (including those of cloud condensation nuclei (CCN) and, secondarily, ice nuclei (IN)) affect the optical and microphysical properties of shallow cumulus and congestus clouds and the development of precipitation from these clouds?

(b) How does the composition and concentration of aerosols (including those of CCN and, secondarily, IN) impact the latent heating and invigoration of congestus clouds, and hence their potential transition to deep convection and larger precipitation rates?

Cloud and Aerosol Radiation Questions:

(a) How does the observed spatial heterogeneity in the aerosol and cloud field impact the spatial distribution of radiative heating rates in the atmosphere and the surface?

(b) How do observed changes in the aerosol field directly and indirectly impact the spatial and temporal distribution of radiative heating rates in the atmosphere and at the surface?

(c) How do these changes in the radiative heating rates feedback into the evolution of the aerosol, cloud, and precipitation fields?

(d) To what extent does the heterogeneity of the atmosphere impede the use of satellite remotely sensed products for quantifying aerosol-induced changes to cloud and precipitation properties?

Meteorological Relationships Between Aerosol and Cloud Lifecycle Questions:

(a) To what extent are perceived aerosol-cloud interactions studies confounded and/or modulated by co-varying meteorology?

(b) By what meteorological mechanisms do polluted conditions transition into background conditions?

(c) What meteorological features are the most influential in regulating the distribution of aerosol particles throughout the atmosphere and ultimately aerosol lifecycle (sources, sinks, and advection)?

(d) What is the statistical variability in aerosol particle concentrations within an airmass and to what extent is knowledge of large-scale aerosol fields and wet deposition in the region sufficient to predict regions of anthropogenically induced aerosol-cloud-precipitation interaction?

3. Programmatic Information

3.1 Programmatic Priorities

Two types of proposals will be considered for support under this ROSES-2016 element. First, proposals requesting support for *in situ* and remote-sensing measurements to be deployed on the NASA P-3B and, second, campaign leadership and flight planning will be considered under this solicitation.

Highest priority will be given to instrument proposals consistent with mission objectives (as described in the mission white paper) and with proven performance heritage. It is not appropriate to propose for significant new instrument development under this call; however, consideration will be given for minor modifications and improvements to existing instruments as may be required to address campaign goals and objectives. In order to ensure the production of useful datasets and the initial analysis of the data collected during the field phase of $CAMP^2Ex$, instrument proposals may request support for up to five project years.

Campaign leadership and flight planning proposals may include requests for support for the field campaign lead, as well as forecast modeling for meteorology and parameters listed as essential for $CAMP^2Ex$ in the white paper. Support for these activities is limited. As a result, only those leadership and flight planning activities deemed as essential will be supported. Proposals for these efforts may request support for up to three project years.

Satellite teams are welcome to participate in $CAMP^2Ex$ by providing near real-time observations and interpretation to guide flight planning, as well as by establishing specific calibration/validation needs for incorporation into aircraft flight plans. However, program resources to support these activities will be limited.

The campaign leader is expected to play an important role in campaign organization, flight planning, and data analysis. Thus, proposals for campaign leader must be submitted as part of proposals for other activities. The leadership section need not be extensive and should be limited to three additional pages. The leadership section should describe previous campaign leadership experience, expertise that will enhance effectiveness and efficiency, and an approach to $CAMP^2Ex$ campaign management. The budget for leadership activities should be presented separately from the budget for the rest of the proposed $CAMP^2Ex$ related activities. The two budgets should be detailed in the budget section of the proposal, but personnel salary figures should be redacted from the budget section of the proposal. The total (i.e., combined) budget should be presented in the budget forms in the proposal cover pages.

A solicitation for additional postcampaign data analysis and modeling proposals using $CAMP^2Ex$ observations will be published at a later time.

3.2 Funding Guidelines

Proposals may request funding to cover the costs of preparation, integration (shipping to Wallops Flight Facility), field deployment, data processing, data analysis, and interpretive modeling. Personnel support at an appropriate and justifiable level related to these activities will be considered. Because it is not possible to accurately budget field campaign travel costs until deployment details are finalized, proposers should not include travel costs for science team meetings, integration, and deployment in the proposal budget. Rather, proposers should submit a workforce plan for integration and deployment, including the total number of personnel and their respective schedules consistent with programmatic priorities. Proposals may include travel to conferences taking place after the field campaign to present results.

4. Summary of Key Information

Expected annual program budget for new awards.	~ \$1.9 M in FY17; ~\$3.4 M in FY18; ~\$3.4 M in FY 19; ~\$2.7 M in FY20; ~\$2.7 M in FY21

Number of new awards pending adequate proposals of merit	~ 15
Maximum duration of awards	3 project years for leadership and flight planning; 5 project years for measurements
Due date for Notice of Intent to propose (NOI)	Not requested.
Due date for proposals	See Tables 2 and 3 in the *Summary of Solicitation* of this NRA.
Recommended Start Date for Awards	August 1, 2017.
Page limit for the central Science/Technical/Management section of proposal	15 pp for standard proposals, see also Chapter 2 of the *NASA Guidebook for Proposers*. 3 additional pp for proposals including campaign leadership.
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	NNH16ZDA001N-CAMP2Ex
NASA point of contact concerning this program:	Hal Maring Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1679 E-mail: hal.maring@nasa.gov

A.19 ATMOSPHERIC COMPOSITION: AURA SCIENCE TEAM AND ATMOSPHERIC COMPOSITION MODELING AND ANALYSIS PROGRAM

NOTICE: Because of Emergency Maintenance between 10:00 p.m. on August 17, 2016, and 6:00 a.m. on August 18, 2016, engineers will replace a failing component on one of the routing devices that hosts the NSPIRES web page. For at least part of this time, NSPIRES will not be available. As a result, proposals to Program Element A.19 Atmospheric Composition: Aura Science Team and Atmospheric Composition Modeling and Analysis are now due August 19, 2016.

1. Scope of Program

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

- How is atmospheric composition changing?
- What trends in atmospheric 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 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, 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. Aura Science Team and ACMAP Activities

This program element seeks proposals for the analysis of satellite remote-sensing data of the Earth's atmosphere, particularly those using data generated by the Earth Observing System (EOS) Aura satellite. Observations from Aura include those from the Microwave Limb Sounder (MLS), Ozone Monitoring Instrument (OMI), Tropospheric Emission Spectrometer (TES), and High Resolution Dynamics Limb Sounder (HIRDLS) that ceased operation in 2008. We are also encouraging proposals that combine data from Aura with data from other sensors within the "A-Train", S-NPP orbit, or morning crossing constellations (particularly Aqua, Terra, CALIPSO, and CloudSAT, S-NPP) or satellites or instruments from other space agencies (for example; SciSat/ACE, MetOp), ground based networks (e.g., but not limited to ozonesondes, NDACC, AGAGE, AERONET, and MPLNET), and NASA suborbital campaigns (e.g., but not limited to DISCOVER-AQ, ATTREX, CARVE, and SEAC4RS). These proposals should enable NASA research in the area of stratospheric and tropospheric chemistry, as well as improve the measurements of aerosols and trace gases, and determining the impacts of trace gasses and aerosols on climate and air quality. Proposals should specifically address the use of the satellite data.

The Atmospheric Composition Modeling and Analysis Program (ACMAP) addresses the following research issues, all of which are relevant to the data sets from Aura:

- Tropospheric air quality and oxidation efficiency,
- Pollution-generated 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 ACMAP 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 directed to ACMAP priorities are encouraged to make use of Aura observations, but their use is not mandatory.

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.

The goals of this program element include:

- Developing new or significantly improving existing data products from the EOS Aura instruments using Level 2 data;

- Developing new or significantly improved Level 2 data that are not supported by the Aura project core data analysis budget (http://disc.sci.gsfc.nasa.gov/Aura/);
- Using Aura data to track changes in stratospheric and tropospheric composition, determine the exchange of trace gases within the troposphere, between the stratosphere and troposphere, and estimate the transport properties of the stratosphere and upper troposphere;
- Using Aura data along with other satellite trace gas data sets to quantify and map emissions and quantify the impact of long-range transport and export of trace gases important to air quality;
- Using the above-described data sets to study tropospheric air quality and oxidizing capacity of the troposphere, including the effects of climate change on tropospheric air quality and air quality on climate, and studies of the attribution of changes in air quality and oxidizing capacity over the past 20 years;
- Using the above-described data sets to study aerosol characteristics with respect to their impacts on tropospheric chemical processes, including 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;
- Using Aura data to better merge the activities of the atmospheric composition research community and air quality monitoring activities of other agencies within the United States.

NASA encourages proposals that develop new Level 2 or high level data products to include a representative from the Instrument Team which produced the original data.

A-Train (Aura, CALIPSO, Aqua) instrument algorithm maintenance, incremental algorithm improvement, data product and the production of standard data products are excluded from this program element.

3. Proposal requirements

Expected program budget for first year of new awards	~ $7.0M/year
Number of new awards pending adequate proposals of merit	~ 15-25
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	Not requested.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
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. See 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	NNH16ZDA001N-ACMAP
NASA point of contact concerning this program	Kenneth W. Jucks Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0476 E-mail: kenneth.w.jucks@nasa.gov Richard S. Eckman Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-2567 E-mail: richard.s.eckman@nasa.gov

A.20 ATMOSPHERIC COMPOSITION: TROPOSPHERIC COMPOSITION PROGRAM

NOTICE: The Tropospheric Composition Program (TCP) will not be competed in ROSES-2016. The TCP program is tentatively scheduled to next solicit proposals in ROSES-2017. Proposers with interests that match the TCP programmatic objectives are encouraged to submit to A.19 Atmospheric Composition: AURA Science Team and Atmospheric Composition Modeling and Analysis Program and A.18 Cloud and Aerosol Monsoonal Processes - Philippines Experiment (CAMP^{2}EX).

The Tropospheric Composition Program (TCP) seeks to improve the utility of satellite measurements in understanding of global tropospheric ozone and aerosols, including their precursors and transformation processes in the atmosphere. Ozone and aerosols are fundamental to both air quality and climate. The program emphasizes suborbital and ground-based measurements acquired during focused field deployments. Along with the other Atmospheric Composition programs, TCP also sponsors interpretation of these comprehensive, but infrequent, measurements to improve the continuous monitoring of tropospheric ozone and aerosols from space and the improvement of prognostic models. 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:

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A.21 TERRESTRIAL HYDROLOGY

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 Appendix 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-2016 elements A.4 and A.13, 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 is currently focused on research relating to multiple missions, either currently operating, such as Gravity Recovery and Climate Experiment (GRACE), Global Precipitation Measurement (GPM) and Soil Moisture Active Passive (SMAP); or in planning and development, such as the Gravity Recovery and Climate Experiment Follow-On (GRACE-FO) and the 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), or numerous others, both national and international. THP furthers study of the relationship between satellite interferometric measurements of surface deformation and changes in underground water stores.

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 U.S. Global Energy and Water Cycle Exchanges Project (U.S. GEWEX) and the U.S. Global Research Program (USGCRP), especially its recent 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 specific websites e.g., http://smap.jpl.nasa.gov/ or http://swot.jpl.nasa.gov/.

2. Next Generation Cold Land Processes Experiment

The Cold Land Processes Field Experiment (CLPX) conducted in 2002-2003 was conceived of and planned by THP's Cold Land Processes Working Group. More information on CLPX can be found at www.nohrsc.noaa.gov/~cline/clpx.html. Much was learned from data collected during CLPX and subsequent investigations, in particular that snow is an elusive quantity to measure from space, requiring multiple wavelengths and different sensor types (e.g., active and passive) to fully satisfy all that desire snow observations. NASA seeks to plan the next iteration of CLPX with an emphasis on improving articulation of satellite remote sensing strategies and requirements, while still connecting to and building on the original motivation of CLPX.

Quantitative understanding of cold land processes over large areas will require synergistic advancements in 1) understanding how cold land processes, most comprehensively understood at local or hillslope scales, extend to larger scales, 2) improved representation of cold land processes in coupled and uncoupled land-surface models, and 3) a breakthrough in large-scale observation of hydrologic properties, including snow characteristics, soil moisture, the extent of frozen soils, and the transition between frozen and thawed soil conditions.

It is anticipated that significant field activities, involving aircraft instruments, would occur, in North America, early in 2019 and span three consecutive winters.

3. Solicited Investigations

To initiate the development of The Next Generation Cold Land Processes Experiment, NASA solicits projects to:

1. Refine and articulate new motivating science questions.
2. Integrate individual project research questions into a single motivating science plan.
3. Fuse individual *in situ* and airborne plans into an implementation plan that addresses the science plan.
4. Lead the first year implementation of the field activity

Note that once the individual science and implementation plans are written, another solicitation, and/or other mechanisms, will be used to acquire and/or enable the necessary components to successfully carry out the full three years of the field campaign.

Although multiple projects will be selected, each project should address its own postulated question(s) by including: (1) a plan of analysis of existing data and/or modeling studies to determine optimum *in situ* and aircraft observation strategies. This should be done in strong coordination with the aforementioned goal of "improving articulation of satellite remote sensing strategies and requirements;" (2) requirements to guide field site selection to provide appropriate environmental conditions (e.g. snow pack properties) as well as logistical services (e.g. power, field access); and (3) an initial approximation of the necessary *in situ* and/or airborne sampling design, including the number of observations and necessary human and instrument resources.

Project leaders will form a team that will require a composite set of knowledge covering, but not limited to:

- Snow physics and properties
- Remote sensing of snow across multiple wavelengths and sensor approaches (e.g., active and passive)
- Snow modeling spanning hydrologic, land-surface, and radiative transfer models and including data assimilation approaches
- Snow field observations, equipment, and techniques
- Snow data set assemble and archival
- Comparable international snow observation and satellite planning activities

Project leaders will use their knowledge of the above topics, and other areas, to provide expert guidance to formulate the science and experiment plans. Project leaders should outline what role they would take during the first year of field activity, as well as any precampaign activity that might be required (e.g., warm season equipment installation).

Proposals should note experiences of the Principal Investigator (PI) in (1) planning and executing snow field campaigns, and (2) snow remote sensing systems, either airborne or satellite.

3.1 Expected Project Requirements and Timelines

Project leaders should anticipate attending approximately three group meetings in the initial year of their investigation (i.e., calendar year 2017). These meetings will fuse together individual project plans into the science and experiment plans. In so doing, project leaders will work with NASA scientists and engineers to select desired field sites to be used and they may aid in securing appropriate permissions and agreements with local property owners.

Projects may extend past the typical three year lifetime if, and only if, years four and five are solely focused on supporting graduate students (including involved students who graduated during the timespan of the project) to allow them to transition from field participants to field campaign leaders during project years four and five. Proposals of these projects should include a description of how the precampaign analysis activities could be employed by these graduate students (or those recently graduated) to respond to lessons learned during the first field season to advise on how aspects of the field campaign sampling strategies could be altered to yield improved data sets.

4. Programmatic Information

Total funds available for work selected under this solicitation are approximately $1.5M per annum for the first three years and $900K per annum for years four and five.

The program anticipates making approximately twelve selections. It is anticipated that project start dates will be January 2017.

5. Table of Key Information

Expected annual program budget for new awards	~ $1.5M for years 1-3, $900K for years 4-5
Number of investigator awards pending adequate proposals of merit	~12
Maximum duration of awards	5 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	January 2017
Page limit for the central Science/Technical/Management section of proposal	10 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	NNH16ZDA001N-THP
NASA point of contact concerning this program	Jared Entin Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Tel: 202-358-0275 Email: jared.k.entin@nasa.gov

A.22 NASA ENERGY AND WATER CYCLE STUDY

NOTICE: The NASA Energy and Water Cycle Study (NEWS) program will not be competed in ROSES-2016.

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. Point of Contact for Further Information

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A.23 WEATHER AND ATMOSPHERIC DYNAMICS

1. Background

The study of weather includes an analysis of the dynamics of the atmosphere and its interaction with the oceans and land. Improvement of our understanding of weather processes and phenomena is crucial in gaining an understanding of the Earth system. The Weather Focus Area (http://science.nasa.gov/media/medialibrary/2015/08/03/Weather_Focus_Area_Workshop_Report_2015.pdf) 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 (TRMM, GPM, Aqua, Terra, Suomi NPP, CloudSat, CALIPSO, SMAP and CYGNSS) and hurricane-themed tropical field experiments.

1.1 Scope of Program

This solicitation is aimed at enabling improved predictive capability for certain weather and extreme weather events in four specific areas. The first one relates to the use of past NASA airborne data from a long series of field experiments, and in conjunction with satellite data and numerical models, to better understand tropical cyclone genesis and intensity changes. The second one is focused on utilizing the soon to be launched CYclone Global Navigation Satellite System (CYGNSS) satellite mission for the study of the Madden-Julian oscillation (MJO) and tropical cyclones. The third one offers research opportunities related to the upcoming availability of a Lightning Imaging Sensor (LIS) on the International Space Station (ISS), and, the last one describes an opportunity related to the conduct of a field experiment in 2017.

2. Proposal Opportunity

The four research areas or subelements are described below. A number of potential research items are suggested in each case. These suggestions do not form a complete list and not all items covered in these lists are likely to be selected for funding. Also, these suggestions are optional. All worthy research ideas related to the four subelements will be entertained. As mentioned in Section 3, the maximum duration of awards is three years. Approximate per year funding available for the subelements are $0.6M for 2.1, $0.6M for 2.2, $0.5M for 2.3 and $1.5M in the first year and $1.0M for year 2 and year 3 for 2.4. Proposers may address more than one subelement by submitting a separate proposal for each subelement.

2.1 Hurricane Science Research

A major goal of NASA's Hurricane Science Research is to better understand the physical processes that control hurricane intensity change using data from airborne and space-based platforms. Since 1998, NASA has conducted several hurricane related field campaigns. In 2010, NASA conducted the Genesis and Rapid Intensification Processes (GRIP) experiment (http://grip.nsstc.nasa.gov/) and collected a wealth of data in developing and rapidly intensifying storms. During the hurricane seasons of 2012-2014, NASA's Hurricane and Severe Storm Sentinel (HS3) investigation (http://www.espo.nasa.gov/hs3) obtained additional observations particularly relevant to the interaction of storms with their environment. NASA's suite of satellites that are relevant to tropical cyclones include the Tropical Rainfall Measuring Mission (TRMM), the Global Precipitation Measurement (GPM) mission, Aqua, and Terra, among others, as well as future missions such as CYGNSS (http://cygnss-michigan.org), TROPICS (Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats https://tropics.ll.mit.edu) as is the National Oceanic and Atmospheric Administration's GOES-R (http://www.goes-r.gov) satellite.

This opportunity relates to the use of NASA airborne data from Convection and Moisture Experiment-3 (CAMEX-3 1998, https://cloud1.arc.nasa.gov/camex3/) through HS3, in conjunction with satellite data and numerical models, to better understand tropical cyclone genesis and intensity changes. Inherent to the topic of storm intensification are questions related to the structure and evolution of clouds and precipitation and their links to kinematic and thermodynamic characteristics of the initial disturbance, and the surrounding environment. We know that certain necessary conditions must exist for storms to develop, such as warm ocean temperatures, weak vertical wind shear, high humidity, and strong initial disturbance. However, competing hypotheses abound about the factors that determine whether a storm will intensify or weaken, including hypotheses related to inertial instability of the upper troposphere, favorable upper-level eddy fluxes of angular momentum associated with nearby large-scale troughs, protection of convective disturbances by a protective wave "pouch," convectively induced vorticity anomalies and self-aggregation, and the Saharan Air Layer (SAL). These different hypotheses can be distilled down to the extent to which either the environment or processes internal to the storm are key to intensity change.

NASA is seeking investigations to address the following key general science questions related to tropical cyclone genesis and intensity changes:

1. What impact does the large-scale environment have on intensity change?
2. What is the role of storm internal processes, such as deep convective towers?
3. To what extent are these processes predictable and what is the limit of intensity predictability?

Of particular relevance to NASA are 1) the use of airborne remotely sensed data, particularly from GRIP and HS3, to improve understanding of the processes that lead to hurricane formation and intensification; 2) application of the field observations to improve analysis and prediction via the study of physical and dynamical processes, their improved representation in numerical weather prediction models, as well as development of data assimilation methods for improved model initialization; and 3) the use of NASA airborne and satellite observations, along with numerical models.

Proposers to this element are expected to demonstrate a clear understanding and use (through past publications or dissertations) of NASA airborne and/or satellites data sets; proposals that do not reflect this will be considered nonresponsive.

2.2 Cyclone Global Navigation Satellite System (CYGNSS)

In addition to producing the bulk of the rainfall in the tropics, Mesoscale Convective Systems (MCSs) play a key role in the formation and propagation of the Madden-Julian oscillation (MJO); which influences the variability of rainfall over much of the tropical western Pacific Ocean, as well as the coasts of North and South America. The MJO also affects the genesis of tropical storms in the Pacific Ocean and Caribbean Sea. As such, the MJO influences global medium and extended range forecasts and the prediction of precipitation (Zhang, 2005; Seo and Wang, 2010). The MJO can be detected and tracked by changes in outgoing longwave radiation (OLR) with time. However, its detailed structure and its coupling to surface fluxes and precipitation in general, and to MCSs in particular, are still not well characterized or understood. Existing measurement systems are capable of characterizing the thermodynamic environment and rain rate associated with the MJO, but information on the surface winds has been limited. It has been demonstrated that satellite scatterometer measurements are capable of effectively observing some of the temporal and spatial characteristics of the MJO (Arguez et al., 2005), but significant portions of its variability spectra are still not well characterized, e.g. due to the present-day difficulty of observing ocean surface winds in heavy precipitation.

With the upcoming launch of CYGNSS, scheduled for fall 2016, we will have the opportunity to better characterize, constrain, and understand the dynamics of the MJO and the relationship between its variability and that of surface fluxes and precipitation in the tropics. In particular, CYGNSS will provide a new capability to observe ocean surface winds with high temporal and spatial resolution in all precipitating conditions. Accordingly, proposals for the following study topics are solicited:

- Use the unique temporal and spatial sampling characteristics of CYGNSS to help characterize the diurnal and other properties of dominant tropical wave features, including: Convectively Coupled Equatorial Waves, Kelvin Waves, Equatorial Rossby Waves, and Mixed Rossby-Gravity Waves.

- Examine the coupling and feedback mechanisms between wind-driven surface fluxes and tropical convection in general, and mesoscale convective systems in particular. Combine CYGNSS gridded wind speed products with GPM gridded precipitation products (e.g. IMERG http://pmm.nasa.gov/category/keywords/imerg) to characterize empirical constraints on the behavior of the coupling and feedback mechanisms.

- Combine CYGNSS with other tropical ocean and atmosphere observations and model outputs to characterize and explain the relationship(s) between the phase of the MJO and diurnal variations in ocean surface winds and fluxes.

Further details about the CYGNSS mission are available at http://cygnss-michigan.org. Studies that are not based on the use of on-orbit CYGNSS data products will be considered nonresponsive to this subelement.

References:

Arguez, A., M. A. Bourassa, and J. J. O'Brien, 2005: Detection of the MJO Signal from QuikSCAT. J. Atmos. Oceanic Technol., 22, 1885-1894.

Seo, K.-H., and W. Wang, 2010: The Madden–Julian Oscillation Simulated in the NCEP Climate Forecast System Model: The Importance of Stratiform Heating. J. Climate, 23, 4770-4793.

Zhang, C., 2005: Madden-Julian Oscillation, Rev. Geophys., 43, RG2003, doi:10.1029/2004RG000158.

2.3 Lightning Imaging Sensor (LIS)

The Lightning Imaging Sensor (LIS) is a space based instrument used to detect the distribution and variability of total lightning (cloud-to-cloud, intracloud, and cloud-to-ground lightning) that occurs in the tropical regions of the globe. LIS operated on board the TRMM (Tropical Rainfall Measuring Mission) satellite for 17+ years and now a spare copy of TRMM LIS has been refurbished and made ready for operation onboard the ISS later this year. An updated instrument known as the Geostationary Lightning Mapper (GLM) has also been developed and is listed for operation onboard the GOES-R satellite that is scheduled for launch in October 2016.

Lightning can be quantitatively related to both thunderstorm and other geophysical processes across a broad range of disciplines, making it an effective and valuable remote sensing tool to address a variety of science and related applications phenomenon. Starting with launch of OTD (Optical Transient Detector) in April 1995 and TRMM LIS in November 1997, a large amount of space based lightning data has been archived at the NASA Global Hydrology Research Center (https://ghrc.nsstc.nasa.gov/home/access-data). Data from ISS LIS and GLM is also expected to be archived there.

Research opportunities enabled by the detection of lightning from space are offered in this ROSES element. Specific research topics of scientific importance are identified below. Again, this is not a complete list and not all items listed below are likely to be covered by the proposals that are selected for funding in this solicitation.

1) Provide information on the total rain volume and degree of convective activity in the core regions of tropical and extra-tropical storms and storm systems, particularly as relevant to severe weather occurrence.
2) Study the global distribution of lightning and its relationship to storm microphysics and dynamics, its dependence on regional climatic environments and their changes, its relationship to precipitation and cloud type, and the incorporation of these relationships into diagnostic and predictive models of global precipitation, the general circulation, and the hydrological cycle.
3) Develop global lightning climatology in order to study the distribution and variability in lightning frequency as an indicator of the intensity of the Walker and Hadley circulations and assess the impact of sea surface and land surface temperature changes on the distribution and intensity of thunderstorms, including extreme weather events.

2.4 A Field Experiment to study Convective Processes (CPEX) in the tropics

The atmospheric processes that lead to convective initiation, and that determine convective organization and its upscale growth, are still poorly understood. Not only are these processes critical to the development of severe weather, they are also important in the resulting vertical transport of heat and moisture and to the cloud and radiation feedbacks that have a large impact on the climate system. Therefore, they need to be represented realistically in weather models. Yet because the models have finite (and rather coarse) spatial resolution, any representation of convective processes has to parameterize at least some of the physical relations between pressure, temperature, moisture, motion, and the phase changes of water and their dynamical, thermodynamic and radiative effects. We need to improve our understanding of these relations in order to improve their representation in the models and improve our ability to model convective initiation and organization.

Some of the broad questions include:
- What leads to convective initiation?
- What are the relative roles of the environment and the convective storms in determining the convective organization?
- What are the factors that limit the storm growth?

Areas of organized convection over the tropical ocean can decay rapidly due to organized downdrafts. Such convective areas may give the impression of forming into a tropical depression, only to essentially dissipate within 6-12 hours, to the surprise of forecasters. How does the low-level wind field evolve in these instances? How does the divergence field organize itself? How far out from the center does the outflow typically extend and how effective is it in preventing the original convection from regenerating, or in triggering new convection along the outflow boundary? Studies of this nature will be encouraged.

When a large mass of Saharan air moves over the Atlantic it is often associated with a "surge in the trades." How does this surge manifest itself in the low-level wind field? How are the fluxes of sensible and latent heat, the drivers of tropical cyclone development, affected by these wind surges? These are the types of questions related to the organization of convection or its disruption that are worth exploring.

This opportunity relates to the conduct of a Convective Processes Experiment (CPEX) in 2017 to study the organization and disruption of convective activity in the tropics. This four-week experiment will take place during June and July 2017, and will be based at Saint Croix, U.S. Virgin Islands. NASA will provide the DC-8 aircraft, a coherent Doppler wind lidar (https://airbornescience.nasa.gov/instrument/DAWN) for wind retrievals in the planetary boundary layer below 4 km, a Doppler radar (http://airbornescience.jpl.nasa.gov/instruments/apr-2) to monitor the convection and rains, and dropsondes to provide a broader picture of the tropospheric environment. It is expected that funding will be available to fly the DC-8 for approximately 100 research hours. With CPEX, NASA is also interested in supporting the calibration/validation activities related the European Space Agency's ADM/Aeolus mission scheduled for launch in 2017. In particular, there is interest in developing simulated wind velocity retrieval algorithms under tropical conditions.

Through this call NASA is seeking three types of proposals; 1) a one year proposal (see the next paragraph for a three year proposal) to provide an instrument that has flown on the NASA DC-8 before and that includes funding for field deployment, data processing, and data archival; 2) up to three year proposals for using CPEX data and participating in tropical convection research; and 3) A Team Leader supplement to a Type2 proposal. Up to two extra pages may be added to the Type2 proposal for this Team Leader supplement along with a separate budget for this component. The team leader will be responsible for onsite flight planning and will be an expert in meteorological forecasting and interpreting real time satellite data products.

This paragraph refers to only Type1 proposals. Type1 proposals are expected to be fairly straightforward and concise. Apart from the detailed budget, these should provide a list of previous field campaigns in which these instruments have participated, a justification for participation in CPEX, and a metric (publications, number of users etc.) by which it is possible to judge how useful the proposed instrument has been in the past. There is a five-page limit for these proposals. Instead of submitting a Type1 proposal, potential instrument providers may submit a Type2 (15 page limit) and, if desired, a Type3 proposal (17 page limit). In these cases, NASA needs to be able to separate the proposed costs to permit funding of only one Type if that should be selected. The NSPIRES-based (or Grants.gov form) budget must include all costs for any combined proposal. The budget justification and total budget files must then be used to describe the breakdown in costs for each proposal type, to permit NASA to understand the cost of selecting only one of the proposed types (e.g., if the Type2 is funded, but not the Type1 instrument). Awards may be contingent upon proposers providing a revised budget. Recall that any discussion of salary should be confined to the separately uploaded “total" budget file, but non-salary costs (and person time) should be described in the justification section of the proposal.

Proposers for CPEX should include the costs of necessary travel within their proposals. For Type1 proposals, this should include costs for required personnel to upload instruments for one week at Armstrong Flight Research Center in California and four weeks in the field in Saint Croix at established per diem rates, as well as the necessary air travel. Type2 and Type3 proposers should include funding for any in-field participation and associated travel during the Saint Croix deployment that they feel may be required as part of their proposal (note Type2 proposals are not required to have in-field presence as part of their proposal; it is available as an option if desired by both the proposer and the program manager), as well as for travel to the Washington, DC area each year for a three-day CPEX team meeting.

3. Summary of Key Information

Expected annual program budget for new awards	~ $3.2M first year and ~$2.7M in year 2 and year 3. See Section 2.
Number of new awards pending adequate proposals of merit	~ 18
Maximum duration of awards	3 years.
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*

Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*
Planning date for start of investigation	5 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	15 pp for all proposals except 5pp for Type1 and 17 pp for Type3 in Section 2.4; 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 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	NNH16ZDA001N-WAAD
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 E-mail: 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 the 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

Priorities for new research within ESI continue to derive from the goals and objectives for Earth science presented in several strategic documents:

- The *NASA 2014 Science Plan* (http://science.nasa.gov/media/medialibrary/2015/06/29/2014_Science_Plan_PDF_Update_508_TAGGED.pdf)
- The Solid Earth Science Working Group (SESWG) report, *Living on a Restless Planet* (2002) (http://solidearth.jpl.nasa.gov/seswg.html)
- Review of the SESWG report by the National Research Council (NRC), *Review of NASA's Solid-Earth Science Strategy* (2004) (http://books.nap.edu/catalog/11084.html)
- The NRC Decadal Survey, *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond* (2007) (http://www.nap.edu/catalog/11820)
- NASA's 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) (http://science.nasa.gov/media/medialibrary/2010/07/01/Climate_Architecture_Final.pdf)
- The NRC report *Precise Geodetic Infrastructure: National Requirements for a Shared Resource* (2010) (http://www.nap.edu/catalog.php?record_id=12954)
- 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 ESI strategy is founded on the six scientific challenges identified in *Living on a Restless Planet*: 1) What is the nature of deformation at plate boundaries and what are the implications for earthquake hazards, 2) how do tectonics and climate interact to shape the Earth's surface and create natural hazards, 3) what are the interactions among ice masses, oceans, and the solid Earth and their implications for sea level change, 4) how do magmatic systems evolve and under what conditions do volcanoes erupt, 5) what are the dynamics of the mantle and crust and how does the Earth's surface respond, and 6) what are the dynamics of the Earth's magnetic field and its interactions with the Earth system?

Guided by these core questions, ESI requests the following types of research investigations in 2016. 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. Deep-Earth Processes: Geopotential field or geodetic research that advances the understanding of the Earth's deep interior. Proposals that address mantle rheology and dynamics or core-mantle coupling are especially encouraged.
2. Lithospheric Processes: Research utilizing time-dependent remote-sensing data sets that advances the understanding of lithospheric processes or properties at regional to global scales.

2.1 Deep-Earth Processes

The dynamics of the mantle and core fundamentally drive the evolution of the Earth's shape, its orientation and rotation, plate motions and deformation, and the generation of the magnetic field. Complete understanding of these global-scale processes requires the perspectives provided by space-based and other remote-sensing observations. This subsection seeks research using geopotential field or geodetic methods and associated modeling and analysis to advance the understanding of the Earth's deep interior and its interdependencies with the Earth's lithosphere and fluid envelopes. Knowledge of mantle rheology and dynamics is critically informed by space-based observations of changes in topography, gravity, and geomagnetism. Energy exchange at the core-mantle boundary due to lateral variations in heat flow and topography manifest in changes in Earth's rotation and influence the magnetic field. Proposals under this subsection that advance our understanding of the mantle through its connections with the lithosphere or core are especially encouraged.

2.2 Lithospheric Processes

The wide field of view afforded by space-based and other remote-sensing observations provides unique opportunities for holistic assessment of lithospheric rheology, and the material properties and evolution of geologic, tectonic, and magmatic provinces. At these scales, discrete dynamic solid-Earth events such as earthquakes and volcanic eruptions must be characterized within the context of broader lithospheric deformation, fault systems, and the magmatic cycle. Perturbations driving signals of interest may be associated with natural or large-scale anthropogenic drivers. This subsection solicits proposals that will develop new methods for the utilization of time-dependent remote-sensing data sets that advance the understanding of lithospheric processes or properties on these regional, continental, or global scales. As the availability of near-global observations of geodetic and spectral properties increases, new scientific opportunities will meet with challenges in data management, analysis, and modeling. Growing real-time GNSS data resources are available through the Crustal Dynamics Data Information System Distributed Active Archive Center (CDDIS DAAC). Sentinel-1A C-band synthetic aperture radar (SAR) data are now available through the Alaska Satellite Facility (ASF) DAAC. Future ALOS-2 and SAOCOM imagery may provide new sources of L-band SAR imagery to consider in preparation for addressing objectives within the surface deformation science focus area of the planned NISAR mission. ASTER and MODIS provide complementary measurements of temperature, emissivity, reflectance, elevation, and aerosol content that can be exploited in advance of volcanology objectives for the Hyperspectral Infrared Imager (HyspIRI) mission concept. Coupling legacy data with the growing density of modern observations can yield decadal time series that require similar approaches to analysis and modeling as future influxes of data will demand. This subsection also welcomes proposals that focus on the use of simulation to explore optimal distributions of sensor networks and methods for integrating multiple of the data types described above towards answering specific questions in lithospheric processes.

3. Additional Proposal Requirements

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 Shuttle Radar Topography Mission (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 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, Ørsted, 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 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.

4. Summary of Key Information

Expected annual program budget for new awards	~$2.5M
Number of new awards pending adequate proposals of merit	~12-18
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	January 1, 2017
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	NNH16ZDA001N-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 E-mail: ben.phillips@nasa.gov

A.25 RAPID RESPONSE AND NOVEL RESEARCH IN EARTH SCIENCE

NOTICE: Updated August 23, 2016. The point of contact has changed to Laura Lorenzoni. See Section 5, The Summary Table of Key Information.

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.
- Prior to proposal submission, contact the most relevant NASA program officer (http://science.nasa.gov/researchers/sara/program-officers-list/#earth) and the current 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).
- Note that support for "limited duration opportunity for an unanticipated research collaboration" that had been included previously but was first eliminated in ROSES-2015 is not being planned for inclusion in any further editions of ROSES, including ROSES-2016.
- Be aware that 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.

1. Introduction

In order to address its strategic goals and objectives (see Section I of the *ROSES Summary of Solicitation*), 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.

In the past, SMD has supported such research through unsolicited proposals and/or the former Innovative Research Program. SMD Earth Science no longer considers such unsolicited proposals and instead solicits them through this program element. 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 rapid response, and 2) novel new ideas of potential high merit and relevance for ESD science 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, disasters, and/or similar unanticipated or unpredictable events. 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 events causing large-scale and 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 on remote sensing of the Earth that 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 elements, 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-2013–ROSES-2015, 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 few proposals will meet these criteria each year and that selection and funding of such proposals will be a rare, but 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 space-based measurements to provide information about the Earth system.

4. Programmatic Information and Additional Requirements

4.1 Proposal Structure, Content, and Budget Requests

All 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 prior to submission 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.

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). 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 Earth science 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 which are discouraged for this area as noted in Section 2.2 above ("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 and at modest cost (e.g., ~$75-150K), and that continued funding would be derived from proposals to ongoing research programs or one of the other periodic ROSES elements (e.g., competed mission science teams, Interdisciplinary Science). 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-2016 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 benefitting program.
Number of new awards pending adequate proposals of merit	The number of proposals selected will be dependent on the availability of funds from the benefitting program 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 31, 2017
Planning date for start of investigation	1½ 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 Chapter 2 of 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	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	NNH16ZDA001N-RRNES
NASA point of contact concerning this program	**Laura Lorenzoni** Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 **Telephone: (202) 358-0917** **E-mail: laura.lorenzoni@nasa.gov** **[Updated August 23, 2016]**

A.26 AIRBORNE INSTRUMENT TECHNOLOGY TRANSITION

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, typically in the form of improved process models, 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 (IIP Program element A.42), or by similar NASA or externally-supported (e.g., corporate, other Federal agency, internal institution funding) programs or activities. 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 to campaign-ready airborne configuration(s). No funding is available for research and development of new instrumentation. 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)[1], 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 goals and activities of existing and future (both those currently being planned and those that are still in the conceptual stage) field campaigns sponsored by the NASA Research and Analysis program; activities that support both one or more of the focus areas and can contribute to the goals and activities of the NASA's Applied Science Program[2] are also welcomed. Examples of previous field campaigns can be found at the Airborne Science Website.[3]

[1] http://esto.nasa.gov/
[2] http://appliedsciences.nasa.gov/
[3] http://airbornescience.nasa.gov/

Proposers may find information on selections from previous calls for this element at NASA's NSPIRES web site.[4]

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 http://science.nasa.gov/media/medialibrary/2010/07/01/Climate_Architecture_Final.pdf.
3. NASA missions listed in the table found at http://science.nasa.gov/earth-science/missions/.

2. Programmatic Information

2.1 Data Management and Data Access

NASA supports a data policy of open access to scientific data. Scientific advancement is generally enhanced by broad access to and use of scientific data. Therefore, proposers should specify how the instrument and its products would be made available for use by, or in concert with, a broad community of Principal Investigators (PI), and address any issues concerning data access. Proposers should provide this information in the mandatory data management plan text box on the NSPIRES cover pages at the time of submission. Please refer to the NASA ESD data policy[5] for more information.

2.2 Available Funding and Period of Performance

Yearly funding guidance is given in the "Summary of Key Information" (Section 3) of this announcement. Funding for subsequent use, maintenance, repair, and/or upgrading of AITT "graduates" should be requested by proposing to future ROSES elements for research and analysis (R&A) programs and/or calibration/validation activities. Since it is expected that the AITT program element will support the full transition of airborne instruments into the regular research and analysis program(s), successor proposals to the AITT for those funded once are very strongly discouraged unless there will have been significantly enhanced technical development to the underlying instrument concept in the period since completion of the AITT-funded work, e.g., through additional support under NASA's Instrument Incubator Program (IIP) or other technology development activities. Under no circumstances are "consecutive" proposals to AITT contemplated.

Proposals for two-year projects are strongly encouraged, but proposers may request up to a 30-month period. Proposals requesting more than 24 months (but not exceeding 30 months) should provide a strong rationale for the need and advantage gained by the additional project duration. In all cases, it is expected that at project conclusion the instrument will be complete and ready for campaign deployments.

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[4] http://nspires.nasaprs.com/external/
[5] http://science.nasa.gov/earth-science/earth-science-data/data-information-policy/

2.3 Program Element Specific Requirements

In addition to the standard rules of the ROSES solicitation, which includes reference to the *Guidebook for Proposers*, proposals submitted in response to this program element are subject to the following additional requirements:

Proposals must provide a description of the existing instrument and a clear assessment of what it will take to make the instrument suitable for reliable and regular airborne operation. This means the instrument will perform under a wide variety of airborne-deployment scenarios, with high reliability, including in "campaign" mode in which multiple flights would be made over short duration periods, potentially from remote locations with limited time and resources available to make modifications and/or repairs between flights. Moreover, flights sometimes take place under challenging weather conditions (extreme cold, turbulence, etc.) and Airborne Instrument Technology Transition (AITT) instruments must withstand the rigor of regular airborne operations and should allow accommodation as part of multiinstrument payloads without interfering with other instrument systems.

Besides clearly stating its relevance to one or more of the Earth Science Focus Areas, the proposal's narrative must provide one or more scenarios for potential use of the instrument including objectives, location(s), duration, candidate platform(s), other synergistic instruments that could be constructively co-manifested; and, other information that illustrates how the proposed instrument operations would further NASA objectives. The proposers should identify what science parameters would be produced by the instrument and how the instrument output would be processed to produce these parameters. Where such observations and measurements are made of localized phenomena, concepts which involve using instrument output to re-direct the instrument, aircraft or spacecraft to an advantageous observing point or angle should be described.

All proposals must include a description of the process that will be followed to be in compliance with Chapter 2 of NPR 7900.3C[6] *Aircraft Operations Management, Airworthiness and Maintenance.*

2.4 Technical Reporting Requirements

The Earth Science Technology Office (ESTO) will provide assistance in managing performance of the awards made under this program element. Therefore, all status information, presentation materials, and reports deliverable for this program element shall be submitted through the ESTO web-based AITT-16 Award Administration e-Book (herein after called e-Books). Reporting submissions to e-Books shall be made in Microsoft PowerPoint (preferred), Adobe PDF (unlocked, searchable PDF files are required), Microsoft Word, or Microsoft Excel. User accounts for e-Books will be provided to the Principal Investigator (PI) upon award.

The following deliverables are required of awarded proposals:

- Initial plans and Reports;
- Quarterly Technical Reports;

[6] http://nodis3.gsfc.nasa.gov/displayDir.cfm?t=NPR&c=7900&s=3C

- Interim Reviews, Annual Reviews, and a Final Review; and
- Final Report (a ~20 page narrative paper)

More information on these reporting requirements can be found at https://esto.nasa.gov/AITT_reportingrequirements.html.

In cases where Co-Investigators (Co-I), partnerships, or subcontract arrangements exist in a Project Team, the submission of consolidated reports is the responsibility of the PI. The proposed budget should provide for these reporting requirements.

3. Proposal Content

Proposal style formats shall be in accordance with Section 2.2 of the *Guidebook for Proposers*. The "Scientific/Technical/Management Section" of the proposal shall be limited to 15 nonreduced, single-spaced typewritten pages. Scientific/Technical/Management Section write-ups that exceed this limit will be truncated at 15 pages prior to the Proposal's review.

For consistency of the evaluation process, proposals shall include the content described here (Section 3.X) formatted in sections that follow the outline and titles used below. Failure to provide any of this material may be a cause for the proposal being judged as noncompliant and returned without further review.

3.1 Proposal Summary

The proposal summary is an abstract pasted into the mandatory 4000 character limited Proposal Summary field in the NSPIRES cover pages that provides an overview of the proposed investigation that is suitable for release to the public should the proposal be selected. The proposal abstract shall discuss the:

- Relevant Earth Science Focus Area(s), *Climate Centric Architecture* mission(s) or other NASA mission(s);
- Proposed work and methodology; and,
- Proposed period of performance.

3.2 Scientific/Technical/Management Section

This section completely replaces Section 2.3.5 of the *Guidebook for Proposers*.

1. Relevance to Earth Science Measurements in the Reference Documents - Clearly state the relevance to one or more of the Earth Science Focus Areas. The proposal narrative must provide one or more scenarios for potential use of the instrument, including objectives, location(s), duration, candidate platform, other synergistic instruments that could be constructively co-manifested and other information that would illustrate how the proposed instrument would further NASA objectives. Proposals that fail to include a relevancy scenario will be considered noncompliant and will be returned without review.

2. Description of Proposed Development - Describe the work to be performed. Include a description of the instrument, a description of its current status (including a summary of the recent advances through IIP or some other activity that make the instrument appropriate at this time for enhancement through the AITT), and a clear assessment of what it will take to make it suitable for reliable, regular airborne use by research and analysis programs and/or satellite calibration/validation activities.

3. Aircraft Operations Maintenance Compliance **-** Include a description of the process that will be followed to comply with Chapter 2 of NPR 7900.3C.

4. Comparative Technology Assessment – Describe the anticipated advantages of the upgraded instrument 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). Review the current state of the art and relate it to the proposed work.

5. Research Management Plan – Provide a statement of work that concisely describes each task or 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 project activities and critical milestones. At least two milestones per twelve-month period must be defined.

   Subcontracting portions of the project is acceptable and is the responsibility of the Principal Investigator and the sponsoring organization.

6. Personnel – Include a list of key personnel and identify experience related to the proposed activity. Proposers should be sure to demonstrate 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 PI. Optionally, one-page resumes for Key Personnel may be supplied; these resumes are not included in the overall page count.

7. Facilities and Equipment – Describe significant procurements, facilities, and equipment required to complete the work. (Note: Sections 7 and 8 do not count towards the 15-page limit)

8. Special Matters – Proposers should include a brief description of the organization, existing facilities, and previous work experience in the field of the proposal.

4. Proposal Evaluation

Proposals submitted to NASA in response to this program element will be evaluated using the standard criteria described in the *ROSES Summary of Solicitation* Section VI (a) with the following additions:

The evaluation of Relevance will be based upon the applicability of the proposed investigation to Earth Science Focus Area(s), Decadal Survey, Climate-Centric Architecture, and other science measurements and technology needs and specifically includes:

- The degree to which the proposed investigation specifically supports the objectives of at least one of the Earth Science Focus Areas (see Appendix A.1 for a description of the Earth Science Focus Areas)
- The potential for the upgraded instrument to provide improved data products, or to reduce the risk; cost; size; or potential development time of Earth science airborne investigations.
- The evaluation of intrinsic merit also includes the feasibility of the proposed technical effort for integration onto the proposed airborne platform(s) and the adequacy of proposed flight tests or demonstrations.
- The evaluation of the proposal against the state-of-the-art includes existing instruments and sources for collecting the data proposed from this instrument.
- Qualifications and capabilities of key personnel and the organization include strong science, technology, and instrument integration skills.

The evaluation of Cost also includes:

- Adequacy and realism of proposed milestones and associated success criteria.
- Use of sound and consistent management practices.

Cost sharing is not part of the peer review evaluation but cost sharing may be taken into account by the selecting official when deciding between proposals of otherwise equal scientific and technical merit.

5. Summary of Key Information

Expected program budget for new awards	~ \$2.0M/year for first two years and ~ \$1M for year 3
Number of awards anticipated	~ 4 to 6
Maximum duration of awards	30 months
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
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 *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 *Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required. See also Section IV in the *ROSES Summary of Solicitation* and Chapter 3 of the *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	NNH16ZDA001N-AITT
NASA point of contact concerning this program	Barry Lefer Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-3857 E-mail: barry.lefer@nasa.gov

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 2018 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.8), Ocean Salinity (Appendix A.9), Cryospheric Science (Appendix A.14), Upper Atmospheric Research Program (Appendix A.17), or Atmospheric Composition: Modeling and Analysis and Aura Science Team (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:

1. their formal relationship with the sponsoring agency's mission (e.g., selected participant, invited participant, or proposed participant);
2. the status of the mission within the sponsoring agency (i.e., Pre-Phase A, Phase A, Phase B, etc.), including the level of commitment that the sponsoring agency has made to complete development;

3. a description of the type and the characteristics of the data from this investigation, as well as any ancillary science data that will be archived as part of this investigation and a 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
4. 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). 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 in the *ROSES Summary of Solicitation*.
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. See 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	NNH16ZDA001N-ESUSPI
NASA point of contact concerning this program	Richard S. Eckman Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Tel: 202-358-2567 Email: Richard.S.Eckman@nasa.gov

A.28 INTERDISCIPLINARY RESEARCH IN EARTH SCIENCE

NOTICE: Amended September 28, 2016. Because the NSPIRES proposal submission system will be briefly unavailable on the evening of September 29, 2016, the due date for proposals has been delayed. Proposals are now due September 30, 2016.

1. Scope of the Program

This solicitation is for new and successor interdisciplinary research investigations within NASA's Interdisciplinary Research in Earth Science (IDS) program. Proposed research investigations will meet the following criteria: a) offer a fundamental advance to our understanding of the Earth system; b) be based on remote sensing data, especially satellite observations, but including suborbital sensors as appropriate; c) go beyond correlation of data sets and seek to understand the underlying causality of change through determination of the specific physical, chemical, and/or biological processes involved; d) be truly interdisciplinary in scope by involving traditionally disparate disciplines of the Earth sciences; and e) address at least one of the five specific themes listed in this solicitation:

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

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.

1.1 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 scientists, and developing the necessary infrastructure to take full advantage of NASA satellite data.

The specific topics of the program have varied through time (see prior solicitations and awards at nspires.nasaprs.com), and this solicitation represents the development of new elements and the continuation of others.

2. Interdisciplinary Research Themes, Proposal Details, and Review information

Specific scientific topics and questions are identified as separate subelements within any given year's solicitation. These topics and questions constitute the complete set of scientific research topics solicited by the IDS program, and no priority should be construed from their relative order. Proposals submitted in response to this element must address at least one of these 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.

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 subelements, 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.

2.1 Subelement 1: Understanding the Global Sources and Sinks of Methane

Methane (CH_4) is an important greenhouse gas (GHG) with large natural and anthropogenic sources. It is responsible for 20% of the global warming produced by all well-mixed greenhouse gases, and constitutes 60% of the climate forcing by CO_2 since preindustrial times. It is an important driver of tropospheric ozone (O_3) and tropospheric OH, the primary atmospheric oxidant. Methane also contributes to water vapor (H_2O) in the stratosphere. Methane-induced cooling of the stratosphere (mainly due to increased water vapor) is a significant issue. However, the sources responsible for the methane trends during recent decades are poorly understood. The U.S. Global Change Research Program (USGCRP) has defined "Methane Cycling within the Carbon Cycle Framework" as a FY 2017 thematic interagency priority. The recent growth in atmospheric methane concentration (following a nearly ten-year plateau), the development of observational capability, the ability to build on advances from the combination of newly-available global data, and the evolving suite of global biogeochemical models all make methane a timely subject.

A NASA Atmospheric Composition Focus Area workshop, held in 2014 (https://espo.nasa.gov/home/sites/default/files/documents/SMDWorkshop_report_final.docx), noted that satellite observations of methane combined with *in situ* observations of fluxes are making important contributions to quantifying anthropogenic emissions (fossil fuel extraction and use, agriculture, landfills) and natural emissions (in particular, from wetlands). The workshop report concluded that better validated space-based methane measurements could constrain top-down approaches to deriving emissions. Satellite observations of methane will also need support from suborbital measurements, including co-emitted species (e.g., hydrocarbon ratios and agricultural tracers) and isotopic methane.

Methane emissions from terrestrial ecosystems play an important role in the atmospheric methane budget. These emissions can be grouped into two categories: biogenic and pyrogenic. Biogenic sources contain methane-generating microbes in anaerobic environments, such as natural wetlands and rice paddies, oxygen-poor freshwater reservoirs, digestive systems of ruminants and termites, and organic waste deposits (such as manure, sewage, and landfills). Pyrogenic methane is produced by the incomplete combustion of biomass and soil carbon during wildfires and of biofuels and fossil fuels. There is a growing database on these various terrestrial and aquatic sources, but the ability of biogeochemical models to accurately and realistically estimate and predict methane emissions from these diverse sources is limited. Better understanding and differentiating the role of managed versus unmanaged ecosystems in the global methane cycle is an important scientific challenge that needs to be addressed. Improving the use of remote sensing of the biophysical states, land use, and land cover properties of the surface as input into biogeochemical models is encouraged.

The role of the ocean in the global methane cycle, and the corresponding role of methane in the broader oceanic carbon cycle, is in need of further research. Given the potential for changes in methane cycling processes as the ocean continues to absorb atmospheric heat, and the potential for large positive feedback effects on global warming, further research is warranted in these areas. A focus on understanding the role of methane in the oceanic carbon cycle and the associated processes (physical, chemical, and biological) that lead to atmospheric exchange of methane with the ocean is, therefore, warranted. Linking increased understanding of these processes with existing atmospheric methane and global carbon cycle models is also of interest. Of particular interest are studies examining the impact of changing oceanic heat content on production (e.g., anaerobic methanogenesis), cycling (e.g., uptake and/or catabolism), and stored inventories (e.g., methane hydrates). As the Earth system and climate warms, it is possible that methane hydrates could destabilize and release methane, a major greenhouse gas, to the atmosphere. The carbon cycle and climate impact of this outgassing is of interest, particularly if the capability to model the outgassing and fate of the methane output could be quantified.

In this subelement, NASA solicits proposals that address research issues relevant to the global methane cycle. Potential areas of interest include, but are not limited to:

- Improved understanding of the processes, source types, and fluxes responsible for natural and anthropogenic methane emissions and emission trends;
- Analysis of the global methane budget over the past 40 years to reconcile observed changes in the ambient atmospheric methane mixing ratio for various zonal regions;
- Integration of top-down and bottom-up approaches to obtain a better understanding of the processes controlling methane sources;

- Research that integrates some or all of terrestrial and aquatic methane sources and sinks into a mechanistic and predictive framework;
- Analytical approaches for separating the contributions and possible interactions of managed versus unmanaged ecosystems to overall methane emissions;
- Using satellites to detect oceanic methane release, from hydrates or other sources, with an eye towards tracking the oceanic release of methane into the atmosphere;
- Understanding, quantifying, and/or modeling methane in the ocean or methane that is transferred from ocean to atmosphere, including novel approaches to track a surface ocean or ocean to atmosphere signature of methane release; and
- Utilization of climate models to simulate the current evolving sources and sinks of methane and the evaluation of methane's near-term climate effects and feedbacks.

In addressing this subelement, proposers are expected to link several of the topics described above through the significant use of space-based remote sensing data (with preference given to NASA-produced data sets). Space-based data may be used, together with data from airborne sensors, surface-based instruments, and/or models of sufficient scope to address the coupled aspects of the problem. Proposed projects are expected to include primarily data analysis and modeling. However, some modest additional airborne and/or surface-based measurements are allowed. All costs for these measurements (e.g., flight hour costs, travel, etc.) must be included in the proposal budget. Proposals are expected to be interdisciplinary in scope and to specifically address the connections addressed in this subelement. Proposals that address only a single component (e.g., solely atmospheric composition) will be considered nonresponsive to this subelement. Multidecadal future climate simulations are not encouraged.

2.2 Subelement 2: Ecology at Land/Water Interfaces - Human and Environmental Pressures

Land/water interfaces, including coastal regions, hold tremendous economic, recreational, and commercial value, supporting extensive resources, such as fisheries and agriculture. Coastal areas and freshwater ecosystems are highly sensitive ecologically and among the most threatened environments on Earth. These regions will change if not properly managed and/or protected. For example, one of the major pressures on land/water interfaces affecting the availability of ecological resources is urbanization. Urban encroachment is affecting coastal areas and freshwater ecosystems worldwide. The extent of conversion of near-coastal and other wetland areas to farmland and the abandonment of historic farmlands to urban or peri-urban settlement are both increasing. Research and management communities must work together to understand the impact of environmental change, climate change, land use decisions, and human activities on dynamic ecosystems at the land/water interface. Managers must ensure ecosystem resilience through collaborative planning, using the results of basic research activities to enable informed decision making and the sustainability of natural resources.

Causes, drivers, and impacts of an expanding human population are reflected in land cover/land use practices, the terrestrial hydrology and ecology, and associated ocean biology and biogeochemistry. Therein, this announcement encompasses coastal areas traditionally defined as marine or saltwater, and it also includes ecosystems associated with streams, lakes, and other land/water interfaces where local ecosystems are subject to human and environmental pressures. NASA welcomes proposals that seek to understand and quantify the impacts and feedbacks of human and environmental influences on land/water interfaces (including coastal) ecosystems with a focus on the biology and ecology of these ecosystems. Locally-induced changes (e.g., due to urbanization or other land use change) do not occur independent of other changes, such as those coming from regional changes associated with global change (e.g., sea level rise, change in precipitation). Studies that take these broader-scale changes into account as part of studies addressing more locally human-induced changes in coastal (or other land/water interface areas) are of particular interest. The objective is to understand, quantify, and model how the specific effects of humans and environmental variability and change impact the ecosystems (structure, composition, function) at the land/water interfaces. One example might be to quantify the biological impact(s) and feedback(s) of human populations and urbanization to local wetlands. Incorporation of retrospective studies or data analyses is also welcome, specifically studies that may look at future ecosystem impacts based on knowledge of the past Earth system or environmental variability and change or human influence (using models whose application is verified by the observations). Any retrospective analyses should make a clear link to an assessment of future ecosystem changes and take into account different scenarios for environmental or human forcing in the future

Integrative research is sought to apply NASA remote sensing (satellite and/or suborbital) observations to the characterization of biological and ecological impacts of human pressures and environmental (including climate) variability and change on the land/water interface. For example, within the domains of coastal zone ecology or freshwater ecology, a wide variety of terrestrial and aquatic ecosystem impacts and vulnerabilities could be addressed in proposals submitted in response to this subelement of the solicitation, but not all will be equally important. Therefore, proposals must offer compelling rationales as to 1) the clear definition and "geographic" boundaries of the ecosystem(s) under study, 2) why the impacts and/or vulnerabilities of a given ecosystem(s) to be studied are expected to be highly significant, representing major perturbations to the Earth system, and 3) how the remote sensing data products to be utilized in the study provide unique and powerful information for addressing the ecosystem(s) research issues/questions posed. Ecosystem in this context could be defined on any number of scales, but the ecosystem under study and planned research must be compellingly defined and justified in the global context.

NASA seeks projects that combine existing (a) satellite data (including, but not limited to NASA's), (b) field observations, including suborbital remotely sensed data, and (c) observationally-driven models to address the challenges of understanding the impacts and feedbacks of environmental change and/or human pressures on ecosystems at the land/water interface. Proposals must include all three of these elements. Projects should use existing NASA satellite data, existing suborbital data, and/or existing field data, although new data collections (*in situ*, suborbital, or remote) may be proposed, if justifications for the new satellite and suborbital remote sensing data collection and/or field observations are compelling. Projects should delineate and justify the scientific basis for the proposed geographic region of study (the land/water ecosystem). The goal is to provide an understanding of and predictive capability for ecosystem organization and management, especially accounting for the drivers of human pressure and environmental variability and change

2.3 <u>Subelement 3: Understanding the Linkages Among Fluvial and Solid Earth Hazards</u>

2.3.1 *Background*

Extreme hazard events may trigger a series of cascading hazards that can collectively pose a greater societal risk than the initial source event. In this subelement, NASA would like to move beyond the study of individual and isolated major regional hazards and begin to understand the physical linkages between the initial trigger event and the subsequent hazards. Extreme hazards are infrequent, significant events often impacting a large geographic area (hundreds of square kilometers), have global implications, and/or have broad societal impact. The associated cascading hazards collectively have a similar scale or may be more significant than the initial trigger. This subelement focuses on the understanding the relationships, interdependencies, preconditioning parameters, triggering thresholds, and tipping points among fluvial and solid Earth hazards that can be ascertained with remote sensing data alone or when coupled with additional *in situ* data.

There have been several extreme hazard events in the past few decades that have triggered multiple cascading hazards. The 1991 eruption of Mount Pinatubo injected an estimated 20 million tons of sulfur dioxide and ash particles into the stratosphere, which circled the globe for weeks, influencing atmospheric chemistry and climate for the next several years. The eruption, in combination with monsoons and a typhoon that coincidentally followed, killed hundreds of people, sent ash, lahars, and mudflows across the landscape and into the ocean, thereby decimating regional ecosystems, rendering cropland unusable, killing corals, significantly impacting the fisheries, and altering watersheds. Another set of examples is the major woodland fires in the Western U.S. throughout the past two decades that have burned and sometimes reburned hundreds of thousands hectares. Following the fires, the denuded landscapes have an elevated time-varied susceptibility for fluvial driven hazards such as debris flow, landslides, flooding, and other dynamic topographic/fluvial hazards that often extended well beyond the boundaries of the initial burn area. A final example is the 2015 Gorkha earthquake in Nepal, which triggered over 3,500 landslides and avalanches in the Himalayas, many of them either partially or completely damming rivers in the valleys below, resulting in localized flooding and the potential risk of debris dam failures. Monsoon rainfall following the earthquake sequence triggered additional river crossing landslides and other mass wasting events, thereby putting communities upstream and downstream at an elevated risk.

2.3.2 *Scope of Program*

NASA's Earth Science Division coordinates a series of satellite and airborne missions for long-term global observations of the land surface, biosphere, solid Earth, atmosphere, and oceans. This approach enables an improved understanding of the Earth as an integrated system. In this subelement, NASA requests proposals that move beyond the study of individual hazards and investigate the fundamental process, critical preconditioning parameters, and the tipping points that are associated with triggering either a secondary hazard or a series of cascading hazards through the integration of space-based remote sensing data with *in situ* observations and computer modeling. The goals of this solicitation are (1) to advance our fundamental understanding about the linkage between and among hydrology and solid Earth hazards, (2) to develop predictive models that identify possible solid Earth-hydrology related cascading hazards and estimate their scale, spatial magnitude, and location (as appropriate for the hazard) based on the initial trigger event and relevant preconditioning observations and, (3) to develop hydro-topography scaling parameters that transform our understanding of local processes and address regional and global sediment transport and mass wasting processes.

Successful proposals to this subelement will (1) develop an interdisciplinary research approach that incorporates representative members of the solid Earth, terrestrial hydrology, and modeling communities and (2) will exploit the unique role that satellite and airborne remote sensing data can play in understanding the causes and impacts of these "downstream" events.

Some of the science questions that NASA is interested in include, but are not limited to: What are the relationships, interdependencies, preconditioning parameters, triggering thresholds, and tipping points between hydrology and solid Earth hazards that can be ascertained with remote sensing data alone or when coupled with additional *in situ* data? How can these remotely sensed factors be used to understand the likelihood of triggering a secondary hazard or a series of cascading hazards and to understand how the likelihood evolves over time? How do changes in climatic patterns, such as precipitation regimes, influence the scale, magnitude, and location of both the initial event and the potential for triggered hazards that follows? How do changes in climatic patterns influence future hazard susceptibility? Potential linked hazards include, but are not limited to: understanding the significance that soil moisture, rainfall intensity/duration/direction, climatic and environmental variability, slope aspect, and topography parameters relate to mass wasting potential (landslides, lahars, debris flows, large-scale sediment transport) following volcanic eruptions, earthquakes, fires, or droughts; and understanding how these parameters can be scaled with remote sensing observations to address and forecast large-scale regional and global hazards.

Proposals to this subelement must:

- Make significant, but not necessarily exclusive, use of NASA produced remote sensing data and/or products.
- Be interdisciplinary in scope. Proposals must include substantive involvement of investigators from the solid Earth, terrestrial hydrology, and modeling communities
- Proposals may additionally include investigators from other disciplines, such as ecosystem and/or social scientists.
- Address the multihazards connections between a solid Earth hazard and a nonsolid Earth hazard component (e.g., hydrology). Proposals that address only a single hazard (e.g., just earthquakes or floods) will be considered nonresponsive to this subelement.
- Go beyond correlation of datasets and use models to connect observations and gain new insight into the physical processes and underlying causality.
- Develop approaches that can be broadly applied and are not tied to site-specific examples.

Substantive connection to NASA-conducted remote sensing data or distributed products is required in all proposals; proposals may include use of non-NASA data in addition to that from NASA. Proposers are encouraged to utilize existing or planned ground, airborne, and space-based observational capabilities and their associated data sets. This solicitation will support limited purchase of new satellite data and limited collection of new airborne imagery – see below for requirements. This solicitation will focus on scientific linkages of cascading hazards and will not consider real-time or near real-time disaster management and disaster response proposals that directly support disaster decision support systems. Large area floods that are only initiated by large storms or hurricanes/typhoons will not be considered in this solicitation.

2.4 Subelement 4: Life in a Moving Ocean

Upcoming NASA missions (e.g., SWOT) will resolve energetic scales of motion in the ocean that have never been sampled globally. The planned Pre-Aerosol, Cloud, ocean Ecosystem (PACE) mission will make unprecedented observations of ocean ecology. These missions will provide an opportunity to make available global high-resolution observed ocean currents for co-registration with ocean ecosystem data. Delineation of the associated physical and biological fronts in conjunction with finer-scale data on the movements of organisms will enable tracking of marine fish and mammal species and patches of marine debris patches. It will also promote efforts to understand better the dynamics of marine biogeographic provinces, which regularly reconstitute themselves temporally and spatially across the global ocean.

NASA seeks proposals to enable preparations for future space missions by improving its current ability to integrate remote sensing of ocean motion at approximately 10km spatial scale with similar or finer scale data on the movement of marine fish, mammal, and other species, as well as the movement of marine debris. Coupling existing ocean current information from sources such as the Ocean Surface Current Analyses Real-time (OSCAR) and GlobCurrent data sets with the aforementioned types of biological movement information builds a foundation for improving understanding of how life moves in the world's oceans. Doing so has significant implications for ecosystem-based management.

Phytoplankton, the ocean's primary producers, and zooplankton, the ocean's primary consumers and the larvae of many higher-level consumers, make up plankton. Plankton health supports all levels of marine life, including commercial fish species and protected marine mammals. Plankton are distributed in the global ocean by surface currents, as well as by the impacts of surface currents on the vertical and horizontal movement of the ocean. Surface ocean currents can strongly influence the location of nutrients that support phytoplankton growth and transfer heat across ocean basins. Thus, currents are key mediators of global ocean ecosystems, as well as climate. Furthermore, currents are primary distributors of marine debris. Finally, through the physical formation of oceanic fronts, marine currents are first-order organizers of marine biomes, provinces, and ecosystems—the organizational components of marine biogeography.

This subelement seeks proposals to address the following high-level question:

How can the coupling of physical ocean current and ocean ecosystem data improve either: the ecosystem-based management of the ocean or our understanding of the organization of the dynamic biogeography of the marine realm?

All proposals to this subelement must use existing satellite and *in situ* observations, as well as models.

The evolution of smaller and more robust electronic devices to track the movement of fish, marine mammals, and other ocean species is driving new research in the expanding field of movement ecology. To date, these tools are rarely used in conjunction with satellite imagery in a manner that places the fine-scale organismal movement information into its broader and also dynamic environmental context. Aligning movement information with global ocean current data establishes a cause and effect framework that provides critical information about physical drivers of the geography of marine ecosystems. The union of these different types of data is required if we are to make progress in establishing a much more dynamic science of marine biogeography, i.e., a complex predictive science of life in motion within a fluid medium.

Proposals to this subelement must involve interdisciplinary teams of satellite oceanographers, marine biologists, and those with modeling expertise appropriate to the science questions proposed. Proposals must also include remote sensing information on ocean currents from satellite and/or airborne instruments, for example Advanced Very High Resolution Radiometer (AVHRR), the Jason series, QuikSCAT/SEAWINDS, and MODIS along with other satellite and airborne platforms. They must also include *in situ* field measures of the movement of marine fish, mammals, other organisms, or marine debris.

Proposals to this subelement should also include physical and ecological models that integrate the ocean physical and biological observations to address the science questions proposed. Proposals may incorporate a range of methodologies for resolving the complex dance of the geophysical and ecological elements of a given study area.

Here are some notional examples of specific proposal topics—meant only to be exemplary and not definitive or exhaustive.

- What was the impact of the 2011 Japan Tsunami debris on North Pacific fisheries?
- How are ocean circulation patterns moving abandoned fishing gear (e.g., ghost nets), widely distributed plastic particles, oil spills, or other oceanic hazards and what are the resulting impacts on marine ecosystems and organisms?
- Based on the movement of organisms and nutrients, how are biogeographic provinces organized within the vast pelagic realm and can we track their movement through time?
- Can information on surface currents and patterns of organismal movement inform better management in a time of changing climate?
- Can we bridge the current gap between our ability to remotely sense and model the distribution and abundance of phytoplankton taxa and our *inability* to remotely sense and model the distribution and abundance of zooplankton taxa?

2.5 Subelement 5 – Partitioning of Carbon Between the Atmosphere and Biosphere

An important feature associated with the continuing emission of carbon dioxide into the Earth's atmosphere from human activity is that, on average, only about half of the increased emissions remain in the atmosphere; the reminder are taken up by biophysical processes in Earth's biosphere (land surface and ocean). While these biophysical processes might continue to take up a significant fraction of fossil fuel and land use change emissions, it is also possible that they might diminish, disappear, or reverse direction in the future as human activities influence environmental and climate change. This is one of the major sources of uncertainty that must be reduced if scientists are to improve predictions of future climate. Thus, accurate representation of the processes that govern the longer-term exchange of carbon between the atmosphere and the biosphere is critically needed. If the strength of the biospheric carbon sink changes, then the sensitivity of climate to fossil fuel and land use change emissions also changes. This has potentially large implications as scientific input to public policy decisions.

The complexity of the carbon-climate system has been clearly demonstrated through existing observational evidence that the fraction of emitted carbon dioxide that is taken up by the biosphere can fluctuate significantly from one year to the next. Indeed, in certain years, the terrestrial carbon sink has essentially disappeared. Interannual and seasonal variability represent both a scientific challenge and an opportunity to our understanding of the biosphere response to environmental change and its feedback to the climate system.

In this subelement, proposals are sought that address the issue of the temporal variability of the uptake of carbon dioxide by the biosphere. While there is a particular interest here in addressing this phenomenon over a multidecadal time frame, studies that make use of the interannual variability to gain insight into decadal and longer-term variability are encouraged.

Studies proposed to this subelement must include coupled analyses of both atmospheric carbon dioxide and the terrestrial and/or marine biophysical processes that contribute to emissions and uptake, as well as the distribution of carbon stocks on land and/or in the ocean; studies that fully integrate the global carbon cycle to include atmosphere, land, and ocean are preferred. However, while studies should be global in extent, zonal, regional, and continental scale analyses that help determine the contributions and sensitivities of smaller scale phenomena to the global scale are also pertinent. All studies must make significant, but not necessarily exclusive, use of NASA-produced satellite data; use of NASA-produced or other airborne data is encouraged, but not required. Studies must use models that provide a representation of the relevant processes to integrate disparate data sets; studies that are based simply on empirical relationships, or correlation will be considered nonresponsive and returned without review.

Studies that both use existing data sets and address how data sets that NASA is looking to make available in the next few years (e.g., ICESat-2, GEDI, ECOSTRESS, NISAR, PACE) are of particular interest, but all studies must make use of existing data to test quantitatively the hypotheses based on currently available atmospheric and surface data.

While the expectation is that proposals to this subelement will make use of existing data, the opportunity exists for acquisition of small amounts of additional airborne data. The full cost of such data acquisition must be included with the proposal, and appropriate input based on discussion with the Airborne Science Program must be provided.

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 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.

4. Summary Table of Key Information

Expected program budget for first year of new awards	~$10.5M Total ~$2.5M/year each for subelements 1, 2, and 5; ~$1.5 M/year each for subelements 3 and 4
Number of new awards pending adequate proposals of merit	~ 4-6 each for subelements 1, 2, and 5; 3-5 each for subelements 3 and 4
Maximum duration of awards	3 years
Due date for Notice of Intent	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for Proposals	**September 30, 2016 [Amended September 28, 2016]**
Planning date for start of investigation	January 1, 2017
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 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	NNH16ZDA001N-IDS

Main NASA point of contact concerning this program. See below for points of contact specific subelements.	Overall: Jack A. Kaye Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-2559 E-mail: Jack.A.Kaye@nasa.gov

General questions about the IDS Program should be directed to the point of contact above. Questions about specific subelements should be directed to those listed below, all of whom share the same mailing address, listed below.

Earth Science Division
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 202546-0001

NAME	PROGRAM RESPONSIBILITY	TELEPHONE	E-MAIL
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A.29 NASA DATA FOR OPERATION AND ASSESSMENT

1. Program Overview

1.1 Background

NASA's Earth Science Research Program aims to use global measurements to understand the Earth system and its interactions as steps toward longer forecasts or better projections of Earth system behavior. To achieve this goal, a combination of shorter-term process-oriented measurements is complemented by longer-term satellite measurements of a limited number of environmental properties. For these measurements, NASA's Earth Science Research Program sponsors algorithm development, calibration/validation activities, and modeling studies to produce high-quality data products for scientific research and operational use.

While NASA recognizes significant advances already made by investigations which were solicited by prior NASA Research Announcements (NRAs) in the areas of sensor calibration, algorithm development and refinement, product validation, and scientific data analysis, this program element focuses on more widespread use of NASA satellite observations, especially in operational weather forecasting, Earth system model (ESM) developments, and ecological modeling, as well as coupled ecological-climate modeling. Evolving from prior solicitations (NASA Data for Operation and Assessment in ROSES-2010 and ROSES-2013), this program element offers investigators an opportunity to increase the impact of NASA data by transitioning the data and algorithms into the operational environment in two areas: Operational weather prediction and ecological or ecosystem-climate models. In addition, because of the recent priority to further constrain the Earth system models using NASA data especially in the upcoming Coupled Model Intercomparison Project Phase 6 (CMIP6), this solicitation offers an opportunity to research and develop data, algorithms, and methodologies for the validation, verification, and the overall assessment of the accuracy and deficiency of Earth system models. For ecosystem and ecosystem-climate models, this solicitation offers an opportunity to research and develop data, algorithms, and methodologies for the validation, verification, and the overall skill assessment of ecological or ecosystem-climate models using NASA satellite data. There is a recent priority from the GLACIER conference (http://www.state.gov/e/oes/glacier/index.htm) to address fisheries science in the Arctic ecosystem, which fits in to the overall solicitation to focus researchers and applied partners in assessing the utility of ecosystem and coupled ecological-climate models to inform ecosystem resource management and decision/policy makers.

2. Specific Areas of Proposals Solicited

Because each specific area will be treated differently, please read this section and also Section 3: Programmatic Information carefully.

2.1 Operational Short-term Weather Prediction

NASA is interested in the more rapid use of NASA's observations for operational weather prediction. Research and development proposals are, therefore, sought to accelerate the operational use of NASA data for the purpose of short-term (0-48 hour) weather prediction.

Proposals may be in the areas of transitioning existing near real-time data products into operational environments or of developing algorithms, methodologies, and processes in NOAA/National Weather Service Weather Forecast Office (WFO) or National Centers for Environmental Prediction operational environments to accept Suomi NPP (S-NPP), Global Precipitation Measurement (GPM), Soil Moisture Active Passive (SMAP), and International Space Station (ISS) Lightning Imaging Sensor (LIS) data:

- S-NPP - improved near real-time products and utilization of unique day-night band capabilities, land surface properties for inclusion in land surface or hydrologic models and numerical weather prediction, retrieval and assimilation of weather-relevant parameters from the VIIRS sensor, or retrieved profiles from Cross-track Infrared Sounder (CrIS)
- GPM – forecasting or analysis products that make better use of passive microwave observations, blended precipitation analysis with ground-based radar networks and gauges, permit discrimination of precipitation type (snow/ice/rain)
- SMAP - downscaling of radiometer measurements (including, but not limited to, use of synthetic aperture radar as augmentation) to improve regional weather and hydrologic prediction within the NASA Land Information System (LIS), and/or WRF-Hydro systems
- ISS-LIS – near real-time applications of lightning data for severe weather, use in monitoring of other lightning-induced hazards (e.g., wildfires and related smoke), data assimilation, or cross-calibration and improvement of other near real-time sources of lightning data.

Responsive proposals must include a clearly identified operational weather prediction model or environment into which the proposer plans to include NASA satellite observations. Proposals should also include a letter of support from an operational partner who currently manages the operational model or environment who are prepared to test, evaluate, and use the products or models operationally. The inclusion of a test plan and timeline for inclusion of NASA satellite data, into the operational weather prediction is highly desirable. Proposals using regional models, data assimilation systems, or weather information systems other than those currently employed by an operational entity will not be considered.

NASA has established the Short-term Prediction Research and Transition (SPoRT; http://weather.msfc.nasa.gov/sport/) Center (Dr. Andrew Molthan, Co-Principal Investigator (Co-PI) on SPoRT; andrew.molthan@nasa.gov) at NASA Marshall Space Flight Center to facilitate the transition of unique observations and research capabilities to the operational weather community to improve short-term forecasts on a regional scale. Collaboration with the SPoRT Center is required as follows:

1) The SPoRT Co-PI should be briefed on the scope of the project before submission of a Notice of Intent (NOI),
2) The proposed budget should include a 25% or up to $40K surcharge, whichever is lower, that NASA will provide directly to SPoRT for their assistance in transitioning proposed product to operational end users,
3) A copy of final selected proposal should be made available to the SPoRT Co-PI, and
4) Close collaboration with SPoRT team members is required throughout the research to better facilitate transition to operations.

For proposals that anticipate the development of NASA products to address particular operational forecast issues, SPoRT will work with funded projects to:

1) Integrate the derived product or solution into the AWIPS-II environment or other appropriate decision support system;
2) Work with the Principal Investigator (PI) and his/her team to develop the appropriate training modules on the use of the product in the users decision support system;
3) Assess the impact of the transitioned product on weather forecast operations.

Specifically for this solicited area (2.1), in order to avoid the appearance of conflict of interest, NASA will not accept proposals including investigators (PI, Co-Investigator (Co-I), or Collaborator) from SPoRT, Marshall Space Flight Center, and the University of Alabama in Huntsville (UAH).

2.2 Joint Center for Satellite Data Assimilation

The NASA/National Oceanic and Atmospheric Administration (NOAA)/Department of Defense (DOD) Joint Center for Satellite Data Assimilation (JCSDA; http://www.jcsda.noaa.gov/) was established by NASA and NOAA in July 2001. It is a distributed center that engages units of NASA: Goddard Space Flight Center (GSFC) Earth Sciences Division; NOAA: National Environmental Satellite, Data, and Information Service (NESDIS) Center for Satellite Applications and Research (STAR); National Weather Service (NWS) National Centers for Environmental Prediction (NCEP); Office of Oceanic and Atmospheric Research (OAR); U.S. Navy: Oceanographer of the Navy and the Naval Research Laboratory (NRL) Ocean and Atmosphere Directorate; and U.S. Air Force Air Weather Agency.

The Joint Center's goal is to accelerate the abilities of NOAA, DOD, and NASA to ingest and effectively use the large volumes of data from current satellite-based instruments and planned satellite missions. The JCSDA supports scientific development work in the following priority areas (1) Radiative transfer, (2) Clouds and precipitation, (3) Advanced instruments data assimilation, (4) Land data assimilation, (5) Ocean data assimilation, and (6) Atmospheric Composition data assimilation. JCSDA research is performed internally (internal research), as well as externally using Cooperative Agreements and/or contracts awarded via a competitive process open to the broader scientific community (external research). The overarching goal of JCSDA research is to accelerate the assimilation of satellite data in U.S. operational numerical environment forecast models. A primary measure of potential impact in this solicitation will be the acceleration of satellite data usage into NASA, NOAA and DOD weather forecast systems and the improvement of forecasts from those systems.

Research and development proposals are sought, exclusively from external investigators, in the following priority areas in global models or data assimilation systems used by the JCSDA partner organizations:

1. Developments to facilitate assimilation of all sky radiances (affected by clouds, precipitation, and aerosols) in the infrared and microwave and improve their impact on numerical weather prediction.
2. CRTM (http://www.jcsda.noaa.gov/projects_crtm.php) improvements for cloudy radiance data assimilation, both scientific and computational algorithms, that will

increase accuracy and efficiency (especially scattering) are of interest. The research and development must be done in coordination with the CRTM team at JCSDA.

3. Research and development of a module to perform 4-dimensional (i.e. including time evolution) localization of ensemble covariances in model space for the 4D hybrid data assimilation systems used at JCSDA especially at NASA and NOAA. This module should work for multiple models and allow for coupled atmosphere-ocean systems.

Baseline models and data assimilation systems will be provided by the JCSDA. Proposals using models or data assimilation systems other than that provided by the JCSDA will not be considered. Regional models and data assimilation systems will not be considered. Proposers are encouraged to make a connection with JCSDA and secure a letter of support.

Specifically for this solicited area (2.2), NASA will not accept proposals, including investigators (PI or Co-I) from the JCSDA partner organizations listed in this section including their support contractors. No funding will be provided to JCSDA partner organizations.

Similar to this solicitation, NOAA may offer the Federal Funding Opportunity (FFO). Research organizations are also encouraged to check out the NOAA FFOs referred to at the JCSDA web site (http://www.jcsda.noaa.gov/opportunities.php) for future opportunities.

2.3 Data and Methodology for Climate Projection Assessment

2.3.1 *Data for Climate Projection Assessment*

As NASA's Modeling, Analysis, and Prediction (http://www.map.nasa.gov/overview.html) and other programs continue to include new physics and parameterizations in the global climate models to build Earth system models (ESMs), there is a significant interest in how we may better constrain the ESMs with NASA satellite observations and how we may support future Earth system modeling assessments, especially the Coupled Model Intercomparison Projects Phase 6 (CMIP6; http://www.wcrp-climate.org/wgcm-cmip/wgcm-cmip6) or any CMIP6 endorsed MIPs (http://wcrp-climate.org/images/modelling/WGCM/CMIP/CMIP6-EndorsedMIPs_Summary_150819_Sent.pdf).

A particular interest is to continue the NASA and DOE Observations for Model Intercomparison Projects (Obs4MIPs; https://www.earthsystemcog.org/projects/obs4mips) and to perform critical comparisons between observations and modeling results - especially the variables in physical climate systems. As examples, the current Obs4MIPs datasets and corresponding technical documents can be obtained at https://www.earthsystemcog.org/projects/obs4mips/satellite_products. Satellite observation products available via Obs4MIPs are:

- Directly comparable to a model output field defined as part of CMIP5 and will be used for upcoming CMIP6 experiments,
- Open to contributions from all data producers that meet the Obs4MIPs requirements,
- Well documented, with traceability to track product version changes, and
- Served through Earth System Grid Federation (ESGF).

Most recently World Meteorology Organization (WMO) Data Advisory Council (WDAC) observations for Model Evaluation Task Team has released a call for data sets: (https://www.earthsystemcog.org/projects/obs4mips/Call2015).

Following the WDAC process, NASA will provide a small amount of funding to support proposals to convert (i.e., reformat and document) and publish WDAC recommended additional NASA satellite observation data in Obs4MIPs. Proposals must justify the need to include the data in Obs4MIPs and carefully follow the "Requirements for Contributing to Obs4MIPs" available at https://www.earthsystemcog.org/projects/obs4mips/how_to_contribute.

2.3.2 *Methodologies for Climate Model Improvement*

Using data available through ObsMIPs and the latest CMIP experiments, NASA encourages proposals to define novel strategies and methodologies to compare results from Earth system models with NASA observations and reanalysis, including, but not limited to, ocean biological and biogeochemical (ocean color) data, sea ice and ice sheet, atmospheric chemistry, constituents and aerosols, terrestrial biogeochemical, and vegetation and hydroclimate observations with the aim to improve and enhance the development of Earth system models. NASA is particularly interested in the methodologies to use NASA observations and reanalysis data to identify any model systematic errors, associate the errors with model algorithm deficiencies, and pinpoint the necessary model improvements. These strategies and methodologies will provide future direction and guidance in Earth system model developments.

2.4 Ecosystem and coupled ecosystem-climate modeling

Advances can be made in existing ocean ecological forecasts by assimilating the growing multiscale physical, chemical, and ecological remotely sensed (NASA satellite) observations into regional and global scale ecosystem models. The diversity of marine organisms and their intricate interactions create the vitality of marine ecosystems, bestow upon these ecosystems resilience to environmental change, and are of tremendous value toward human health, commerce, and recreation. Healthy marine ecosystems rely on a diversity of biological, chemical, and physical processes that function at different spatial scales. Current and developing measurement and monitoring capabilities include global remote sensing, which provide observational data across the entire range of ecologically relevant scales. With these data, significant advances can now be made in regional ecological modeling to oceanographic operational forecasting, but significant developments are needed to effectively assimilate the growing observational database and to realize their practical forecasting potential. Thus, as basic research unfolds, new understandings of ocean ecosystem structure, productivity, and the interdependence of living marine resources on our planet are realized; parallel advances must be made in assimilating these new observations and insights into models that advance the state of the art in ecological forecasting.

NASA welcomes proposals that seek to integrate NASA satellite observations, particularly ocean color data, into operational assessments. There is a recent priority from the GLACIER conference (http://www.state.gov/e/oes/glacier/index.htm) to address fisheries science in the Arctic ecosystem, with a goal of assessing the model skill to inform ecosystem resource management and decision/policy makers. Responsive proposals must include: 1) a clearly identified researcher or team of researchers, 2) operational model and/or assessment into which the proposer plans to include NASA satellite observations, and 3) operational partners who currently manage the operational assessment/model as part of the proposing team who are prepared to test and use the revised operational assessment/model. Proposals must clearly state what scientific operational assessment for management they wish to advance by inclusion of NASA satellite data, identify a plan and timeline for inclusion of NASA satellite data, as well as a test plan for operational model assessment and validation of model output. NASA may entertain proposals for new operational assessments to be developed using NASA satellite data, but in this case the aforementioned requirements hold, plus the requirements of clearly identifying the operational management/decision-making agency or partner requirement or law that will be supported by development of the new operational assessment, aside from detailing the operational assessment and test plan to be developed. Some examples of areas of operational assessment might include (and are not limited to): fisheries stock assessment and recruitment forecasting, harmful algal bloom assessment, and water quality/public health assessments, etc.

Within the domain of ocean ecology, a wide variety of aquatic ecosystems and their operational management could be addressed in the proposals submitted in response to this element of the solicitation, but not all will be equally important. Therefore, proposals must offer compelling rationales as to 1) the clear definition and "geographic" boundaries of the ecosystem/region ecological model under study, 2) why the operational use of a given ecosystem model whose skill will be assessed is expected to be highly significant, and 3) how the remote sensing data and data products to be utilized in the assessment provide unique and powerful information for addressing the ecosystem modeling/management/policy issues/questions posed. Ecosystem in this context could be defined on any number of scales, but the ecosystem under study must be compellingly defined and justified in the global context.

Substantive use of NASA remote sensing data is required in all studies.

3. Programmatic Information

3.1 Award Information

A NASA peer review panel will be set up for each of the four areas in Section 2. The review and selection for each of the areas will be independent. It is critical for proposers to identify and respond to only one of the areas defined in Section 2.

Funding for Operational Short-term Weather Prediction (area 2.1) is approximately $500K per year. Three to four projects may be awarded in the form of grants. NASA will not accept proposals to this area with any investigators (PI, Co-I, or Collaborator) from SPoRT or Marshall Space Flight Center.

Total funding for Joint Center for Satellite Data Assimilation (area 2.2) is approximately $500K per year. Three to four projects may be awarded. NASA will not accept proposals to area 2.2 with any investigators (PI, Co-I, or Collaborator) from the JCSDA partner organizations (http://www.jcsda.noaa.gov/partners.php).

The total funding for Data and Methodology for Climate Projection Assessment and Ecological Forecasting **(**areas 2.3 and 2.4**)** is approximately $1M per year. Six to ten projects may be awarded in the form of grants.

3.2 Prior Research Results

Proposers must identify prior research results that demonstrate the potential value of the NASA research data on operational activities. The citation of one or more peer reviewed papers in which positive results have been reported, is considered to be the minimum requirement.

3.3 Peer Review

Proposals will be evaluated by peer review panels. In some cases, mail reviews may be used to provide input to peer review panels. For the proposals responding to the JCSDA requirements, the panel members will be recommended by the JCSDA partner agencies. NASA will manage the review and selection process. The final selection authority will be NASA.

4. Summary of Key Information

Expected program budget for first year of new awards	Up to $2M; see Section 3.1
Number of new awards pending adequate proposals of merit	~ 12 – 18; see Section 3.1
Maximum duration of awards	2 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *Summary of Solicitation* of this NRA.
Due date for proposals	See Tables 2 and 3 in the *Summary of Solicitation* of this NRA.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science/Technical/Management section of proposal	15 pages; see also 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 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	NNH16ZDA001N-NDOA
NASA points of contact concerning this program	Tsengdar Lee Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0860 E-mail: tsengdar.j.lee@nasa.gov Paula S. Bontempi Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1508 E-mail: paula.bontempi@nasa.gov

A.30 Remote Sensing of Water Quality

NOTICE: NASA intends to solicit research proposals under the Remote Sensing of Water Quality element of ROSES-2016. The final text for A.30 will be released as an amendment to ROSES-2016. Proposals will be due no earlier than 90 days after the release of the amendment.

1. Scope of Program

The Terrestrial Hydrology and Ocean Biology and Biogeochemistry Programs support the science of this program element. Both programs support Presidential mandates and associated Federal research objectives, including the U.S. Global Change Research Program (http://www.globalchange.gov/) and its strategic priorities, the science priorities of the U.S. Carbon Cycle Science Program (http://www.carboncyclescience.us/), the National Ocean Policy Implementation Plan of the National Ocean Council (NOC), and the Federal role in water resource science and technology as stated in A Strategy for Federal Science and Technology to Support Water Availability and Quality in the United States (http://water.usgs.gov/swaq/pubs.html).

NASA's Ocean Biology and Biogeochemistry program focuses on describing, understanding, and predicting the biological 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.

NASA's Terrestrial Hydrology program focuses use of 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.

Previous awardees from 2012 are listed at http://tinyurl.com/RSWQ12.

2. Summary of Key Information

Expected annual program budget for new awards	~ up to $1M
Number of investigator awards pending adequate proposals of merit	~5
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	TBD
Due date for proposals	TBD
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	NNH16ZDA001N-RSWQ
NASA point of contact concerning this program	Jared Entin Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Tel: 202-358-0275 Email: jared.k.entin@nasa.gov

A.31 UTILIZATION OF AIRBORNE VISIBLE/INFRARED IMAGING SPECTROMETER – NEXT GENERATION DATA FROM AN AIRBORNE CAMPAIGN IN INDIA

NOTICE: November 16, 2016. This program element has reopened. NASA requests revised or new Notices of Intent to be resubmitted by December 8, 2016. The new due date for proposals is January 17, 2017. New text is in bold, deleted text is struck through.

April 11, 2016: The site list under "Other Documents" has been updated to include acquisition dates and a point of contact to discuss potential collaborations with counterparts in India and also to gain access to potential Indian ground data.

March 23, 2016: The list of sites in India for which imagery has been acquired has been posted under "Other Documents" on the NSPIRES web page of this program element. The due dates are unchanged. New text is in bold, deleted text is struck through.

1. Scope of Program

NASA and the Indian Space Research Organisation (ISRO) have a mutual interest in using imaging spectroscopy for improved detection and understanding of Earth surface features. As part of a broader cooperative effort in Earth science research and applications, these agencies operate**d** the NASA Airborne Visible/Infrared Imaging Spectrometer – Next Generation (AVIRIS – NG) instrument aboard the ISRO National Remote Sensing Centre King Air B-200 aircraft in the December 2015, to February 2016 time period. AVIRIS-NG is a NASA airborne imaging spectrometer in which each ground pixel measures the complete surface-reflected solar spectrum over the 380 to 2500nm spectral range. This airborne campaign ~~will~~ generat**ed** data products relevant to Earth science research and applications activities in a number of topic areas by capturing spectra from terrestrial, freshwater, and marine sites throughout India. The products will provide ISRO with important baseline spectroscopy data for a wide variety of Indian environments and offer NASA researchers an opportunity to use an important new dataset. Both NASA and ISRO ~~will~~ have access to all scientific data coming from the AVIRIS-NG instrument. This campaign marked the first step in a potential multiyear effort between NASA and ISRO to advance imaging spectroscopy of the Earth. The sites selected are expected to support research into the following topics:

- Agriculture and soils
- Wetland ecosystems
- Mangrove ecosystems
- Forest ecosystems
- Coral reef ecosystems
- Mineral exploration
- Snow and glaciers
- Urban studies
- Biological oceanography
- Coastal land use/land cover

- River water resources and water quality
- Clouds, atmosphere, and air pollution
- Calibration studies

Lists of selected sites are in the ISRO-NASA AVIRIS-NG Airborne Flights Over India Science Plan Document: Hyperspectral Remote Sensing. A link to download this document as a PDF file will appear under "other documents" on the NSPIRES web page of this program element. Proposers should focus on the priority 1 sites listed in this document, as priority 2 sites may not be acquired due to the limited flight hours available. ~~After the acquisition of the AVIRIS-NG imagery, this solicitation appendix will be amended to incorporate~~ The list of sites in India for which imagery has been acquired **has been posted under "Other Documents" on the NSPIRES web page of this program element. [Corrected March 23, 2016]**

Plans are for ISRO to operate the aircraft at an altitude of approximately 7km to generate products of approximately 7m ground spatial sampling. NASA will make Level 1 (at sensor radiance) and Level 2 (surface reflectance) data products available under this solicitation through the AVIRIS-NG website at http://avirisng.jpl.nasa.gov. Data will become available approximately three months after the completion of the flight campaign, so proposals should be written in such a way that the effort proposed fully benefits from the newly acquired data. Expected data volumes range from 50 gigabytes to 250 gigabytes per site.

Quicklooks for the AVIRIS-NG data are available at https://avirisng.jpl.nasa.gov/quicklooks.html and by then clicking on the links to "2015 Flights" and "2016 Flights." The site list for the 57 Indian sites is still available through the NSPIRES cover page for this solicitation under "Other Documents" as is the Science Plan for these flights.

Investigators wanting to pursue opportunities for potential collaborations with Indian investigators are encouraged to send their notices of intent to Dr. Bimal K. Bhattacharya, SAC, ISRO, Ahmedabad, India at the contact information below by December 7, 2016.

Dr. Bimal K Bhattacharya
Head, Agriculture and Land Eco-system Division (AED), BPSG/EPSA
Science Team Leader (AVIRIS-NG Airborne campaign)
Space Applications Centre
Indian Space Research Organisation
Ahmedabad 380015, Gujarat, India
E-Mail: bkbhattacharya@sac.isro.gov.in. [Added November 16, 2016]

2. Description of Solicited Research

This solicitation seeks proposals for data analysis and modeling of AVIRIS-NG airborne data from this campaign that are relevant to programs in the six NASA Earth Science Research and Analysis (R&A) Focus Areas: Carbon Cycle and Ecosystems, Earth Surface and Interior, Water and Energy Cycle, Climate Variability and Change, Weather, and Atmospheric Composition (http://science.nasa.gov/earth-science/focus-areas/). Proposals relevant to applications research in support of the NASA Applied Sciences Program (http://appliedsciences.nasa.gov) are also welcome.

Only proposals making primary use of data products from the AVIRIS-NG Indian campaign will be responsive to this solicitation. In addition to the AVIRIS-NG data products, use of data from surface-based networks associated with the airborne campaign sites is welcome. Utilization of relevant data from other sources, including data from NASA satellites or those of NASA's interagency and international partners, is encouraged. Proposals may not include costs for acquisition of any additional or complementary airborne data.

Details of the airborne campaign may be found in the ISRO-NASA AVIRIS-NG Airborne Flights Over India Science Plan Document: Hyperspectral Remote Sensing, which may be downloaded as a PDF file at the NSPIRES web page of this program element under "other documents."

3. Programmatic Information

Proposals should request one-time funding for use over an eighteen (18) month period to cover the costs of personnel, computing, publication, and travel associated with the data analysis and modeling activities. No follow-on to this solicitation is planned, so proposers should expect no opportunities for continuation awards, except as may become available through future solicitations of ongoing R&A programs.

4. Summary of Key Information

Expected one-time program budget for new awards.	$1.35 M
Number of new awards pending adequate proposals of merit	~ 10 to 15
Maximum duration of awards	18 months
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*
Planning date for start of investigations	Six months after proposal due date
Page limit for the central Science/Technical/Management section of proposal	15 pp for all proposals; 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 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	NNH16ZDA001N-AVRSNG
NASA point of contact concerning this program:	Woody Turner Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1662 E-mail: woody.turner@nasa.gov

A.32 NEW (EARLY CAREER) INVESTIGATOR PROGRAM IN EARTH SCIENCE

NOTICE: The New Investigator Program (NIP) in Earth Science will not be competed in 2016. NIP is scheduled to solicit proposals in ROSES-2017. The text below is draft for ROSES-2017 and is included for reference only.

1. Scope of Program

1.1 Introduction

The New (Early Career) Investigator Program (NIP) in Earth Science is designed to support outstanding scientific research and career development of scientists and engineers at the early stage of their professional careers. The program 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 basic research and analysis, the Focus Areas include:

- Carbon Cycle and Ecosystems,
- Climate Variability and Change,
- Water and Energy Cycle,
- Atmospheric Composition,
- Weather, and
- Earth Surface and Interior.

In applied scientific research, 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. See Appendix A.1 for more detailed descriptions of the Focus Areas, themes in applied sciences, and related research topics of high priority to the ESD.

The proposed research project must be led by a single, eligible (see further description below for eligibility) investigator serving as the Principal Investigator (PI). Indeed, this individual must be the only essential team member; no Co-Investigators (Co-Is), paid or unpaid, are permitted. The NIP does not accept proposals with Co-PIs nor two types of PIs, such as 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.

This early career program, NIP in Earth Science, was established in 1996. The frequency of solicitation is currently every two years.

1.2 Eligibility

A NIP proposal PI must 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]. He/she must be a recent Ph.D. recipient, defined as having graduated on or after January 1 of the year that is no more than five years before the issuance date of this ROSES NRA (i.e., after January 1, 2012).

Institutions and organizations are encouraged to submit proposals under the NIP on behalf of their outstanding new faculty members or employees in Earth system science and associated applications, as long as the individuals are the proposed PIs.

To be eligible for an NIP award, proposed PIs must meet the following requirements:

- Be employed at an institution in the U.S., its territories, or possessions, or the Commonwealth of Puerto Rico, which awards a baccalaureate or advanced degree in a field supporting the objectives of NASA Earth system studies, or be employed at any nonprofit research institution or other nonprofit organization that performs a significant amount of work in fields of research supporting the objectives of NASA Earth Science Program. Such organizations could include museums, observatories, Government or nonprofit research laboratories, as well as nonprofit entities in the private sector.
- Be in tenure- or nontenure-track positions 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.
- Despite being more than five 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 for prior concurrence from NASA before the due date for Notices of Intent to propose. NASA will provide a written response within three weeks. Such exception is not intended for individuals who have had successful employment in technical fields in science and engineering, even though the employment is not a direct continuation of their Ph.D. research, nor is it intended for individuals with a recent Ph.D. degree after having already established a successful career in Earth system science and related disciplines.
- Not hold or have held tenure (or equivalent) on or before the submission deadline of this program.
- Not be a current or former recipient of the NIP or PECASE (see further below) award.

[1] The prospective PI may submit a proposal to NIP if he or she is reasonably certain that the Green Card will be in hand soon after the proposal submission. The evaluation of proposals takes approximately five 5 months, and awards are made within a couple of weeks after the announcement of selections. NASA will not award a grant if the submitting institution cannot certify the PI's eligibility.

2. Programmatic Information

2.1 Funding

Proposals to the NIP are openly solicited approximately every two years. The anticipated average award is $80-90K per year for a period of up to three years, subject to satisfactory progress and availability of funds.

2.2 Relationship between NIP and PECASE

The Presidential Early Career Awards for Scientists and Engineers (PECASE) recognize outstanding scientists and engineers who, early in their career, show exceptional potential for leadership at the frontiers of knowledge. Each year, NASA selects its nominees based on exceptionally meritorious accomplishments in research sponsored by NASA. The nominations are made by the NASA mission directorates and its field centers; individuals cannot apply for PECASE. The NIP awardees constitute an important, but not the only, source of nominations for the PECASE by the Earth Science Division. A current or former recipient of a PECASE award is not eligible to apply to the NIP.

2.3 Proposal Preparation

The NIP proposals should be prepared in accordance with the instructions given in the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*. The Science/Technical/Management section of the proposal should contain a detailed statement of the proposed research of no more than 15 single-spaced pages including figures and tables.

2.4 Budget Requirements

The NIP awards are typically three years in duration. The award amount for each is judged according to the scope of the proposed work and the overall competition. Salary for up to three months per year of PI time is allowable. NASA will not reimburse the salary if the PI is a Civil Service employee at a Federal agency, other than NASA. Funds may be used for support by students (undergraduate or graduate) and/or postdoctoral fellows who are involved in the proposed research; for research expenses, such as costs incurred in field experiments, purchase of equipment and/or supplies, computing, travel, etc. If research collaboration is a component of the proposal, it is presumed that the collaborator(s) have their own means of research support; that is, a NIP award may not include expenses for personnel or activities at collaborating institutions, nor salary costs for senior personnel, consultants, or subcontractors.

NASA strongly encourages, but does not require, that the submitting institution contribute to the cost of the proposed NIP project. Of special interest is cost sharing in which the employing institution would provide release time to enable the applicant to more fully concentrate on the activities related to the proposal. Institutional support of equipment purchase and co-funding of student and/or postdoctoral support would also be recognized as valuable cost sharing. Hardware purchased through start-up funds for a recently hired investigator or salary support provided through other Federally sponsored research may not count as cost sharing for the purpose of a NIP proposal.

2.5 Proposal Review and Evaluation

The general evaluation factors, relevance to NASA's stated objectives, intrinsic merit, and the realism and reasonableness of its cost, are described in Appendix C of the *NASA Guidebook for Proposers* apply to the NIP proposals with the following exception:

- For the Research Plan, the relative weighting for Relevance to the strategic goals and objectives of Earth Science at NASA, Intrinsic Merit, and Cost is approximately 40%, 40%, and 20%. Furthermore, the Relevance criterion specifically includes the following factor: long-term commitment to the applicant's career development by the employing institution.

3. NASA Point of Contact concerning this Program

Ming-Ying Wei
Earth Science Division
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546-0001
Telephone: (202) 358-0771
E-mail: Ming-Ying.Wei-1@nasa.gov

A.33 SUOMI NATIONAL POLAR-ORBITING PARTNERSHIP (NPP) SCIENCE TEAM AND SCIENCE INVESTIGATOR-LED PROCESSING SYSTEMS FOR EARTH SYSTEM DATA RECORDS FROM SUOMI NPP

NOTICE: The Suomi NPP Science Team (ST) and Science Investigator-led Processing Systems (SIPS) for Earth System Data Records from Suomi NPP program will not solicit proposals in ROSES-2016. All funds currently available for research under this program will be committed to the support of awards selected through the 2013 Suomi NPP solicitation. The Suomi NPP ST funds will be competed again in ROSES-2017 in a program element that combines the work of the Terra and Aqua science teams with that of the Suomi NPP ST. The Suomi NPP SIPS funds will not be competed again before 2019.

NASA's Earth Science Program aims to utilize global measurements in order to understand the Earth system and interactions among its components. To achieve this goal, a combination of shorter-term, process-oriented satellite measurements is complemented by longer-term satellite measurements of a limited number of environmental properties. For the latter, a key requirement is the provision of well-calibrated, multiyear and multisatellite time series data and data products. The Suomi National Polar-orbiting Partnership (Suomi NPP) mission acquires data to extend more than 30 high-quality time series data records initiated by earlier NASA satellites (i.e., the NASA Earth Observing System's (EOS) Terra, Aqua, and Aura satellites). Its observations 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.

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 also will collect data for both weather and climate. As such, Suomi NPP also is providing preoperational demonstration and validation risk reduction for the future U.S. Joint Polar Satellite System and sensor data and data products to the operational weather system to minimize the possibility of a gap in the operational weather mission. Suomi NPP is the first satellite designed to collect critical data to both improve weather forecasts in the short-term and increase our understanding of long-term climate change.

The NASA Suomi NPP ST has evaluated the JPSS-provided data products for Suomi NPP and is now directing its attention to developing the refined, alternative, and/or new data products yet needed to ensure high-quality data records for Earth system science and applications that enable continuity with EOS data products. The NASA Suomi NPP ST is also conducting applications-relevant Suomi NPP research.

NASA recognizes that there are strong synergies between EOS Terra and Aqua and NASA Suomi NPP algorithm-related activities. Therefore, NASA is planning to continue its transition from mission/instrument teams to measurement teams for its long-term Earth system data records. When NASA next solicits NASA Suomi NPP ST member research, it plans to combine that solicitation with the next EOS Terra-Aqua solicitation and to adjust the allowable maximum period of performance in order to align the two program's science team renewal schedules.

For further information on this program, contact:

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

A.34 THE SCIENCE OF TERRA AND AQUA

NOTICE: NASA will not solicit research proposals under the Science of Terra and Aqua program element in ROSES-2016. All funds currently available are committed to the support of awards selected through previous Science of Terra and Aqua announcements. Science of Terra and Aqua funds will be competed again in ROSES-2017, and may be combined with the next Suomi National Polar-Orbiting Partnership (NPP) program element, and/or Terra and Aqua – Existing Algorithms.

1. Scope of Program

NASA's Earth Science Research Program aims to utilize global measurements in order to understand the Earth system and interactions among its components as steps toward ultimate 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 a limited number of environmental properties. For the latter, a key requirement is the provision of well-calibrated, multiyear, and multisatellite data and product series. The Earth Observing System (EOS) was intended to provide the 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 (http://esdis.eosdis.nasa.gov/eosdis/overview.html).

Historically, this program follows on from the 2009 NASA Research Opportunities in Space and Earth Science (ROSES) Program Element A.41 The Science of Terra and Aqua (NNH09ZDA001N-EOS in ROSES-2009) and Program element A.28 The Science of Terra and Aqua in ROSES-2013. The program provides an opportunity for scientists to undertake significant studies responsive to NASA's and the Science Mission Directorate's science objectives (http://nasascience.nasa.gov/about-us/science-strategy) and the NASA Earth Science Research objectives (http://nasascience.nasa.gov/earth-science) through the use of data and derived products from two of the EOS satellites, namely Terra and Aqua, and their measurement sensors. It represents a continuation of the research aspects of the EOS Instrument Teams for these satellites, emphasizes new opportunities for scientists to analyze and exploit EOS data, as well as develop new products by combining multisensor and multiplatform data or by developing an innovative approach to data retrievals. This program offers investigators an opportunity to conduct integrative research projects using the data and products resulting from these satellites and to become involved in the utilization of EOS data to provide answers to NASA's Earth Science Research questions (http://nasascience.nasa.gov/earth-science/big_question_list).

This program recognizes the advances already made by investigations that were solicited by prior NASA Research Announcements and ROSES program elements, and that focused in the areas of sensor calibration, algorithm development and refinement, data product validation, and scientific data analysis. As these EOS missions continue to mature and move even further into the extended mission phase, less emphasis will be placed upon algorithm refinement, and more emphasis will be directed to multisensor product development, accompanied by active utilization of these data and products in scientific research, modeling, synthesis, and diagnostic analysis to answer Earth science questions.

NASA recognizes that there are strong synergies between EOS Terra and Aqua and NASA Suomi NPP algorithm-related activities. Therefore, NASA is planning to continue its transition from mission/instrument teams to measurement teams for its long-term Earth system data records. When NASA next solicits NASA Science of Terra and Aqua member research in ROSES-2017, it plans to combine that solicitation with the next Suomi NPP ST solicitation and to adjust the allowable maximum period of performance in order to align the two program's science team renewal schedules.

Questions related to this program may be directed to:

Paula Bontempi
Earth Science Division
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546-0001
Telephone: (202) 358-1508
Email: Paula.Bontempi@nasa.gov

A.35 TERRA AND AQUA – ALGORITHMS – EXISTING DATA PRODUCTS

NOTICE: NASA will not solicit research proposals under the Terra and Aqua – Algorithms – Existing Data Products program element in ROSES-2016. All funds currently available are committed to the support of awards selected through previous Terra and Aqua announcements. Funds for this program may be competed again in ROSES-2017, combined with the program element for Suomi National Polar-Orbiting Partnership (NPP) Science, or absorbed as part of the Senior Review/Mission Extension Review process.

1. Scope of Program

NASA's Earth Science Research aims to utilize global measurements to better understand the Earth system and interactions among its components as steps toward ultimate 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 a limited number of environmental properties. For the latter, a key requirement is the provision of well-calibrated, multiyear data. The Earth Observing System (EOS) provides a broad set of 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 (http://esdis.eosdis.nasa.gov/eosdis/overview.html).

Historically the program solicits proposals for the maintenance and minor refinement of the standard Terra and Aqua sensor algorithms. This program element is typically a partner to The Science of Terra and Aqua program element.

NASA recognizes the need for an opportunity for scientists to continue the maintenance and minor refinement of Terra and Aqua algorithms and data products selected under prior NASA awards. Studies must also be responsive to NASA's and the Science Mission Directorate's science objectives (http://nasascience.nasa.gov/about-us/science-strategy) and the NASA Earth Science Research objectives (http://nasascience.nasa.gov/earth-science). This program element represents a continuation of the research aspects of the EOS Instrument Teams for Terra and Aqua sensors.

Proposers wishing to respond to new opportunities to analyze and exploit EOS data, as well as develop new products by combining multisensor and multiplatform data or by developing an innovative approach to data retrievals, should look for an opportunity under the Science of Terra and Aqua program element (anticipated to be open in ROSES-2017).

Questions related to this program may be directed to:

Paula Bontempi
Earth Science Division
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546-0001
Telephone: (202) 358-1508
Email: Paula.Bontempi@nasa.gov

A.36 PACE SCIENCE TEAM

NOTICE: NASA will not solicit research proposals under the PACE Science Team program element in ROSES-2016. All funds currently available are committed to the support of awards selected through the previous PACE Science Team announcement. PACE Science Team funds will be competed again in ROSES-2017.

1. Scope of the Program

The Pre-Aerosol, Cloud, ocean Ecosystem (PACE) mission is a strategic Climate Continuity mission and is included in NASA's 2010 plan: *Responding to the Challenge of Climate and Environmental Change: NASA's Plan for a Climate-Centric Architecture for Earth Observations and Applications from Space* (hereafter referred to as the "Climate Initiative") sponsored by NASA's Earth Science Division. The Climate Initiative can be found at http://science.nasa.gov/earth-science/. The Climate Initiative plan complements NASA's implementation of the National Research Council's (NRC) Decadal Survey of Earth Science at NASA, NOAA, and USGS, entitled Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond (the NRC's Earth Science Decadal Survey, is available at http://www.nap.edu/catalog.php?record_id=11820).

In 2011, NASA issued a Dear Colleague Letter to compete a PACE Science Definition Team (SDT) to develop the scientific foundation of the mission following the guidance given in the Climate Initiative. The PACE SDT has completed a report regarding science priorities of the PACE mission. The report has undergone a public comment period and been finalized; the final version of the report can be found on the PACE web site (http://dsm.gsfc.nasa.gov/PACE.html).

In 2014, NASA released a PACE Science Team program element that formulated a Pre-Aerosol, Cloud, ocean Ecosystem (PACE) Science Team (ST) for a three-year period. Proposals from prospective Science Team members pursued theoretical and analytical studies associated with one of two sets of measurements, Inherent Optical Properties and Atmospheric Correction.

PACE will be a polar-orbiting mission with an ocean color sensor for ocean color, aerosols, and cloud data products, and possibly an aerosol-cloud polarimeter. The mission will be capable of performing radiometric and possibly polarimetric ocean and atmosphere surveys, returning a range of geophysical data from which properties of the ocean and atmosphere can be produced to add to other critical climate and Earth system variables. As currently envisioned, the Pre-Aerosol, Clouds, and ocean Ecosystem (PACE) mission has multiple scientific and applications goals, including making climate-quality global ocean color measurements that are essential for understanding the carbon cycle and global ocean ecology and determining how the ocean's role in global biogeochemical (carbon) cycling and ocean ecology both affects and is affected by climate change. The ocean color instrument capabilities will include bands for aerosols and clouds, and, therefore, extend key observations of aerosols and clouds, focusing on reducing the largest uncertainty in radiative forcing of the Earth System. The ocean color instrument will thus extend the ocean and (some) of the atmosphere data records from Sea-viewing Wide Field-of-view Sensor and Moderate Resolution Imaging Spectroradiometer (MODIS). Polarimetry measurements would complement the aforementioned observations, providing better quantitative estimates of aerosol type and height, improving our understanding of atmospheric dynamics and radiative sciences, and improve the atmospheric correction for ocean color remote sensing. If a polarimeter flies, those measurements would provide extended data records on clouds and aerosols, focusing on reducing the largest uncertainty in radiative forcing of the Earth system. The current PACE Launch Readiness Date is 2022/2023.

Questions related to this program may be directed to:

Paula Bontempi
Ocean Biology and Biogeochemistry Program
Earth Science Division
Science Mission Directorate
National Aeronautics and Space Administration
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Hal Maring
Radiation Sciences Program
Earth Science Division
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546-0001
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A.37 EARTH SCIENCE APPLICATIONS: WATER RESOURCES

NOTICE: Proposals to this program will be taken by a "binding" two-step process in which the Notice of Intent is replaced by a required Step-1 proposal submitted by an organization Authorized Organizational Representative. Only proposers who submit a Step-1 proposal 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 that can be used 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 and imbalances between water supply and demand.

The specific goal of this solicitation is to advance the use of satellite observations to detect and mitigate threats to water security and sustainability with an emphasis on monitoring and management of 1) water quality and 2) agricultural water use.

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 that Earth observations broadly include a range of products and capabilities, including Earth-observing satellite measurements (NASA in-orbit and planned satellites, as well as foreign, commercial, and other U.S. Government satellites), airborne and ground measurements, outputs and predictive capabilities from Earth science models, algorithms, visualizations, knowledge about the Earth system, and other geospatial products. Hereinafter, this set is referred to collectively as "Earth observations."

[1] Examples include, companies, regional associations, international organizations, multinational financial institutions, philanthropic institutions, Government agencies, tribal organizations, and not-for-profit organizations.

The Applied Sciences Program has three primary lines of business: Applications, Capacity Building, and Satellite Mission Planning. The Applications themes include four of the nine societal benefit areas (SBA) of the international Group on Earth Observations (GEO): Health (including Air Quality), Disasters, Ecological Forecasting, and Water Resources.[2] In addition, there is a cross-cutting Wildfires theme and an initiative on Food Security. The Program includes the impacts from a changing climate within each of these topics.

The Capacity Building program improves the ability of individuals and institutions in the U.S. and abroad, especially in developing countries, to access and apply Earth observations. The program includes three elements: ARSET training sessions for professionals; 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 Application 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, water quality, and climate impacts on water resources. The Water Resources applications area website is available at http://appliedsciences.nasa.gov/programs/water-resources-program.

The Water Resources application area identified the water quality and agriculture water use as priority topics from community interactions with end users and scientists that included two workshops on water quality in 2014 and a major international evapotranspiration workshop in 2015, among other convenings. This solicitation also comes after two major solicitations from this program in recent years on water supply issues.

2. Scope of Solicitation

This solicitation seeks to: 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 water managers' 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 the proposed effort would enhance current decision-making processes employed by water managers and their stakeholders.

[2] The nine GEO SBAs are: Agriculture, Biodiversity, Climate, Disasters, Ecosystems, Energy, Health, Water, and Weather.

This solicitation seeks proposals that apply remote sensing observations to improve sustainability of water resources and enhance resiliency to threats to water security and variability in water use over time. Specifically, this solicitation focuses on two key components of enhancing water security: 1) characterizing and understanding changes in water quality to identify and mitigate threats to water quality OR 2) understanding variability of agricultural water use and characterizing short and long-term imbalances between agricultural water supplies and agricultural water requirements. Proposals are encouraged to seek innovative, open and sustainable data processing and delivery solutions for stakeholders.

The proposed solutions must include a plan for integration into an existing water resource decision-making process. Application innovation, 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 by, water management/policy personnel who will facilitate the transition to sustained operational use by the water management partner or stakeholder.

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. For research pursuits, the reader is referred to other ROSES-2016 Earth Science solicited research programs, Appendices A.21, A.22, and A.30

[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

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 recently-launched NASA missions (e.g. SMAP, GPM,), as well as simulated products from upcoming, planned missions (e.g. GRACE-FO, SWOT), and NASA-sponsored activities (e.g. SPoRT, NASA Earth Exchange - NEX, SERVIR). Proposals that request resources on NEX or other NASA high end computing resources should specify the data sets, anticipated data volumes, 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/.

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 program element. For instance, project teams should consider including experts in the areas of management, planning, statistics, economics, 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 (FY15-19)	$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, 2016
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-2016 *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 page 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, 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 relevant previous research carried out by the scientific community in the subject area.
d. Identify existing decision methods being used and new approaches/aspects being proposed, including anticipated enhancements from the proposed work.
e. List the remote sensing assets, models, or tools the proposed work can potentially use.
f. Identify potential societal impacts and outcomes, including the proposed deliverables.

g. Provide a tentative schedule.
h. Identify Co-Investigators (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 Scope of Solicitation in Section 2. 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.

The content and formatting of Step-2 proposals should adhere to Section 2.3 of *Guidebook for Proposers* and the ROSES-2016 *Summary of Solicitation* (SOS). Where they disagree, the ROSES SOS takes precedence.

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*. The information below supersedes direction provided in the respective sections of the *Summary of Solicitation* or Guidebook.

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, modify Section 2.3 of the *NASA Guidebook for Proposers*.

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
- Earth Observations
- Project Elements (including 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

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 Water Quality or Agriculture Water Use challenge;
- Methodology to be employed for the application to address the challenge, including discussion of the innovative aspects and rationale for Earth observations to be used;
- 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.

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[4] Please follow the ARL definitions in http://www.nasa.gov/sites/default/files/files/ExpandedARLDefinitions4813.pdf

- 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.

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 from End-User Organizations

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 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.

[5] Commercial remote sensing data that has been validated by the Joint Agency Commercial Imagery Evaluation (JACIE, http://calval.cr.usgsgov/jacie.php) are encouraged.

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 Water Quality or Agriculture Water Use challenges and
- Breadth and potential impact of the project.

In addition to the factors given in 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 a sustained (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.

Cost sharing from the end user is encouraged, but not required for proposals to this solicitation. Cost sharing will not be 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 funds or in-kind contributions from non-Federal sources and Federal agencies, consistent with this appendix and Section III(c) of the *Summary of Solicitation.*

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 (NASA Water Resource program visits to project site) and annual Program Team meetings (Principal Investigator attendance in Washington, DC area) 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 of on-line (e-Books) 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. NASA capabilities in support of the technical and interoperability standards are available at the NASA Centers, as described in the NASA Earth Science Strategic Plan at http://science.hq.nasa.gov/strategy/. Proposers involving private sector organizations and/or proprietary products and services in such projects are strongly encouraged to read NASA guidelines on cooperative agreements.

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 in the *Summary of Solicitation* of this NRA.
Due date for invited Step-2 proposals	See Tables 2 and 3 in the *Summary of Solicitation* of this NRA.
Planning date for start of investigation	December 1, 2016
Page limit for the central Science/Technical/Management section of proposal	Step-1 proposals: 5pp; Step-2 proposals: 15 pp; see also Section 4.2.2
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 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	NNH16ZDA001N-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 E-mail: Bradley.Doorn@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-2016. 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

Dave Meyer
Earth Science Division
Science Mission Directorate
National Aeronautics and Space Administration
Washington, DC 20546-0001
Telephone: (202) 358-1942
E-mail: HQ-ROSES-ACCESS@mail.nasa.gov

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-2016. 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-2017.

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

Lucia Tsaoussi
Earth Science Division
Science Mission Directorate
NASA Headquarters
Washington, DC 20546-0001
Telephone: (202) 358-4471
E-mail: Lucia.S.Tsaoussi@nasa.gov

A.40 Computational Modeling Algorithms and Cyberinfrastructure

NOTICE: Computational Modeling Algorithms and Cyberinfrastructure (CMAC) will not be competed in ROSES-2016. The CMAC was competed in ROSES-2014 and is anticipated to be open again in ROSES-2017.

1. Scope of Program

Satellite observations are typically used for initializing models, constraining the model external forcings, and calibrating the models' parameterizations. They are also used to create long-term assimilated weather and climate records often used in climate assessments and model evaluations. Data-model intercomparisons provide effective ways to evaluate and improve model performance, and thus to advance our understanding of the Earth system.

Because the most advanced models are run on supercomputers available only at computing centers, the Computational Modeling Algorithms and Cyberinfrastructure (CMAC) program funds research and development activities to enhance and modernize the computing, storage, network, and visualization services at high-end computing centers. CMAC builds advanced modeling infrastructure used at NASA computing centers to support Earth system science investigations while fundamentally utilizing both models and data.

This program element provides research and development opportunities for new or improved computational modeling algorithms, the exploitation of new computing, storage, and networking architectures, the development of programming and analysis environments, interfaces between observational data and models, large scale observational input data and model output data management, and the adoption of rigorous software engineering methodologies, practices, and tools.

Not all topics are solicited at the same time. Investigators should always consult the published solicitation and amendments. Questions or comments may be directed to the Computational Modeling Algorithms and Cyberinfrastructure Program Manager at the address given below:

Tsengdar Lee
Earth Science Division
Science Mission Directorate
NASA Headquarters
Washington, DC 20546-0001
Telephone: (202) 358-0860
E-mail: tsengdar.j.lee@nasa.gov

A.41 ADVANCED INFORMATION SYSTEMS TECHNOLOGY

NOTICE: Amended November 14, 2016. This Amendment releases the final text for A.41 Advanced Information Systems Technology, which replaces the placeholder text provided in ROSES-2016 in its entirety. Notices of Intent are requested by December 21, 2016, proposals are due February 16, 2017.

1. Introduction

The Earth is a vast, complex, dynamic, interconnected system. Information systems technologies play an essential role in our ability to understand, to forecast, and to predict the Earth system's behavior through the generation, management, and scientific exploitation of the very large amounts of data and information from space-, airborne-, and ground-based sensors, as well as model output. Advances in information systems impact all Earth Science focus areas:

- Atmospheric Composition
- Climate Variability and Change
- Carbon Cycle & Ecosystems
- Earth Surface and Interior
- Water and Energy Cycle
- Weather

The Earth Science Technology Office (ESTO) manages the early development of advanced technologies and applications that are needed for cost-effective NASA Earth Science Division (ESD) missions. ESTO plays a major role in shaping Earth science research and application programs of the future. These important technology investments enable promising scientific and engineering concepts to be explored. ESTO ensures its technology programs create an effective balance of investments by coordinating across missions and science focus areas to define technology needs of NASA's Earth Science Division.

1.1 Background

The NASA Earth Science Division's (ESD) Research and Analysis (R&A), Applied Sciences, and Flight Programs are described in Appendix A.1 of the overall ROSES Announcement. NASA Earth Science's overarching implementation plan is defined in the 2010 Climate-Centric Architecture document (https://smd-prod.s3.amazonaws.com/science-green/s3fs-public/atoms/files/Climate_Architecture_Final.pdf) and the NASA Strategic Plan (https://www.nasa.gov/sites/default/files/files/FY2014_NASA_SP_508c.pdf). Consistent with these plans, the Advanced Information Systems Technology (AIST) program has the responsibility for providing advanced technologies to enable science measurements, make use of data for research, and facilitate practical applications for societal benefit by directly supporting each of the core functions within NASA's Earth Science Division: Research and Analysis, Flight, and Applied Sciences.

2. Goals of the Advanced Information Systems Technology program

The goals of the Advanced Information Systems Technology (AIST) program are to identify, develop, and demonstrate advanced information system technologies that:

- Reduce the risk, cost, size, and development time for Earth science space-based, airborne, and ground-based information systems,
- Increase the accessibility and utility of science data, and

- Enable new observations and information products.

The AIST is focused on maturing technology projects early in the Technology Readiness Level (TRL) cycle (2 to 4) and to mature the technologies (typically TRL 6) for potential infusion into the appropriate science, applications, and mission communities.

3. Proposal Research Topics

Key technical themes being solicited are grouped into core topics (refer to Section 3.1):

- Operations Technologies
- Computational Technologies
- Data-Centric Technologies

Three additional special subtopics are being solicited to address more specific needs of the Earth Science Division (refer to Section 3.1.4). For each area, the investments are intended to reduce the risk and cost of evolving NASA information systems to support future Earth observations and to transform those observations into Earth information. The topics encompass both hardware and software for space-based, airborne, or ground-based systems.

Automation in any of these topics is of interest to NASA. There is an ongoing requirement to operate, manage, and exploit an increasing number of diverse missions and large and varied data and models. Automation allows NASA to operate large numbers of spacecraft safely with an affordable mission operations workforce. Automated data product generation is expected to accelerate the availability of data products from a growing inventory of data sources. Automation of instrument controls permits rapid mode changes in response to changes in the observed conditions. Of course, the needs of the observing strategy and the science community must dictate the degree and type of automation which is appropriate.

Recent ESTO investment strategy studies on Lidar (https://esto.nasa.gov/LidarStrategies/index.html) and Microwave (https://esto.nasa.gov/MicrowaveStrategies/index.html) instruments identify needs for information technology advances to support future capabilities in those instrument types.

3.1 Core Topics

3.1.1 *Operations Technologies*

Operations information systems technologies broadly support the future challenges of operating NASA's Earth Science space-based, airborne, or ground-based systems. New developments, (i.e., Unmanned Aerial Vehicles (UAVs) and small satellites) are being coordinated with other more mature observing systems platforms and sensors to advance how scientific observations are performed. Opportunities exist to improve observation strategies and to enable new types of observations. These advances will increase the degree of coordination among different platforms and sensors. Platforms and sensors of interest, with examples of areas of application, include:

- Spacecraft - traditional multiinstrument systems, small satellites, and U-class satellites, both as individuals and as constellations;
- Aircraft – automation of mission coordination and instrumentation operation and inflight reconfiguration based on observations of opportunity;

- In-situ sites and instruments – platform networking; automated management, and data polling;
- Models – automated execution of models with varying inputs to support studies of science sampling strategies, mission design trade studies and/or scientific investigations;
- Sensor Web – integrated multinode systems which may be composed of homogenous or heterogeneous nodes.

Innovative approaches are required to advance a variety of goals, such as:

- managing increasing numbers of remote sensing measurements;
- handling a variety and uncertainty of data;
- handling volume and analysis of data for improved operations;
- event-driven operations;
- autonomous remote sensing management.

Technologies in this category are intended to increase the operations effectiveness of Earth observing instruments, software, and missions.

Example technology areas and challenges include, but are not limited to:

- Technologies for automated real-time operations of individual platforms or collections of platforms and instruments.
- Tools for operations planning, scheduling, data acquisition, product distribution, and/or archiving from distributed and high data rate observations.
- Technologies for real-time data acquisition and control for science analysis and decision support applications.
- Technologies for efficient and/or automated equipment operation and control of small satellites, UAVs, and in-situ devices.
- Technologies for coordinated operation and data management of distributed, heterogeneous, and dynamic Earth observing assets (e.g., sensor webs and/or distributed mission operations), including small satellites, airborne platforms, UAVs, and in-situ sensors and instruments, in order to support science objectives.
- Technologies for improving and accelerating generation of low latency data products from the growing number of instruments supporting real time and near real time science objectives and applications.
- Reusable and rapidly reconfigurable ground data systems technologies.
- Operations technologies specific to aircraft missions, such as goal-directed planning, model driven replanning, vehicle health and monitoring, and on-board processing to support such capabilities.
- Operations technologies specific to small satellites (e.g., processing, compression, storage, downlink, autonomous operations, and attitude determination and control) to meet operational pointing requirements.
- Technologies supporting Synthetic Aperture Radar (SAR) science data processing, calibration and validation.

3.1.2 *Computational Technologies*

Computational technologies refer to innovations in computer architectures, computing hardware, algorithms, and novel approaches to software programming and software engineering. It also includes software developments that improve computing performance or provide new or improved functionality. Technologies in this category are intended to improve or enhance the science value of the data. As a consequence, they have the potential for improving the overall cost effectiveness of a mission or science research effort and reduce the end product latency. Computational Technologies include information systems technologies that operate directly on the following:

- Information extracted from the data stream or model outputs
- Measurements to be acquired by a new mission or science campaign
- Researchers' tools for analytics

Example technology areas include, but are not limited to:

- Data mining and visualization to enable analysis (e.g., data immersion approaches to enable real-time interaction with the models, and visualization of highly complex systems).
- Data exploration that significantly advances state of the art in Earth Science research, such as virtual or enhanced reality aiding in the understanding and evaluating of model output or earth science data.
- Enhancements of workflows, automation, data accessibility, multiple computing paradigms, and collaboration that accelerate model runs or data production.
- Techniques to exploit specialized processing units or accelerators and cloud computing technologies for large-scale on-demand data processing, mining, and distribution.
- Tools to manage and to accelerate the assessment and validation of model-data inter-comparisons (e.g., to more easily evaluate new algorithms and/or quantify data and product uncertainty).
- Tools to broaden the applicability and reduce the cost of simulations (e.g., Observing System Simulation Experiment, OSSE) for evaluating instrument, mission, sensor networks, and field campaigns.
- Tools to expand the integration of Quantum Computing into applications for analysis of Earth Science data and model output.

3.1.3 *Data-Centric Technologies*

Data-centric technologies are those that broadly support the science and applications communities in conducting the sequence of activities needed to transform Earth science mission's observational data, model output and other related datasets to

- improve information reuse, facilitate collaboration within the research community,
- increase the speed of production and publication of results.

AIST focus includes the design of novel and innovative technologies that advance the discovery, access, and use of NASA's Earth Science data within rapidly developing community architectures (e.g., interagency efforts) including:

- the Global Change Information System (https://data.globalchange.gov/),
- the Climate Data Initiative (https://www.whitehouse.gov/the-press-office/2014/03/19/fact-sheet-president-s-climate-data-initiative-empowering-america-s-comm),
- EOSDIS community APIs (https://earthdata.nasa.gov/api)
- global architectures (e.g., the Internet of Things, Smart Cities, and Smart World).

Once matured to Technology Readiness Level (TRL) 6, these technologies lay the foundation for adoption through the Earth Science Division data management programs and projects. They also yield data fusion products that serve to advance Earth science research and resulting publications, and aid decision-making within the research and application communities.

The scope of data-centric technologies includes, but is not limited to, the following sample technology areas:

- Big data analytics applied to the large volumes of Earth science observations' data and metadata and the use of other data-centric technologies.
- Tools and techniques for data fusion and data mining, particularly among files of different formats, sources, and internal data structures. Of particular interest is the use of these tools leveraging cloud computing economics, elasticity and scalability.
- Software architectures and frameworks that support the incorporation of scaling, models, data, sensor webs, data mining algorithms, and visualization by leveraging and/or enhancing interoperability standards.
- Tools and techniques to ease the incorporation of data quality, provenance, semantics, and any relevant metadata into Earth observation data.
- Capabilities to implement, discover, and consolidate/integrate shared services for effective use and management of data and metadata in the science and applications communities (e.g., data provenance mechanisms, uncertainty quantification methods, data quality metrics).
- Storage, management, and processing techniques for large data volumes (e.g., cloud computing, data distribution services and service migration) to enable near-real time end product delivery.
- New and/or enhanced customized tools for managing the development, reuse, and evolution of large scientific codes (e.g., enhancements to open source tools).
- Tools to enable software applications to execute functions and autonomously share results with one another, without compromising system security or violating associated data policies.
- Technologies that provide opportunities for more efficient interoperations with the observations data systems, such as high end computing and modeling systems.
- Tools, workflows, and techniques for formulating and testing families of hypotheses from a seed hypothesis.
- Capabilities that enable discovery and access to Service Oriented Architecture (SOA) components and services.

3.2 Special Subtopics

The AIST program works closely with each of the Earth Science elements (Research and Analyaia (R&A), Flight, and Applied Sciences) to identify technology challenges and to designate special subtopics to help address their longer-term science needs. Offerors are encouraged to submit proposals that advance novel, higher risk/return approaches to the stated challenges. Core topics proposals are not required to address the Special Subtopics.

3.2.1 Innovation Breakthroughs to Aid in Understanding the Impact of Global Change focusing on Climate Change and Changes in Biodiversity

Global change is threatening to push the Earth system through a range of tipping points threatening global sustainability (*A Safe Operating Space for Humanity*, Johan Rockstrom[7]). The need to understand global change is identified by the National Academy of Sciences (http://sites.nationalacademies.org/PGA/sustainability/PGA_048724) and various conferences, such as Planet Under Pressure (http://www.planetunderpressure2012.net/). Two significant global changes affecting life on Earth are occurring simultaneously: climate change and biodiversity loss. Currently, data from individual instruments and systems are first analyzed individually and then measurements of other parameters are computed from those results. The use of data fusion is growing, along with the analysis of the propagation of uncertainties. The placement of instruments at different vantage points from in-situ sensors up through geostationary satellites affords different measurement characteristics, including spatial resolution (e.g. grain size and extent), temporal resolution (e.g., revisit rate) and coverage of various areas along the electromagnetic spectrum. Climate change observations are typically taken at large regional to global spatial scales while biodiversity observations are often made at plot to landscape scales. The integration of observations of multiple types from all vantage points is required to improve our ability to understand both climate change and biodiversity loss and how each affects the other in space and through time.

The National Climate Assessment (http://nca2014.globalchange.gov) observed that "Impacts of climate change on ecosystems reduce their ability to improve water quality and regulate water flows. Rapid changes to ecosystems may cause the displacement or loss of many species. Timing of critical biological events is shifting, affecting species and habitats." It also pointed out that some scientific barriers present challenges to implement adaptive strategies. More accurate, timely and comprehensive information will be needed to reduce the uncertainties in the short-, medium-, and long-term and to help appropriately respond to these changes.

Advanced information technologies are prevalent across Earth Science R&A activities and are both an enabler and a major cost driver in supporting scientific breakthroughs. Recent results in several NASA programs (Cryosphere, Terrestrial Hydrology, Biodiversity and Ecological Forecasting, Terrestrial Ecology, Ocean Biology and Biogeochemistry) have identified the opportunity to apply recent advances in information technology (such as machine learning, cloud computing, workflow technologies) to enable scientific investigations to use much larger sets of data from dissimilar sources to improve support for their conclusions. Key science research questions are described in these ROSES announcements.

Improvements needed in the use of advanced information technology include:

a) the integration of output from sensors at varying observational levels (in-situ, airborne and orbital) into a more complete and more accurate picture of the spatial distribution and behavior of key populations of organisms, communities, and species.
b) the integration of output from sensors at varying observational level (in-situ, airborne and orbital) into a more complete and more accurate picture of the water distribution and hydrological processes.

c) the integration of instrument data into models with improved accuracy and reduced latency.
d) the correlation of time series measurements of key environmental parameters with the spatiotemporal distribution of organismal populations, communities, and species for improved understanding of the impact of climate change along with other drivers of change on biological systems.
e) the application of the principles of data-driven modeling to improve context for and selection of measurements.
f) the application of uncertainty estimates from machine learning and applied statistics to improve the understanding of the limitations on observational data and model output.
g) improving the ease with which the biology and ecology communities can understand, select and use appropriately NASA remote sensing data.
h) automated analytic techniques to scale the use of all relevant observational data in the understanding of patterns and processes in biodiversity.
i) tools which aid the researcher in formulating and evaluating hypotheses quickly.
j) the integration of automation and workflow tools into the analysis process to accelerate testing, repeatability and inter-organizational collaboration in analysis of data and model output.
k) the prediction and modeling of extreme water-related events, including droughts and floods.
l) the rapid preparation and update of disaster response products, consistent with the NASA's Disaster Response Program.

3.2.2 Alternative Approaches/Disruptive Technologies for Mission Planning and Operations

Developments in the employment of U-class satellites and smallsats to conduct scientific investigations or to supplement conventional orbital platforms is described in a recent report by the National Academy of Sciences (https://www.nap.edu/catalog/23503/achieving-science-with-cubesats-thinking-inside-the-box). New opportunities for integrated sensor webs involving coordination of sensors from in-situ, suborbital and multiple orbital vantage points, thereby permitting a more coherent picture of a phenomenon or event. It is anticipated that, as the number of these platforms expands, the pressure on conventional mission planning and operations capabilities will grow, adding to the cost of missions. Additionally, new measurement strategies could address transient and transitional phenomena by leveraging steerable instruments, coordination among multi-altitude devices and more flexibility in platform orbital dynamics. As key orbital paths become more crowded, planning and signaling among the various mission operations centers become essential to traffic control and critical to collision avoidance. Automation, responsive analytic capabilities and intuitive decision support tools are needed to manage effectively and efficiently these growing numbers of measurement assets.

Such advances include:

(a) integration of multi-satellite mission planning/design tools with multi-satellite tasking and operations capabilities.

(b) goal-oriented mission replanning to maximize the value of science gained.

(c) algorithms for integrating instrument output into mission commanding functions, both on the same platform and on related platforms.

(d) security measures to ensure all commands are appropriately originated, authorized, and authentic.

3.2.3 Technology Enhancements for Applied Sciences Applications

Proposals are sought that develop new and potentially "game changing" capabilities for decision support or end user applications through the use of Earth Science data and/or models in one of the Applied Sciences active applications themes (http://appliedsciences.nasa.gov):

1) Health and Air Quality
2) Disaster Response
3) Water Resources
4) Ecological Forecasting
5) Wildfires

Technology development activities in this topic area must target a public or private sector organization considered to be a value-adding entity or an end-user of NASA Applied Sciences data and services, and at least one member of the proposal team must be from this organization. A letter of endorsement supporting the technology development and committing to an evaluation of its longer term use if successfully demonstrated is required from the identified organization end user.

Proposers who are targeting the Disaster Response application theme should reference *GEOSS Architecture for the Use of Satellites for Disasters and Risk Assessment* (http://ceos.org/ourwork/workinggroups/wgiss/past-activities/ga4disasters/), a report issued by the Committee on Earth Observation Satellites Working Group on Information Systems and Services (CEOS-WGISS). This document should be used when describing the activities and rationale for the proposed technology.

Technology development to translate science and technology into useful tools to help with the response to flood, earthquake and volcano hazards, tropical and hazardous weather, and coastal hazards – including oil spill and chemical releases are particularly needed, including tools for teaming related to response to these hazard areas. Disaster project attributes, such as low latency data, data automation, visualization, monitoring and prediction, are also needed. Global disaster response efforts in support of or related to demonstration and pilot activities aligned with disasters community partners such as the CEOS Working Group for Disasters, the International Charter for Space and Disasters, and the AmeriGEOSS Plan on Water and Disasters are also germane.

4. Special Matters

The AIST Program is designed to bring information system technologies to a level of maturity that allows integration or infusion into existing or future NASA technology, science research and missions, to enable timely and affordable delivery of NASA information to users.

4.1 Technology Infusion

Technology developed with a target audience in mind is more likely to have important impacts on NASA's Earth Science Program. Proposals should address technology development that identifies specific community-based science problems to be solved.

AIST supports development of technologies to the point where they have been demonstrated and are ready to be adopted by NASA Earth Science elements (R&A, Flight, and Applied Sciences). The Earth Science elements influence AIST starting with the requirements definition through the technology infusion phase. Representatives of the relevant elements participate in the proposal review, ranking, and programmatic decisions. After award, element members participate in project reviews and continuation decisions. An early and ongoing influence by the target element ensures a technology will ultimately be useful to that element in the accomplishment of NASA Earth Science goals.

Projects are required to identify a target recipient element and understand their needs in order to produce impactful technology development. A representative of that element should be on the proposed team to ensure design and development decisions are made to support element acceptance. If a technology is potentially useful to multiple elements, they should pick one element where they will obtain effective collaboration.

4.2 Technology Community Resources:

4.2.1 *AIST Managed Cloud Environment (AMCE)*

The AIST Program has implemented a Managed Cloud Environment as a demonstration of how to supply inexpensive, elastic computational and storage services using Amazon Web Services (AWS). The AMCE service provides the AIST IT development community

- collaboration and infusion opportunities,
- flexibility for users,
- adherence to the NASA security requirements.

Successful projects are encouraged to explore this service as a means of obtaining information technology services and reducing their cost. Proposals should not be dependent upon this service for their computation. Upon award, information can be obtained through the AIST Program.

4.2.2 *Independent Testing*

The AIST Program uses the Earth Science Information Partners (ESIP) Federation to perform independent assessments of TRL and adoptability of AIST Projects. This has the additional benefit of improving the adoption of projects or infusion of technologies by giving additional target audiences an opportunity to evaluate the product and to influence final enhancements and make it more usable. Awarded projects may participate in this assessment by arranging it through AIST in the final year of their development.

4.2.3 *Quantum Computing*

Proposals for the development of quantum annealing/computing applications for Earth sciences will be given access to the NASA quantum annealing system located at the NASA Ames Research Center (see http://www.nas.nasa.gov/projects/quantum.html). Proposals must address NASA Earth Science problems that are suitable for solving via quantum optimization algorithms, such as clustering for pattern recognition, data fusion and image matching for remote sensing, structured learning for multiple label classification, and others.

Successful proposals need to describe the full cycle of research on the quantum system. This includes (1) the identification of the specific application embodying an optimization problem, (2) the strategy for mapping the problem into the quadratic unconstrained binary optimization (QUBO) format, and (3) the strategy for embedding the QUBO into the underlying Chimera graph of qubits of the quantum device.

4.3 Technology Best Practices

4.3.1 *Geographic Information Systems (GIS)*

The AIST Program encourages technology development that can be deployed into frameworks commonly in use in 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 to enhance the use of large data sets from a variety of sources, including NASA Distributed Active Archive Centers (DAACs) and field campaigns. The development of unique visualization or analysis frameworks duplicating work already in use is discouraged.

4.3.2 *Software Engineering Practices*

The AIST Program encourages the use of quality software engineering practices. Proposals must address a software engineering and testing plan to describe the software engineering practice to be used by the project, including the use of software engineering standards and procedures. The proposal will be considered unresponsive without this plan. The plan should include the design and architecture documents to facilitate future expansion and maintenance of the software.

4.3.3 *Open Source Software*

The software developed under this ROSES Appendix must be designated and distributed to the public as open source software. Software developed may be created to run in conjunction with commercial or other restricted use software (such as MATLAB, Envi, arc-GIS), but must be separate from that software and should include a brief open sourcing plan and re-use license equivalent to the Apache License 2.0 (http://www.apache.org/licenses/LICENSE-2.0).

5. Proposal Content and Submission

Proposers are advised to periodically check the solicitation website (http://nspires.nasaprs.com/) for any amendments to the ROSES-2016 NASA Research Announcement (NRA), and consult the 2016 version of the NRA *Guidebook for Proposers*.

Notices of Intent (NOI) to propose are encouraged, but not required. Submit NOIs electronically via NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) by the due date given in Section 9, Summary of Key Information. Please refer to the *Guidebook* for more information regarding NOIs.

The table below identifies the required proposal sections and identifies the appropriate Guidebook sections.

Required Proposal Section	Reference
Proposal Cover Page	2.3.2(a), (b)

Table of Contents	2.3.5
Scientific / Technical / Management Applicability to NASA Earth Science (Relevancy Scenario) Description of Proposed Technology	2.3.6 and additional elements (see Important notes below)
Comparative Technology Assessment TRL Assessment Research Management Plan	See important notes in section 5.3 below
References and Citations	2.3.7
Biographical Sketch	2.3.8
Current and Pending Support	2.3.9
Statements of Commitment and Letters of Support	2.3.10
Budget Justification – Narrative Details	2.3.11

5.1 Virtual Q&A

An online question form is available at https://esto.nasa.gov/AIST2016_VBC from release date thru December 20, 2016. Proposers may submit their questions regarding this solicitation at any point during that time period using the online form. Responses will be posted to that website and on the NSPIRES page for this program element under "other documents" by January 20, 2017. Please continue to check these websites periodically in case there are additional questions and answers posted.

5.2 Proposal Summary

The NSPIRES web page requires proposers fill in a text box with a proposal summary of no more than 4000 characters. The proposal summary includes: (a) objectives and benefits; (b) an outline of the proposed work and methodology; (c) the period of performance; and (d) entry and planned exit Technology Readiness Level (TRL).

5.3 Scientific/Technical/Management Section

This section is specific to this NRA and replaces Section 2.3.6 of the *Guidebook*. This section must include the following content information in subsections that use the same titles. Failure to provide any of this material may be cause for the proposal to be judged as noncompliant 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 may be returned without review. The following subsections are required to be included and clearly identified in the Scientific/ Technical/Management section of the proposal.

To respond to the solicitation, proposers are required to identify exactly one core topic area to identify their proposal theme. If a proposer desires to address a special subtopic, then the subtopic should be selected in addition to the core topic. Proposers are required to select one core topic and any subtopics on the NSPIRES cover page, or to explicitly name the topics in the abstract if the proposal is submitted through Grants.gov.

5.3.1 *Applicability to NASA Earth Science*

Describe the benefits to future Earth Science missions, research or applications that utilize the proposed technology including a relevancy scenario. In no more than one page, the offerors should provide a relevancy scenario (i.e., use case) that describes how the proposed technology will benefit NASA Earth Science and how the work links to the elements of the strategic planning documents mentioned above, and as appropriate, to the special topics in Section 2.2. The relevancy scenario is intended to sell the concept being offered and should provide clear examples of how the technology would be infused or integrated (i.e., if the technology is targeted at a flight program the applicable NASA mission or measurement should be identified). Involvement of Earth Science researchers who are familiar with NASA's Earth Science programs is highly encouraged. Projects are required to identify a target recipient community and understand their needs in order to produce impactful technology development; a representative of that community should be on the proposed team to ensure design and development decisions are made to support community acceptance. Proposals that fail to include a relevancy scenario may be rated significantly lower.

5.3.2 *Description of Proposed Technology*

Provide a description of the proposed element, system, or subsystem technology. Describe the technical approach and include an operational concept of the proposed technology that addresses Earth science needs. Explain and justify how the proposed technology enables science. Discuss any possible cross-cutting or commercial benefits. Include the use of any Open Source or commercial tools use and Open Source licensing for any software to be delivered. Each proposal shall:

a. Identify any proprietary software, software owned by a non-Federal entity, or open source software that is incorporated into the software being proposed, and an open source plan;
b. Indicate whether a license has been obtained in situations where proprietary software, software owned by a non-Federal entity, or open source software has been incorporated into the software that is the subject of the proposal and attach a copy of the license to the proposal, along with evidence of permission obtained from the software owner to release improvements or derivative works to the software as Open Source under the Apache License, Version 2.0.

Proposals will be evaluated for compliance with the above open source software requirements. A proposal that does not include documentation sufficient to satisfy NASA that the developed software will be open source may not be selected.

5.3.3 *Comparative Technology Assessment*

Describe the anticipated advantages of this element, system, or subsystem technology 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. Describe the current state of the art, identify other competing technologies or efforts and compare it to the proposed effort.

5.3.4 *TRL Assessment*

The TRL scale is used to assess the maturity of a particular technology. The AIST program accepts technology development at various stages of maturity and advances the TRL through appropriate risk reduction activities, such as requirements analysis, conceptual design, prototypes, and proof-of-concept demonstrations. Proposals are required to include an entry TRL estimate along with a brief justification, the planned exit TRL, and success criteria. Provide the current TRL assessment of the technology and the anticipated progression of TRL levels throughout the proposed effort based on the NASA software or hardware TRL definitions. Note that ESTO desires the TRL to advance by at least one during the two years of performance of the activity. For this solicitation, the entry TRL should be from 2 through 4. Past and ongoing work on the research activity should help to determine the entry TRL. TRL definitions and information can be accessed on the ESTO web page (https://esto.nasa.gov/technologists_trl.html). Technologies at a higher level may be considered as a lower priority for this solicitation.

5.3.5 *Research Management Plan*

The Proposer must provide a Statement of Work that concisely describes each task and milestone to be accomplished, the duration, and the responsible team member in the course of the research and development. Define the success criteria associated with each task or milestone. Also include a milestone schedule chart that identifies at least two critical milestones per twelve-month period.

Subcontracting portions of the research project is acceptable; overall management, reporting, and integration of the work to achieve the end state are the proposing organizations responsibility.

Proposals developing significant new datasets must include a data management plan.

5.3.6 *Personnel*

Provide a list of key personnel and identify experience related to the proposed activity. Proposers should include all relevant skills (i.e., science, technology development, and instrument development). The key personnel list is included in the overall page count and must include, at 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.

5.3.7 *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.

For any of the topics, facilities needed for computation, testing, verification, or validation of components, subsystems, and/or systems can be included and priced as an integral part of a proposed technology effort, but should not be submitted as a stand-alone proposal. If any special purpose equipment is needed, the proposers should identify how such equipment would be acquired and how it would contribute to the overall effort.

5.3.8 *Quad Chart*

Provide a quad chart using the template and example at
https://esto.nasa.gov/files/EntryQuad_instructions_template.ppt.
Note: This quad chart is not included in 15-page limit for the Project Description Section.=

6. Award Information

6.1 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 that NASA determines are acceptable for award under this program element. No additional funds beyond the negotiated award value will be available. NASA does not allow for payment of profit or fee to commercial firms under grant awards, and few fees are permitted (For example, see http://science.nasa.gov/researchers/sara/faqs/#16).

Proposers are encouraged to offer cost sharing. If a cost sharing arrangement is proposed, appropriate data rights that recognize the proposer's contributions, as well as the Government's rights to access, will be negotiated prior to award.

6.2 Period of Performance

The expected period of performance is 12-24 months. Proposals must define clear, measurable milestones to be achieved for each year of performance in order to warrant continuation.

6.3 Type of Award

All selected proposals will result in the award of grants, cooperative agreements, or intra- or inter-Government transfers, as appropriate. Grants and cooperative agreements will be subject to the provisions of the *Grants and Cooperative Agreement Manual* (GCAM) and Appendix D of the *NASA Guidebook for Proposers*. In the case of any conflict, the GCAM takes precedence. If a commercial organization wants to receive a grant or cooperative agreement, cost sharing is required, unless the commercial organization can demonstrate that it does not expect to receive substantial compensating benefits for performance of the work. If this demonstration is made, cost sharing is not required, but may be offered voluntarily (see references in Section III(d) of the *ROSES Summary of Solicitation*).

7. Evaluation Criteria

For this solicitation, the following important factors are included in the evaluation process (relevance, intrinsic merit, cost realism/reasonableness) and replace those given in the *Guidebook* Appendix C.2.

Relevance is defined as the applicability of the proposed investigation to Earth Science missions and technology needs and specifically includes the relevance to NASA's Earth Science scientific and technical areas of emphasis, as described in ROSES program element A.1. Endorsement by a representative from the target audience either participating in or advising the Project will be considered as part of relevance.

Intrinsic merit is defined as:

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.
c) Past performance and related experience in the proposed area of technology development.
d) Qualifications of key personnel, and adequacy of facilities, staff, and equipment to support the proposed activity as it contributed to cost realism.
e) Substantiated justification and appropriateness of the entry and exit TRL. For this solicitation, the entry TRL is constrained to be between 2 and 4 inclusive, with the exit TRL no higher than 7. Higher entry TRL technology can be proposed but will be considered as a lower priority.
f) Feasibility of obtaining the potential reduction in risk, cost, size, and development time with the proposed technology, and 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 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 Support endorsing the value from a mission or research area potential adopter must be included.
h) The potential of the technology to be integrated, once matured, into an Earth science mission, research activity, or a product for use by the Applied Sciences function. A Letter of Support from an appropriate representative of the science team and/or direct participation in the Project must be included.
i) The potential for the technology to have commercial benefits, and if applicable endorsed by a potential commercial adopter including an appropriate Letter of Support.

Cost realism and reasonableness is defined as:
a) Adequacy and realism of proposed milestones and associated success criteria.
b) Realism and reasonableness of the person time to successfully achieve the proposed task, proposed cost of procurements and (by NASA) comparison of costs to available program funds.
c) Adherence to sound and consistent management practices appropriate to the TRL level 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.

8. Technical Reporting Requirements

Proposers should be aware that technology programs require more extensive reporting than many other ROSES elements and these costs should be taken into account in submitted proposals.

Once awarded, submit all status information, presentation material, and report deliverables applicable to this AIST program element to the web-based ESTO Reporting System (ERS). A user account on the ESTO ERS will be provided to the PI upon award. Due to NASA IT security requirements, all PIs must register with the Identity Management and Account Exchange

(IdMAX) system before a user account on ERS will be established. To create an IdMAX account, some personal information will be required.

The following deliverables are 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.

8.1 Initial Plans and Reports

Within 15 days of award, provide an updated Project Plan, initial Quad Chart, and initial TRL assessment. Also, provide 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.

The initial quad chart shall follow the template and example at https://esto.nasa.gov/files/EntryQuad_instructions_template.ppt

Proposers are required to update the Quad Chart and TRL assessment at least annually and more often, if appropriate. This can be done on the ESTO ERS under the "Quad Chart" section and "TRL" section respectively.

8.2 Quarterly Technical Reports

The quarterly technical report shall focus on the preceding three months' efforts. Address the following in each report:

1. Technical status: 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: 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.

Upload the Quarterly Technical Reports to the appropriate location in the ESTO ERS at three-month intervals, starting on the third-month anniversary date of the start date specified in the award vehicle. In months for which the PI is providing 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 may 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 ESTO and the PI to review and discuss each report.

8.3 Interim Reviews

An Interim Review occurs 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 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. Create and maintain a schedule milestone chart of all major task activities and show at all reviews. Also, create and maintain a cost data sheet that shows 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; and
5. At the second review and subsequent reviews, address the comments and recommendations prepared by the reviewers participating in the most recent review.

The Interim Review will be conducted via teleconference and uploaded to the appropriate location in the ESTO ERS at least three (3) working days prior to the review. Following the review, the presentation, updated in accordance with comments and discussion resulting from the review, shall be uploaded to the appropriate location in the ESTO ERS within ten days after the review.

8.4 Annual Review

An Annual Review occurs at the end of the twelve-month calendar period commencing from the date of award. The Annual Review is 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. An independent technical reviewer from an organization separately funded by ESTO participates in the review.
3. The PI may provide a laboratory demonstration, if appropriate, to show technical results and status.
4. 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.
5. The Annual Review should be comprehensive, and should cover the progress over the previous twelve months.

Upload the review package to the appropriate location in the ESTO ERS at least three (3) working days prior to the review. The presentation, updated in accordance with comments and discussion resulting from the review shall be uploaded to the appropriate location in the ESTO ERS within ten days after the review.

8.5 Final Review and Final Report

The Final Review occurs at the completion of the activity. The Final Review is similar to the Annual Review 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.

Include the following in the written Final Report:

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 advance the TRL to next level;
6. Updated Quad Chart; and
7. At the end of the period of performance, the PI shall create a final Accomplishments Chart which contains the following information (a template is available in the ERS):
   - Upper Left: "Objective"
   - Upper Right: A visual, graphic, or other pertinent information.
   - Middle: "Accomplishments."
   - Bottom: "Co-Is" (name and affiliation), "Entry TRL" and "Exit TRL."

The Final Report and updated Final Review presentation shall be uploaded to the appropriate locations in the ESTO ERS within thirty days of the final review. Also, update the Accomplishment Chart and TRL assessment on the ESTO ERS under the "Quad Chart" section and "TRL" section respectively.

8.6 Earth Science Technology and Other Relevant Forums

The awardee is encouraged to make the community aware of their work by participating in relevant technology forums and other conferences and meetings related to Earth Sciences (please note slots are limited for NASA civil servant and contractor personnel for such events). Offerors must include travel costs in their proposals. The awardee should be prepared to make a presentation, provide a paper, or create a poster providing a description of the project, the objectives, approach, technical status, and schedule information. Such events may include, but are not limited to, the NASA discipline Science Team Meetings, the AGU Annual Meeting, the AMS Annual Meeting, relevant IEEE and ACM conferences, and the semi-annual ESIP Federation meetings.

PIs or their representatives are also expected to participate in the ESTO Earth Science Technology Forum to advance information sharing of their work. Follow-on efforts are envisioned to identify candidate Earth science scenarios that will benefit from information systems technology concepts, and approaches and that can be prototyped to demonstrate those benefits through collaboration and science participation.

9. Summary of Key Information

Expected program budget for first year of new awards	~ $12.5 million
Number of new awards pending adequate proposals of merit	~ 18-20
Maximum duration of awards	2 years
Virtual Q&ASite	https://esto.nasa.gov/AIST2016_VBC Open from release date through December 20, 2016
Due Date for Notice of Intent to Propose (NOI)	December 21, 2016
Due date for delivery of proposals	February 16, 2017
Planning date for start of investigation	5 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* and Section 5.2.2 of this solicitation.
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 Section 3 of the *NASA Guideline 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 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	NNH16ZDA001N-AIST

NASA point of contact concerning this program	Michael Little Earth Science Technology Office Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 E-mail: Michael.M.Little@nasa.gov

[1] National Research Council, Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond, http://www.nap.edu/catalog.php?record_id=11820, 2007.

[2] 2012 Midterm - National Research Council, Earth Science and Applications from Space: A Midterm Assessment of NASA's Implementation of the Decadal Survey, https://www.nap.edu/read/13405/chapter/1 .

[3] *A Safe Operating Space for Humanity*, Nature 461, 472-475 (24 September 2009).

A.42 INSTRUMENT INCUBATOR

NOTICE: Amended April 7, 2016. This Amendment releases the final text for this program element. Notices of Intent are requested by May 31, 2016, and proposals are due July 11, 2016. Proposers to this program element do not need to submit a data management plan.

1. Scope of Program

1.1 Introduction

NASA's Earth Science Division (ESD) in the Science Mission Directorate (SMD) supports research activities that address the Earth system 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 surface-, balloon-, aircraft-, and/or space-based platforms; and uses the results to increase basic process knowledge.

Within ESD, the Earth Science Technology Office (ESTO) demonstrates and provides technologies that can be reliably and confidently applied to a broad range of science measurements and missions, as well as to practical applications that benefit society at large. As NASA's lead Earth Science technology organization, ESTO is focused on the technological challenges inherent in space-based investigations of our planet's dynamic, interrelated systems and technological advances that enable improved understanding of and/or new insights into the highly complex Earth system.

The Instrument Incubator Program (IIP) funds innovative technologies that lead directly to new Earth observing instruments, sensors, and systems in support of SMD's ESD. The technologies and measurement concepts developed under the IIP may extend up through field demonstrations, with a longer-term aim for infusion into future ESD research and flight programs.

1.2 Goals of the Instrument Incubator Program

The goals of the IIP are to research, develop, and demonstrate new measurement technologies that:

- Enable new or greatly enhance Earth observation measurements and
- Reduce the risk, cost, size, mass, and development time of Earth observing instruments.

Rapid advances in Earth science instrument technology are enabling significantly smaller instruments that may be able to meet many science needs in the future when using modularized subsystem architecture ("plug and play"), and/or architectures that allow increased flexibility and adaptability to multiple measurement objectives. Also, rapid evolution of spacecraft bus technology toward smaller satellites, when combined with increased launch opportunities on a more diverse set of platforms and launch vehicles, opens the possibility for many new approaches to Earth science mission implementation.

As discussed in more detail in Section 2 below, this program element requests proposals for technology development activities aimed specifically at: (1) development and demonstration of new innovative Earth Science remote sensing instruments; and (2) demonstration of new instrument concepts and/or measurements.

2. Proposal Research Topics

This IIP solicits new instrument and measurement technologies addressing any of the science focus areas in NASA's Earth Science program (see Appendix A.1 for descriptions of the focus areas) to enable new types of observations that improve: (i) temporal and spatial resolution, and/or (ii) cost-effectiveness of Earth science measurements. Technologies may target any Earth science question or issue in order to advance the strategic goals, questions, and research objectives outlined in Appendix 1 of the *2014 Science Plan for NASA's Science Mission Directorate* (hereafter the *2014 Science Plan*; available at http://science.nasa.gov/about-us/science-strategy/). In addition, recent ESTO community workshops were held that focused on lidar and microwave technologies in support of the 2017-2027 Decadal Survey for Earth Science and Applications from Space. A summary of the workshop results can be found at https://esto.nasa.gov/files/2016CommunityWorkshops.pdf.

This program element actively seeks instruments that enable new remote sensing measurements and/or provide improvement to traditional instrumentation and measurement techniques that: (i) enable increased flexibility and adaptability to measurement objectives; and/or (ii) provide cost-effective instruments enabling innovative measurement techniques, including those that could employ multiple sensors in formation or use alternative platforms. These alternative platforms could be small satellites or co-manifested opportunities, including hosted payloads and ride-share programs appropriate for observations of the Earth system. This program element also seeks instruments that demonstrate innovative ways to combine both passive and active measurement capabilities to generate multiple science measurements.

Proposals are sought that advance the goals and objectives of IIP through technology developments in two distinct subelement topic areas:

1) Instrument development and demonstration and

2) Instrument concept demonstration (a new program subelement seeking shorter duration, lower cost, earlier stage measurement or instrument demonstrations designed as proof of principle for a future remote sensing measurements)

2.1 Instrument Development and Demonstration (IIP-IDD)

This subelement covers the entire instrument development process that includes instrument design, breadboard, prototype, and engineering model construction, laboratory, and/or airborne demonstrations for innovative measurement techniques that have the highest potential to meet the objectives of the IIP and substantially improve the state-of-the-art Earth science measurements.

The proposed IIP-IDD activity is expected to have an entry Technology Readiness Level (TRL) between 3 and 4 with an exit TRL between 4 and 6.

2.2 Instrument/Measurement Concept Demonstration (IIP-ICD)

This subelement seeks demonstration of innovative concepts that have high potential to meet the objectives of the IIP and substantially improve the state-of-the-art Earth science measurements.

The IIP-ICD is intended to advance development and maturity level of these concepts, which are typically at the early stage of formulation, through detailed analytical studies, model simulation, and/or breadboarding of critical functions or instrument subsystems. Also, proposals can include innovative ways in which the instrument can be controlled or the output processed to improve the quality of the measurement, extend the life of the instrument or to create new uses of the measurements.

The proposed IIP-ICD activity is expected to have an entry TRL between 1 and 2 with an exit TRL between 3 and 4.

3. Programmatic Information

This document provides requirements and details tailored to this specific program element that supplement or may supplant the general guidelines of the ROSES-2016 Summary of Solicitation or *Guidebook for Proposers*. See Section I(h) of the ROSES-2016 Summary of Solicitation regarding the order of precedence.

3.1 Proposal Content and Submission

3.1.1 *Notice of Intent to Propose*

A Notice of Intent (NOI) to propose is encouraged, but not required, 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. Submit NOIs 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 E-mail to the point of contact for this program element (see Section 3).

3.1.2 *Questions and Answers*

Prospective proposers are requested to submit any questions in writing to p.ghuman@nasa.gov no later than 30 days before the proposal due date. Questions and answers may be posted in a Frequently Asked Question (FAQ) on the NSPIRES page for this program element under "other documents." It is the proposer's responsibility to check the NSPIRES page for this program element for possible updates to any FAQ document or clarifications to the solicitation. Proposers who subscribe to the SMD email distribution list in NSPIRES will receive an email if this solicitation is amended.

4. Proposal Content

4.1 Proposal Summary (abstract)

The NSPIRES web page requires proposers fill in a text box with a proposal summary of no more than 4000 characters. The proposal summary includes: (a) objectives and benefits; (b) an outline of the proposed work and methodology; (c) the period of performance; and (d) entry and planned exit Technology Readiness Level (TRL).

4.2 Scientific/Technical/Management Section (Project Description)

This section must include the following content information in subsections that use the same titles. Failure to provide any of this material may be cause for the proposal being 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 may be returned without review. The Project Description Section includes:

1. Applicability to Earth Science Measurements – Describe the benefits to future Earth Science missions that utilize the proposed technology. Include a one-page relevancy scenario showing how the proposed technology contributes to one or more Earth Science measurements.

2. Description of Proposed Technology – Provide a description of the proposed new technology for an instrument system or subsystem. Describe the technical approach and include an operational concept for the proposed technology that shows how it addresses Earth science needs. Explain and justify how the proposed choice of measurement platform enables science. Discuss any possible benefits to other NASA Earth or Space Science activities or commercial benefits.

3. Comparative Technology Assessment – Describe the anticipated advantages of this technology 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 technology or measurement technique and the exit or success criteria for the proposed activity. The TRL shall advance by at least one level during the period of performance of the activity. If proposed activity duration is for multiple years, advancement of one TRL per year is desirable.

TRL definitions can be found at http://esto.nasa.gov/files/TRL.doc. Identify the entry TRL, the planned exit TRL, and success criteria in their proposal and substantiate the entry TRL in the proposal.

5. Research Management Plan – Proposer must provide a statement of work that concisely describes each task and milestone to be accomplished in the course of the research and development. Define the success criteria associated with each task or milestone. Also include a schedule chart that identifies critical milestones. At least two 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 science, technology development, and instrument development skills on the team. The key personnel list is included in the overall page count and must include, at 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. Quad Chart – Provide a summary chart (quad chart) that contains the following information:

   - Upper Left Quadrant: "Objective"
   - Lower Left Quadrant: "Approach" and "Co-Is/Partners"
   - Upper Right Quadrant: A visual, graphic, or other pertinent information
   - Lower Right Quadrant: "Key Milestones" and "Entry TRL."

   A template and example of the quad chart can be downloaded from http://esto.nasa.gov/files/EntryQuad_instructions_template.ppt. Note: This quad chart is not included in 15-page limit for the Project Description Section.

5. Award Information

5.1 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 that NASA determines are acceptable for award under this program element. No additional funds beyond the negotiated award value will be available. NASA does not allow for payment of profit or fee to commercial firms under grant awards, and few fees are permitted (See http://science.nasa.gov/researchers/sara/faqs#16 for more information).

Proposers are encouraged to offer cost sharing. If a cost sharing arrangement is proposed, appropriate data rights that recognize the proposer's contributions, as well as the Government's rights to access, will be negotiated prior to award.

5.1.1 *Instrument Development and Demonstration Funding*

The total funding available for the Instrument Development and Demonstration subelement of the program element will limit the number and magnitude of the proposals awarded. It is anticipated that a total of 14-18 proposals will be selected and the value of each will be approximately $1.5M per year.

5.1.2 *Instrument/Measurement Concept Demonstration Funding*

The total funding available for the Instrument/Measurement Concept Demonstration subelement of the program element will limit the number and magnitude of the proposals awarded. It is anticipated that a total of 3-5 proposals will be selected and the value of each will be approximately $500K per year.

5.2 Period of Performance

5.2.1 *Instrument Development and Demonstration Period of Performance*

The expected period of performance is 12-36 months. Proposals must define clear, measurable milestones to be achieved for each year of performance in order to warrant continuation in the second and third years.

5.2.2 *Instrument/Measurement Concept Demonstration Period of Performance*

The expected period of performance is 12-18 months. Proposal must define clear, measurable milestones to be achieved for the first 12 months of performance in order to warrant continuation of an additional six months.

5.3 Type of Award

All selected proposals will result in the award of grants, cooperative agreements, or intra- or inter-Government transfers, as appropriate. Grants and cooperative agreements will be subject to the provisions of the *Grants and Cooperative Agreement Manual (GCAM)* and Appendix D of the *NASA Guidebook for Proposers*. In the case of any conflict, the *GCAM* takes precedence. If a commercial organization wants to receive a grant or cooperative agreement, cost sharing is required, unless the commercial organization can demonstrate that it does not expect to receive substantial compensating benefits for performance of the work. If this demonstration is made, cost sharing is not required, but may be offered voluntarily (see references in Section III(d) of the *ROSES Summary of Solicitation*).

6. Evaluation Criteria

The three basic evaluation criteria are given in the *ROSES Summary of Solicitation* Section VI (a) and Section C.2 of the *NASA Guidebook for Proposers* and they are Relevance, Merit, and Cost. Clarifications and additions specific and to this program element are listed below.

The first criterion, relevance, is the applicability of the proposed investigation to Earth Science Focus Area(s) and other Earth Science measurements and technology needs and specifically includes:

- The degree to which the proposed investigation specifically supports the objective of at least one of the Earth Science Focus Areas (see Appendix A.1 for a description of Earth Science Focus Areas);
- The potential for the sensor or instrument technology development to reduce the risk, cost, size, and development time of Earth science instruments or to enable new Earth science measurements. Potential cost reductions should be clearly stated and substantiated to the extent possible with supporting analysis that indicates scalability;
- The potential of the sensor or instrument technology to be integrated, once matured, into future Earth Science NASA missions; and
- The potential for the sensor or instrument technology development to have commercial benefits.

The second evaluation criterion "intrinsic merit" specifically includes:

- Feasibility and merit of the proposed technical approach to achieve the technology development objectives;
- Degree of innovation of the proposed technology development concept and approach;
- Past performance and related experience in the proposed area of technology development;
- Qualifications of key personnel and adequacy of facilities, staff, and equipment to support the proposed activity to ensure that the team has strong technology development and instrument development skills, as well as any leveraging/teaming such as recent SBIR awards/awardees;
- Substantiated justification and appropriateness of the entry and exit TRL; and
- Feasibility of obtaining the potential reduction in risk, cost, size, and development time, or making the newly enabled measurement with the proposed sensor or instrument; and feasibility of making a demonstrable TRL increase. The TRL must advance by at least one (1) level during the performance period of the project.

The third criterion, cost realism and reasonableness, includes:

- Adequacy and realism of proposed milestones and associated success criteria;
- Realism and reasonableness of the proposed cost and comparison of costs to available funds;
- Adherence to sound and consistent management practices appropriate to the TRL of the proposed task; and

- Commitment of the organization’s management to the proposed technology development (evidenced by prior teaming arrangements, etc.). Proposers should identify any previous investment by the organization/program and provide supporting documentation.

Cost sharing is not part of the cost criteria, but cost sharing may become a factor at the time of selection when deciding between proposals of otherwise equal scientific and technical merit.

7. <u>Technical Reporting Requirements</u>

Once awarded, submit all status information, presentation material, and report deliverables applicable to this IIP program element to the web-based ESTO Reporting System (ERS). A user account on the ESTO ERS will be provided to the PI upon award. Due to NASA IT security requirements, all PIs must register with the Identity Management and Account Exchange (IdMAX) system before a user account on ERS will be established. To create an IdMAX account, some personal information will be required.

The following deliverables are 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.

7.1 <u>Initial Plans and Reports</u>

Within 15 days of award, provide an updated Project Plan, initial Quad Chart, and initial TRL assessment. Also, provide 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.

The Quad Chart should contain the following information:

- Upper Left Quadrant: "Objective"
- Lower Left Quadrant: "Approach" and "Co-Is/Partners"
- Upper Right Quadrant: A visual, graphic, or other pertinent information
- Lower Right Quadrant: "Key Milestones" and "Entry TRL."

Proposers are required to update the Quad Chart and TRL assessment at least annually and more often, if appropriate. This can be done on the ESTO ERS under the "Quad Chart" section and "TRL" section respectively.

7.2 <u>Bimonthly Technical Reports</u>

The bimonthly technical report shall focus on the preceding two months’ efforts. Address the following in each report:

1. Technical status: Summarize accomplishments for the preceding two months, including technical accomplishments (trade study results, requirements analysis, design, etc.), technology development results, and results of tests and/or demonstrations.
2. Schedule status: 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.

Upload the Bimonthly Technical Reports to the appropriate location in the ESTO ERS at two-month intervals, starting on the second-month anniversary date of the start date specified in the award vehicle. In months for which the PI is providing interim or annual review, the requirement for a bimonthly report is superseded by the interim or annual review requirements discussed in the next two sections.

Reports may 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 ESTO and the PI to review and discuss each report.

7.3 Interim Reviews

An Interim Review occurs 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 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. Create and maintain a schedule milestone chart of all major task activities and show at all reviews. Also, create and main a cost data sheet that shows 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; and
5. At the second review and subsequent reviews, address the comments and recommendations prepared by the reviewers participating in the most recent review.

The Interim Review will be conducted via teleconference and uploaded to the appropriate location in the ESTO ERS at least three (3) working days prior to the review. Following the review, the presentation, updated in accordance with comments and discussion resulting from the review, shall be uploaded to the appropriate location in the ESTO ERS within ten days after the review.

7.4 Annual Reviews

An Annual Review occurs 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. An independent technical reviewer from an organization separately funded by ESTO participates in the review.
3. The PI may provide a laboratory demonstration, if appropriate, to show technical results and status.
4. 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.
5. The Annual Review should be comprehensive, and should cover the progress over the previous twelve months.

Upload the review package to the appropriate location in the ESTO ERS at least three (3) working days prior to the review. The presentation, updated in accordance with comments and discussion resulting from the review shall be uploaded to the appropriate location in the ESTO ERS within ten days after the review.

7.5 Final Review and Final Report

The Final Review occurs 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. 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.

Include the following in the written Final Report:
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 advance the TRL to next level;
6. Updated Quad Chart; and

7. At the end of the period of performance, the PI shall create a final Accomplishments Chart which contains the following information (a template is available in the e-Book):
   - Upper Left: "Objective"
   - Upper Right: A visual, graphic, or other pertinent information.
   - Middle: "Accomplishments."
   - Bottom: "Co-Is" (name and affiliation), "Entry TRL" and "Exit TRL."

The Final Report and updated Final Review presentation shall be uploaded to the appropriate locations in the ESTO ERS within thirty days of the final review. Also, update the Accomplishment Chart and TRL assessment on the ESTO ERS under the “Quad Chart” section and "TRL" section respectively.

7.6 Earth Science Technology Forum

The awardee is encouraged to participate in the Earth Science Technology Forum (ESTF) if held. The ESTF is an opportunity for NASA planners, managers, technologists and scientists to review the research funded by the ESTO. It is also an opportunity for researchers from NASA, academia and industry to meet with their peers and to better understand NASA Earth science requirements.

8. Summary of Key Information

Expected program budget for first year of new awards	IIP-IDD: Up to $22M IIP-ICD: Up to $4M
Number of new awards pending adequate proposals of merit	IIP-IDD: ~ 14-18 IIP-ICD: ~ 3-5
Maximum duration of awards	IIP-IDD: Minimum 1-year / Maximum 3-year awards IIP-ICD: Minimum 1-year/ Maximum 18- month awards
Due Date for Notice of Intent to Propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for delivery of proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Page length for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*. See Section 4.2 of this appendix.
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. See Section 4.2 of this program element.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	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.*
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	NNH16ZDA001N-IIP
NASA point of contact concerning this program	Parminder Ghuman Science Mission Directorate Earth Science Technology Office Telephone: (301) 286-8001 E-mail: p.ghuman@nasa.gov

A.43 ADVANCED COMPONENT TECHNOLOGY

NOTICE: The Advanced Component Technology Program will not be competed in ROSES-2016. NASA expects to continue to solicit Earth science component technology development through future ACT solicitations. The next opportunity is currently anticipated to be included in ROSES-2017.

1. Objectives

The Advanced Component Technology (ACT) program seeks proposals for technology development activities leading to new component- and subsystem-level airborne and space-based 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 new Earth observation measurements, and
- Reduce the risk, cost, size, volume, mass, and development time of Earth observing instruments and platforms.

2. Program Description

The ACT program brings instrument components to a maturity level that allows their integration into other NASA technology programs, such as the Instrument Incubator Program. Some of these components are directly infused into mission designs by NASA flight projects and others "graduate" to other technology development programs for further development.

3. Point of Contact for Further Information

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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-2016. InVEST was last competed in ROSES-2015. NASA expects to solicit Earth Science technology flight validation projects through future solicitations. The next opportunity is currently anticipated to be included in ROSES-2018.

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 for Further Information

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A.45 SUSTAINABLE LAND IMAGING TECHNOLOGY

NOTICE: The Sustainable Land Imaging Technology Program will not be competed in ROSES-2016. NASA expects to continue to solicit sustainable land imaging technology development through future SLI-T solicitations. The next opportunity is currently anticipated to be included in ROSES-2018.

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. The SLI-T program seeks to:

- Reduce the risk, cost, size, volume, mass, and development time for the next generation SLI instruments, while still meeting or exceeding the current land imaging program capabilities.
- Enable new types of observations that improve the temporal, spatial, and spectral resolution of SLI measurements.
- Enable new SLI measurements and architectures, which can improve the program's operational efficiency and reduce the overall costs of the Nation's land imaging capabilities.

The SLI-T program is envisioned to be flexible enough to accept new instruments, sensors, systems, components, architectures, data systems, and measurement concepts that offer flexibility in implementing and enhancing future SLI measurements.

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 EARTH SCIENCE APPLICATIONS: ECOLOGICAL FORECASTING

NOTICE: Amended on May 13, 2016: The text has been modified to allow proposals for awards of less than four years in duration. Potential proposers should carefully read the new text in Section 3.3.1 regarding cost sharing. The due date for proposals has been delayed to June 30, 2016, to allow proposers to modify their schedule, if appropriate, and the Planning start date has been delayed to October 1, 2016. New text is in bold and deleted text is struck through.

1. Scope of Program

1.1 Overview

The NASA Earth Science Division Applied Sciences Program solicits proposals that develop and demonstrate innovative and practical applications of Earth observations, models, visualizations, and other Earth science products in decision-support activities related to ecological forecasting for conservation and natural resource management.

This solicitation encompasses two elements: Applications Projects and Workshops. The specific topics for each element are described within.

The goal of Applications Projects is to transition the application(s) developed by a funded project to a public or private organization for sustained use in decision-making and provision of services to end-users. The goal of Workshops is to advance understanding of the selected topic and inform the Applied Sciences Program about the potential for future activities in the topic area.

1.2 Applied Sciences Program Objectives

The Applied Sciences Program promotes the discovery and demonstration of innovative and practical uses of Earth observations for decision making. This Program funds applied science research and applications projects to enable near-term uses of Earth observations, formulate new applications, integrate Earth observations and related products within practitioners' decision-making, and transition the applications to sustained use by partner organizations. Projects are carried out in partnership with public and private organizations (e.g., government agencies, private companies, regional associations, international organizations, multinational financial institutions, tribal organizations, and not-for-profit organizations). The goal is for these partner organizations to achieve sustained use of and benefits from the Earth observations. For more information visit the Applied Sciences Program website at http://appliedsciences.nasa.gov.

For the purposes of this solicitation, the Program considers "Earth observations" to include a broad range of products and capabilities: Earth-observing satellite measurements from NASA on-orbit satellites and simulated measurements for planned satellites, as well as measurements from foreign, commercial, and other U.S. Government satellites (the use of other satellite products is welcome though proposals should include specific NASA satellite products in the mix of data products proposed); outputs and predictive capabilities from models associated with NASA products; algorithms; visualizations; and other geospatial products.

The Applied Sciences Program has three primary lines of business: Applications, Capacity Building, and Satellite Mission Planning. The Applications areas include four of the eight societal benefit areas (SBAs) of the international Group on Earth Observations (GEO): Health (including Air Quality), Disasters, Ecological Forecasting, and Water Resources.[1] In addition, there is a crosscutting Wildfires theme and an initiative on Food Security. The Program includes climate-related influences and impacts within each of these themes. The Capacity Building elements focus on foreign and domestic activities to build skills and capabilities in uses of Earth observations, including international and economic development.

The Applications Projects solicited are for applied Ecological Forecasting projects focused specifically on the integration of Earth observations and related products into decision-making activities. Any proposal that aims to conduct only fundamental Earth science research will be considered noncompliant. For fundamental research pursuits, the reader is referred to other Earth Science appendices in the ROSES solicitation.

2. Scope of Ecological Forecasting Applications Area

The Ecological Forecasting Applications area promotes the use of Earth observations and models to analyze and forecast changes that affect ecosystems and to develop effective resource management strategies. Primary user communities are natural resource managers (both land and marine) and those involved in conservation and ecosystem management. The Applications area operates through the development, improvement, and application of predictive tools, with associated uncertainties, for assessing alternative approaches and designing effective decision support strategies for managers. It applies current scientific understanding and modeling capabilities to determine how ecosystems and their components (e.g., species, genes) are changing and likely to change over time. More information is at: http://appliedsciences.nasa.gov/programs/ecological-forecasting-program.

3. Scope of Solicitation

This solicitation encompasses two elements: Applications Projects (3.1) and Workshops (3.2). The specific topics for each element are described in the respective sections. A proposal should only address one of the total of four topics described in 3.1 and 3.2. However, an investigator may submit more than one proposal.

3.1 Topics for Ecological Forecasting Applications Projects

The NASA Ecological Forecasting Applications area seeks proposals for **up to** four-year projects addressing the following three topics using Earth observations as defined in section 1.2 above.

[1] The eight GEO SBAs are: Agriculture, Ecosystems/Biodiversity, Disasters, Energy/Minerals, Health, Infrastructure/Transportation, Urban Development, and Water Resources.

All Applications Project proposals must identify a specific management challenge requiring better ecological forecasting tools or products and also include direct and significant participation by an end-user organization(s) involved in the management and/or decision making activity identified in the proposal. This organization(s) should be the end-user for any tools or products developed and deployed by projects funded through this solicitation. The goal is for the end-user organization to host the ecological forecasting products or outputs developed through the life of the project. Proposals must also include plans to deploy and test the tools or products developed. In addition, Applications Projects welcome 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).

3.1.1 *Remote Sensing as a Catalyst for Large-scale Conservation*

Human activities frequently fragment natural environments. Fragmentation isolates populations of fauna and flora by preventing gene flow within and among populations through barriers to their movement and dispersal. Limiting gene flow often—but not always—has detrimental impacts on organismal populations. In addition, limiting the movement and dispersal of organisms obstructs a key response of organisms and other components of ecosystems to climate variability and change. Enhancing the connectivity of natural areas is one means to address the fragmentation of nature with implications for wildlife management and protected area design in an era of changing climate. Effectively linking natural landscapes and seascapes for enhanced connectivity and large-scale conservation requires a "big-picture" perspective. Satellite imagery can enable organizations to understand the broader contexts for conservation planning and assist in assembling integrated landscapes and seascapes. Applications Projects must apply Earth observations and models to enhance organizations' decision making, management strategies, and landscape/seascape management practices.

Proposals to this topic should identify and describe a conservation challenge dependent upon enhancing connectivity and/or biological movement at spatial scales sufficient for satellite remote sensing to have a positive impact. Proposals must plan for the development—and deployment—of an Earth observations-based solution to this challenge.

3.1.2 *Remote Sensing-based Approaches Simultaneously Promoting Biological Conservation and Energy Self-sufficiency or Food Security*

Often, human needs for energy development and increased food production come at the expense of native biodiversity. This topic seeks proposals that will provide Earth observations-based solutions that mitigate the negative impacts—or even promote positive impacts—from energy exploration and development or from food production on the conservation of biodiversity at the level of ecosystems, species, or genes. NASA seeks proposals for projects that will bring together energy or agribusiness companies with conservation organizations to promote the development and use of Earth observations solutions to ameliorate or reverse negative impacts of energy exploration and development or of food production on natural systems. Proposals must include participation by both an energy or agribusiness corporation and a conservation group to develop and deploy Earth observations tools or products that further the sustainable use of natural resources through enhanced biodiversity conservation. These tools or products can function at the individual activity or project level (e.g., activities at a specific site or a related group of sites), at the level of an entire class of activities (e.g., activities that cut across an entire industry or agricultural system), or at the policy level (e.g., activities providing information necessary to implement a national or international law or policy). Proposals focusing on the individual activity or project level should develop tools or products that are applicable well beyond a specific project site or small group of sites.

3.1.3 *Managing Marine Ecosystems in a Time of Changing Climate through Better Forecasts*

Improving marine ecosystem management in the context of changing climate requires the application of data and research findings as to how the climate is changing and how ecosystems will respond to change. Furthermore, ecosystem change may, in turn, drive additional climate change and so on through time. A goal of this topic is to advance and apply accurate forecasts of changes in marine ecosystems with associated uncertainties. This topic seeks proposals to develop and deploy Earth observations-based tools or products that integrate all of the following elements:

(a) time series of biological observations on the distribution and/or abundance of marine populations, species, or communities;
(b) time series of climate observations; and
(c) an interoperable modeling framework serving predictive climate model outputs as inputs to predictive ecological models, which also accounts for uncertainties.

3.2 Topic for Workshop Proposals

The NASA Ecological Forecasting Applications area seeks workshop proposals for activities of up to 1.5 years duration to help inform the Applied Sciences Program about the potential for future activities. This Workshop topic is specifically on the use of Earth observations to value ecosystem services.

All Workshop proposals developing approaches to use Earth observations to value ecosystem services must include participation by a partner organization with a need, as expressed in the proposal, to value these ecosystem services.

3.2.1 *Using Earth Observations to Value Ecosystem Services*

On October 7, 2015, the U.S. Office of Management and Budget, Council on Environmental Quality, and Office of Science and Technology Policy within the Executive Office of the President directed Federal agencies to incorporate ecosystems services into their planning and decision making. The guidance memorandum broadly defined ecosystem services as benefits that flow from nature to people, e.g.: nature's contributions to the production of food and timber; to life-support processes, such as water purification and coastal protection; and to life-fulfilling benefits, such as places to recreate. Agencies are to develop and institutionalize policies to promote consideration of ecosystem services in planning, investment, and regulatory contexts. Most methods for considering ecosystem services require an ability to place a value upon these services so that they might be measured alongside and compared with other types of services to which the broader economy already ascribes a particular value through market or other mechanisms. In short, the Executive Office of the President is directing NASA and other Federal agencies to factor the value of ecosystem services into Federal planning and decision making.

NASA seeks proposals for a workshop (or possibly a series of workshops) that would characterize the state of practice, identifying key issues and opportunities, and provide approaches for Earth observation-based solutions to the challenge of valuing ecosystem services. For the purposes of this activity, Earth observations are defined in section 1.2 above.

3.3 General Requirements for Proposals

Proposed activities should include the following elements.

- Products from Earth observation, as defined in section 1.2
- Biological observations of ecosystems, species, and/or genetic components of biodiversity
- Models uniting Earth observations and biological observations to provide ecological forecasts of use to the end-user organization with associated uncertainties noted and explained

Ecological forecasting requires the integration of observations and modeling. This integration can improve predictive tools used in decision-making activities for assessing scenarios, analyzing options, and designing effective management strategies, among other things.

Proposals must clearly define the decision making activity(-ies) and the need for the application (tool, product, etc.) to be developed, identify the practitioners, and—for the **up to** four-year Applications Projects—describe in detail plans for the transition of the developed application (tool, product, etc.) to the end-user community within the ~~four-year~~ term of the award.

The solicitation allows projects at any level – multinational, national, regional, tribal, U.S. states, and substate (e.g., county, local). However, proposals at U.S. state and substate levels must include elements to enable and deliver impact beyond that specific, limited location so that project results accrue broadly. Proposal teams wishing to work internationally must involve an established public or private organization with an international mandate (e.g., a U.S. Government organization with a foreign relations mandate and appropriation, nongovernmental organization, international financial institution, or philanthropic foundation). Proposals involving international participants should also follow the guidance in Subsection 1.6.1 of the *NASA Guidebook for Proposers* on "Proposals Involving Non-U.S. Organizations." The Program allows and strongly encourages private sector companies (and teams of companies) to submit proposals and/or be involved in project teams.

Proposers are also invited to explore avenues for supporting activities of the GEO Biodiversity Observation Network or GEO BON (http://geobon.org) and its components, such as the Global Biodiversity Change Indicators, Marine BON, or BON in a Box.

3.3.1 *Partner Organization Involvement in Applications Projects*

Commitment from end-users and practitioners is critical to the eventual success of all Applications Projects. For these ~~four-year~~ projects, this commitment is necessary for the transition and adoption of products for sustained use. Projects need to involve end-users and practitioners at the onset of the project and to the fullest extent possible, particularly to describe the management challenge(s) 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 all funded projects. 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 tiered cost sharing requirement to accomplish this transition.

Proposers are required to include cost share in the budget, in the amounts listed in the chart below. Proposers may propose to meet the cost share at a higher rate than listed in this chart. If the proposal is funded, the awardee must meet the cost share percentage that was proposed in the funded proposal. Proposal budgets that fail to include the required cost share at these minimum percentages will not be peer reviewed.

Failure to meet the required cost share during any budget year of the project:

- will require the awardee to return funds based on the approved cost share rate in proportion with the total (cost share and Federal funds) of that year’s funding,
- will be part of the yearly review to determine if NASA will continue funding for the following year, and
- may result in enforcement actions, including termination, for failure to comply with the terms and conditions of the award.

As part of the annual and final reports, awardees will verify that the cost share requirements have been met.

Project	Activity	NASA Share	Partner Share
Year 1	Prove out application potential	100%	0%
Year 2	Develop application	80%	20%
Year 3	Continue development	60%	40%
Year 4	Complete application and transition	40%	60%

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 the table 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.

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. [Amended May 13, 2016]

Following the ~~four-year~~ Applications Project, the end-user organization(s) is responsible for the operational costs to run its decision support system using the Earth observations.[2] If additional activities are needed to assist in the sustained use of the Earth observations, NASA will support additional efforts with in-kind support, as possible. NASA will continue to provide appropriate Earth observations through the NASA data centers for use by the partner organization(s), as possible.

The final project year should include transition activities and an end-of-project event to announce results.

3.4 Specific Suggestions and Considerations

The Applied Sciences Program strongly encourages Applications Projects to use an array of Earth observations and Earth science resources. The Program encourages project teams to consider and use products from recently-launched NASA missions, as well as simulated products from upcoming, planned missions. Proposals can include data products from non-NASA satellites, including foreign and commercial satellites, if used in conjunction with some NASA observations.

The Program strongly encourages multiorganizational, multidisciplinary, and multisectoral teams. Applications Projects are strongly encouraged to have team members familiar with the topics identified and relevant management or policymaking activities and also the needs of end-users in these areas. The Program encourages early interaction with personnel knowledgeable of NASA Earth science, models, and sensors (e.g., NASA science team and instrument scientists) to understand capabilities and limitations of these NASA tools.

Applications Project teams 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 should engage and involve agency, state, and intergovernmental structures already in place and addressing the topics identified, as well as private sector, civil society, and nongovernmental organization entities, to determine priorities for proposals to address. Proposals should provide statements from the practitioners describing the problem and how the Earth observations can be included in the decision-making activity.

[2] The ongoing costs to incorporate and maintain the application of the Earth observations in the decision-making activities will likely be much less than the costs to develop, test, and transition the application.

4. Alterations and Modifications to the ROSES *Summary of Solicitation*

The following information provides, for this call, alterations and modifications to some of the rules in the *Summary of Solicitation* of this NRA. The information below supersedes direction provided in the respective sections of the *Summary of Solicitation*.

Projects involving private sector organizations and/or proprietary products and services are strongly encouraged to read NASA guidelines on cooperative agreements.

4.1 Award Type and Cost Sharing or Matching

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.

Cost-sharing and partner resource commitments for Applications Projects are required in years two through four of the project. While the solicitation accepts in-kind contributions during the course of the project as cost sharing, financial contributions are preferred. 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 for proposals to this solicitation.

4.2 Proposal Format and Contents: Changes to Subsection 2.3 of the *NASA Guidebook for Proposers*

All proposals should provide sufficient detail to allow reviewers to assess viability and potential for success. Proposals should adhere to the following page guidelines and order. Content descriptions, if specified below, modify Section 2.3 of the *NASA Guidebook for Proposers*.

Proposal Cover Page.. As found on NSPIRES site
.... (includes budget summary)
Proposal Summary...4000 characters (on cover page)
Table of Contents.. 1 page
Decision-Making Activity .... 1 page
Earth Observations.. 1 page
Science-Technical (including figures/tables) .... 11 pages
- Figures and Tables (as appropriate; integrated into text if possible)
Anticipated Results/Improvements.. 1 page
Project Management [only for Applications Projects]........................ 1 page
Letters from End-User Organizations........................up to 4 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
Each Co-Investigator .... 1 page

4.2.1 *Proposal Summary*

As a summary, this section should briefly describe the concept for the proposed activity. This section should state why the activity should be done and how it relates to the topics identified in Sections 3.1 or 3.2 of this opportunity.

4.2.2 *Decision-Making Activity*

This section explicitly identifies and describes the decision-making activity/action to be addressed, created, and/or enhanced by the proposed activity. The description should describe the management, business, policy topic, or other issue that it serves, including any quantitative information regarding its use. This section must identify and describe the partner/end-user organization(s) and their responsibility and/or mandate to address the topic/issue. This section must provide statement(s) from the practitioner(s) describing the management challenge and the need and opportunity to improve decision making. As such, this section must state the metrics used by the partner/end-user organization to assess their decision making and state the baseline performance standard by which project improvements will be compared.

4.2.3 *Earth Observations*

This section identifies and describes the Earth observations, derived products and/or models (see Section 1.2) that the proposal seeks to apply to improve decision making. This section should include any non-NASA data sets that are expected to play an important role in the application.

4.2.4 *Science and Technical*

As the main body of the proposal, this section should cover the following material:

- How the proposed activity responds and relates to the topics identified in Sections 3.1 or 3.2;
- Application of the Earth observations to the decision-making activity, including rationale;
- Methodology to be employed in the application, including discussion of the innovative aspects;
- Approach to assess the feasibility of the application, including scientific and technical aspects, should state and describe the measures (both quantitative and qualitative) the team will use to assess and judge the feasibility of the application;
- For ~~four-year~~ Applications Projects only, estimate of the Applications Readiness Level (ARL, per Section 5) of the application, including any expected improvements from beginning to end of the project;
- Challenges and risks affecting project success (technical, policy, operations, management, etc.) and the approaches to address the challenges and risks; and
- Relevant tables/figures that demonstrate key points of the proposal.

4.2.5 *Anticipated Results/Improvements*

This section describes the expected results and improvements to the decision-making activity from the application.

4.2.6 *Project Management*

Only for proposed ~~four-year~~ Applications Projects, this section should articulate the management approach and structure; plan of work; partnership arrangements; and the expected contribution, roles, and responsibilities of the team members. Project schedule and milestones must be included. Note: Meetings (number of, frequency of, etc.) do not qualify as project management milestones.

4.2.7 *Letters of Support from End-User Organizations (optional)*

This section may include up to four, one-page letters from the end-user organizations that will benefit from the proposed activity. The letters may include input from the community and beneficiaries served by the end-user organizations. All letters must be addressed to the PI and included in the proposal.

4.3 Evaluation Criteria:

In addition to objectives given in Section 3, the evaluation criterion relevance specifically includes:

- Intent, scope, and plan to demonstrate the applicability of Earth observations to address a topic of importance;
- Intent and ability to determine the utility of Earth observations for potentially substantive improvements to a conservation or other relevant natural resource management challenge(s) and decision-making activities;
- Cross-cutting nature of the project; and,
- Potential impact of the project (given its level of risk).

In addition to or as a clarification of the factors given in Section VI(a) of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*, the evaluation criterion "intrinsic merit" specifically includes:

- Likelihood for potential, demonstrable impact to the state of practice and community capabilities;
- Quality and adequacy of the approach and methodology and ability to apply Earth observations and related products;
- Ability to characterize the decision-making activities and needs for improvement; and,
- Quality of teaming across appropriate sectors and areas of expertise and the involvement of the end-user organization(s) in the project.

In addition to or as a clarification of the factors given in Section VI(a) of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*, the evaluation criterion "cost" specifically includes:

- Overall approach to manage the project and to achieve stated objectives;
- Appropriate level of effort to meet the objectives cost-effectively; and
- For Applications Projects only, the extent to which the proposed project includes funds or in-kind contributions from non-Federal sources and Federal agencies, consistent with Sections 3.3.1 and 4.1 of this opportunity and Section III(d) of the *Summary of Solicitation.*

4.4 Award Reporting Requirements: Consistent with Subsection VII(c) of *the Summary of Solicitation*

Each awarded activity will be responsible for timely maintenance (via an on-line system) of project information, status updates, highlights, and milestone achievements. NASA will coordinate with each PI at award to provide the necessary information for the on-line system.

The following reports will be required of awarded ~~four-year~~ Applications Project 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. The proposed budget should provide for these reporting requirements.

Applications Projects will have a Project Plan due within three months of award and the first annual report due no later than twelve months after the project start date with annual reports for ~~four-year~~ **Applications** Projects due thereafter on the project anniversary date. At the project mid-term, the annual report will take the form of an initial assessment report.

Annual Report: Annual reports, other than the initial assessment report, involve three items. One item is a brief (one page), written summary of the progress in the project to date; it should identify key milestones (met or upcoming) and highlight changes. The second item is a one-page project "quad-chart" (format provided at award) with Purpose and Objectives, Approach, a Figure, and Key Milestones and ARL; quad charts are updated as needed.
The third item is the verification of cost share requirements.

Assessment Reports: NASA program management will provide guidelines for the initial assessment report and the final assessment report (aka the final report).

NASA, the NASA Earth Science Division, and the NASA Applied Sciences Program may periodically request information to support outreach efforts, website content, etc.

A Final Assessment Report is required prior to the conclusion of the project. The Final Assessment Report should describe how the grant activities met the solicitation requirements and demonstrated an impact on decision-making activities using Earth observations. This report should also include lessons learned and recommendations. The Program may request a presentation of the awardee’s report, results, and findings.

5. Application Readiness Levels

The Applied Sciences Program developed a nine-step Applications 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 to 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 applications development. In general, ARLs 1-3 encompass application discovery and feasibility; ARLs 4-6 address application development, test, and validation; and, ARLs 7-9 focus on application demonstration in partners' systems and transition.

The following are the nine levels of the ARL:

1. Basic Research - Basic principles and 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 so application can be tested in a simulated decision making environment.
6. Demonstration in Relevant Environment - Major increase in the application's demonstrated readiness. Prototype system demonstration in a relevant environment or simulated operational decision making environment
7. Application Prototype in Partners' Decision Making - Prototype near or at planned operational system. A major advance from ARL 6, requiring prototype system demonstration of an actual system prototype in an operational environment, such as partners' decision-making activity.
8. Application Completed and Qualified - Actual system completed and 'qualified' through test and demonstration for partners' decision-making activity. Application has been proven to work in its final form and under expected conditions.
9. Approved, Operational Deployment and Use in Decision Making - Actual operational, successful use of application by users in decision making activities.

6. Summary of Key Information

Total Amount of NASA Funding	$9,600,000 Applications Projects: Year 1: $2.7M, Year 2: $2.5M, Year 3: $2.3M, Year 4: $1.8M. Workshops: Year 1: $300,000 (one-time funding)
Anticipated Number of Awards	9 to 20 Applications Projects 1 to 2 Workshops (Year 1 funding only)
Period of Performance	Projects: **up to** 4 Years **[Changed May 13, 2016]** Workshops: 1.5 Years

Contributions from Partner Organizations	Applications Projects: Transition plan and annual resource commitments from partner organizations are expected
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *Summary of Solicitation* of this NRA.
Due date for proposals	**June 30, 2016.** See Tables 2 and 3 in the *Summary of Solicitation* of this NRA. **[Changed May 13, 2016]**
Planning date for start of investigation	~~August~~ **October** 1, 2016 **[Changed May 13, 2016]**
Page limit for the central Science-Technical section of proposal	11 pp.; see Subsection 4.2 of this Program Element and 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 element are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	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 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	NNH16ZDA001N-ECO4CAST
NASA point of contact concerning this program	Woody Turner Applied Sciences Program Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1662 E-mail: Woody.Turner@nasa.gov

A.47 CITIZEN SCIENCE FOR EARTH SYSTEMS PROGRAM

NOTICE: May 20, 2016. An FAQ has been posted on the NSPIRES web page for this program element, under "Other documents."

May 3, 2016. The typo conversation biology has been corrected to conservation biology. New text is in bold, deleted text is struck through.

1. Scope of the Program

1.1 Overview

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.

For the purpose of this solicitation, citizen science is defined as efforts or projects which use voluntary public participation in the scientific endeavor, including – but not limited to – formulating research questions, conducting experiments, collecting and analyzing data collected by citizen and/or professional scientists, interpreting results, making new discoveries, and/or developing technologies and applications. Crowdsourcing, another frequently used term describing voluntary contributions, is included under citizen science in this solicitation. (See the Federal Crowdsourcing and Citizen Science Toolkit for further explanations and guidance: https://crowdsourcing-toolkit.sites.usa.gov/).

Through this solicitation, two types of proposals are sought – citizen science research and low cost sensor deployment for the collection of well calibrated citizen science data. All proposals must demonstrate linkages between citizen science and NASA satellite observations.

This solicitation supports NASA's contributions to Action 8 of the *National Plan for Civil Earth Observations*, "Engage in Stakeholder-Driven Data Innovation," which specifically calls for agencies to support crowdsourcing and citizen science projects that contribute machine-readable and open data. NASA anticipates making awards in the form of cooperative agreements in two phases: prototype and implementation. Approximately $1M is available for the prototype phase of about eight months. Pending the outcome of an independent review of the projects funded for prototyping, two to five projects may be funded to continue with full implementation; approximately $2M per year is available for the implementation phase of three years.

1.2 Scientific Focus

The Citizen Science for Earth Systems Program is using this solicitation to promote the use of citizen science and crowdsourcing platforms or techniques applied to atmospheric composition, water and energy cycle, surface water topography, biodiversity and **conservation** ~~conversation~~ biology, and physical oceanography. With respect to atmospheric composition, human activities have contributed to changes of greenhouse gases, aerosols, air quality, and the type and amount of clouds that vary with weather. Intertwined with the atmospheric condition is the water and energy cycle that can be observed via, for example, surface energy budget, precipitation, evaporation and evapotranspiration, height of inland water bodies and the costal ocean. Changes in these physical processes or variables have a direct implication for water resources and coastal management.

Regardless of the scientific focus, the type of proposals, or sources of data, proposals may aim to address real-world problems at the local, regional, continental, or global scales, to complement NASA satellite observations by increased temporal or spatial sampling, to contribute to the validation of NASA data products derived from satellite observations, to deploy innovative sensors about our environment, a combination of the above, or other innovative ways to enhance the utility of NASA's observation systems from space, air, land, and water. See further details at https://earthdata.nasa.gov/, https://nex.nasa.gov/nex/, Section 4.2 of the *NASA Science Plan* at http://science.nasa.gov/about-us/science-strategy/, and NASA's Earth observing satellites at http://eospso.nasa.gov/content/all-missions.

2. Types of Proposals

This solicitation aims to use citizen science and crowdsourcing platforms or techniques for advancing our scientific knowledge of the Earth system and complementing the research currently conducted using NASA's Earth-observing satellites. This solicitation requests proposals to address this aim through one or both of the following types:

1. Projects using citizen science for research on biodiversity and **conservation** ~~conversation~~ biology, atmospheric composition, water, and energy cycle and surface water topography and physical oceanography.
2. Citizen science data collection using calibrated low-cost off-the-shelf components that can be widely deployed.

2.1 Proposals for Citizen Science Research

NASA will support development of new research projects or enhancement of existing projects that use citizen science to advance scientific understanding of the Earth system related to biodiversity and **conservation** ~~conversation~~ biology, atmospheric composition, water and energy cycle, and physical oceanography. Possible topics include, but are not limited to:

- Drought monitoring and mitigation
- Biodiversity and **conservation** ~~conversation~~ biology
- Greenhouse gas monitoring
- Snow monitoring and runoff forecasting

- Atmospheric aerosol monitoring
- Surface water and sea level monitoring and forecasting
- Climatic and ecological impacts on groundwater

These projects could include crowd-sourced observations using instrumentation with established specifications, analysis of citizen science data or joint analysis by incorporating NASA satellite-based data products, or development of user interface applications and websites to increase the efficiency and accuracy of crowd sourced data.

Proposals must address all aspects of recruitment and retention of citizen scientists, as well as commit to open sharing of the data collected through NASA data and information systems throughout the project. Data from projects selected for full implementation will be archived at a NASA designated data center, following a successful peer review of data quality.

2.2 Proposals for Citizen Science Sensors

Proposals for the deployment of sensors to be used for citizen science Earth observations will be considered. This solicitation is particularly intended for projects utilizing existing technology (e.g., off-the-shelf or simple 3D-printed parts). Such sensors should be low in cost and simple and safe to use in order to make wide distribution to volunteer data collectors viable. Sensors should have a well-documented calibration process (described in the proposal) to ensure accurate measurements.

In addition to plans for designing and building the sensor, proposals of this type should include:

- Description of the intended research by the volunteer when using the sensor(s)
- Plans for low-cost production of the sensor(s) or other method of deployment (e.g., instructions for do-it-yourself construction)
- Proposed practices for data collected to be properly managed and archived
- Plans for recruitment and retention of potential users of the sensor(s)
- Plans and/or existing processes for validation and calibration of sensor(s) and quality assurance of data

3. Proposal Preparation and Submission

The general information provided in Section IV of the ROSES-2016 Summary of Solicitation about proposal preparation and submission applies to this solicitation. A "Program-specific Questionnaire" will accompany the cover page where the proposer must specify the type of proposal being submitted, the scientific focus, and the relevant current or future NASA Earth-observing satellite(s).

Proposals should address both the prototype and implementation phase of the project. All proposals must include a data management plan, including a strategy for monitoring data quality and consistency throughout the lifetime of the project. Proposals must commit to the use of open source formats and metadata standards to increase interoperability with other Earth observation data. (See NASA recommended standards at https://earthdata.nasa.gov/user-resources/standards-and-references).

Data, results, and other information created for this proposal 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. Data and results will be archived at a NASA designated data center.

All software along with source code will be released as open source software to https://github.com/nasa and is subject to the NASA Earth Science Alternate Data Rights language to be included into Cooperative Agreements for Projects selected (http://science.nasa.gov/earth-science/earth-science-data/data-information-policy/data-rights-related-issues/).

Proposers are encouraged to consult the White House Office of Science and Technology Policy which announced the release of the Federal Crowdsourcing and Citizen Science Toolkit (https://crowdsourcing-toolkit.sites.usa.gov/) published in September 2015. This toolkit provides guidance on developing and running citizen science research projects.

Proposers should describe how the project would become self-sustained after the initial award.

4. Proposal Evaluation Criteria

The general information provided in Section VI of ROSES-2016 Summary of Solicitation about the proposal review and selection process applies to this solicitation, as refined by the proposal evaluation criteria described below.

Relevance is defined as:

- Demonstrated degree of understanding of how the proposed citizen science will specifically contribute to NASA objectives in Earth Science, as well as how NASA satellite observations and other resources can enhance the proposed citizen science.
- Degree of alignment of the offer's goals and objectives with NASA's mission to drive advances in science and technology to enhance knowledge, learning, innovation, economic vitality, and stewardship of Earth.
- Degree of alignment with the Federal Crowdsourcing and Citizen Science Toolkit.

Intrinsic merit is defined as:

- Overall scientific and technical merit of the proposal, including incorporation of innovative methods, approaches, concepts, or technologies demonstrated by the proposal
- Overall quantitative and qualitative merit of the proposed engagement and participation by citizen scientists, including methods of internal or external evaluation
- The approach for generating, calibrating and validating data
- The approach for communicating results and plans for addressing the recruitment and retention of citizen scientists
- The practicality, appropriateness, and likelihood of success of the project plan for the prototyping and implementation phases of the project
- The qualifications, capabilities, and experience of the proposing team

Management and Cost is defined as:

- The soundness of the management approach and work plan, milestones, and schedule for the prototype and implementation phases
- Plan for self sustainment of project after conclusion of award
- The realism and reasonableness of the proposed cost

5. Summary of Key Information

Expected total program budget for new awards	~ $1M for prototype phase; ~$2M per year for implementation phase
Number of new awards pending adequate proposals of merit	~7-10 for prototype phase; 2-5 for implementation phase
Maximum duration of awards	~8 months for prototype phase with the potential for an additional 3 years for projects selected for implementation (See Section 1.1)
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *Summary of Solicitation* of this NRA.
Due date for Proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*
Planning date for start of investigation	3 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	See Section 1.1 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 *Summary of Solicitation* of this NRA.
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 hardcopy is required. 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 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	NNH16ZDA001N-CSESP

Point of contact concerning this program	Kevin Murphy Program Executive for Earth Science Data Systems Earth Science Division Science Mission Directorate, NASA Headquarters Washington, DC 20546 Telephone: (202) 358-3042 E-mail: kevin.j.murphy@nasa.gov

A.48 SPACE GEODESY RESEARCH

1. Scope of Program

The Space Geodesy Program (SGP) has the long-range goal of building, deploying, and operating a next generation NASA Space Geodesy Network (NSGN) of integrated, multi-technique space geodetic observing stations. This infrastructure enables the establishment and maintenance of a precise terrestrial reference frame that is foundational to many Earth observing missions and location-based observations. 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 seeks the implementation of NSGN core sites that are comprised of the four major space geodetic observing systems: Very Long Baseline Interferometry (VLBI), Satellite Laser Ranging (SLR), Global Navigation Satellite System (GNSS), and Doppler Orbitography and Radio-positioning by Integrated Satellite (DORIS). A prototype core site with all four geodetic techniques at NASA's Geophysical and Astronomical Observatory completed demonstration of next-generation systems in 2013. This site now serves as a model for upgrading and expanding the NSGN as part of NASA's contribution to the Global Geodetic Observing System (GGOS). The new network is expected to improve the International Terrestrial Reference Frame (ITRF), as well as all other network products (e.g., precision orbit determination), with associated benefits to the supported and tracked missions, science projects, and engineering applications.

2. Description of Solicited Research

Priorities for new research in support of SGP derive from the goals and objectives for space geodesy presented in several strategic documents:

- The Solid Earth Science Working Group (SESWG) report, *Living on a Restless Planet* (2002) (http://solidearth.jpl.nasa.gov/seswg.html)
- Review of the SESWG report by the National Research Council (NRC), *Review of NASA's Solid-Earth Science Strategy* (2004) (http://books.nap.edu/catalog/11084.html)
- The NRC Decadal Survey, *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond* (2007) (http://www.nap.edu/catalog/11820)
- NASA's report *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) (http://science.nasa.gov/media/medialibrary/2010/07/01/Climate_Architecture_Final.pdf)
- The NRC report *Precise Geodetic Infrastructure: National Requirements for a Shared Resource* (2010) (http://www.nap.edu/catalog.php?record_id=12954)
- 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 *Precise Geodetic Infrastructure* report highlighted stability and accuracy of the ITRF as critical to understanding key Earth science processes associated with land-, ice-, and sea-surface change. In particular, quantifying long-term sea level change sets goals for an ITRF accurate to 1 millimeter and stable to 0.1 millimeters per year, roughly an order of magnitude better than currently realized.

Guided by these goals, the following types of research investigations are solicited by this element:

1. Space Geodesy Network Architecture: Proposals that develop improved simulations to inform future space geodesy network architecture.
2. Geodetic System Ties: Proposals that explore, develop, and/or simulate innovative methods for tying geodetic systems together to improve precision of the ITRF.

Roughly four awards are expected to result from this solicitation, selected from one or both topics, depending on proposal quality and relevance. Proposers should not anticipate renewal opportunities beyond the performance period of this solicitation. Pending sufficient availability of funds, NASA may compete this element in the future with updated foci that best address scientific and programmatic priorities at that time.

2.1 Space Geodesy Network Architecture

A core objective of SGP is to increase and optimize the global geodetic network coverage towards improving the accuracy and stability of the ITRF. The *Precise Geodetic Infrastructure* report recommended that the United States collaborate with international partners in increasing the density of the international geodetic network. Results of simulations presented in that report suggested that ITRF accuracy goals could be largely achieved if the number of international sites with co-located SLR and VLBI stations was increased from seven to at least 24. These initial simulations focused on SLR and VLBI at GGOS sites of opportunity, leaving a space for advanced simulations that consider additional combinations of instrumentation and geographic distribution. This subsection calls for proposals that develop improved simulations to inform future space geodesy network architecture. Proposals that consider project outputs that assess technical performance as a function of cost and schedule are especially encouraged.

2.2 Geodetic System Ties

A major limitation in obtaining a precise multitechnique reference frame to meet NASA geodetic needs is the ability to precisely tie different space geodetic measurement techniques together through methods such as ground systems, collocation in space, and/or simultaneous data analysis. The *Precise Geodetic Infrastructure* report identified the need for scientific and/or technological innovation to improve approaches for determining system ties. This subsection solicits proposals to explore, develop, and/or simulate innovative methods for tying the systems together to improve precision of the ITRF. Proposals should explore approaches that transcend existing approaches based on classical geodetic methods and GNSS and demonstrate the potential to achieve a precision of 1 millimeter or better in local ties.

3. Additional Proposal Requirements

3.1 NASA Space Geodesy Network Systems Focus

Proposals must seek to advance the capabilities of NASA's next generation geodetic sites with a focus on two or more of the key NSGN systems of SLR, VLBI, GNSS, and DORIS.

3.2 Modeling, Simulation, and Analysis Focus

Proposals must focus on modeling, simulation, or advanced analysis of geodetic data or related data products. Proposals to develop hardware or other infrastructure or conduct routine analysis will be considered nonresponsive under this element. Computational resources may be available to support appropriate research through NASA's High-End Computing (HEC) program. Interested proposers should consult the ROSES-2016 Summary of Solicitation, Section I (d), for a summary of HEC offerings and guidance on requesting computing time.

3.3 Collaboration with the Space Geodesy Project

Selected investigators will be expected to interact with the Space Geodesy Project through communication of results and consideration of Project objectives and requirements as appropriate. Proposers should budget for two trips per year to the Washington, DC area to facilitate these interactions.

4. Summary of Key Information

Expected annual program budget for new awards	~$750k
Number of new awards pending adequate proposals of merit	~4
Maximum duration of awards	2 years
Due date for Notice of Intent to propose (NOI)	June 15, 2016
Due date for proposals	August 15, 2016
Planning date for start of investigation	January 1, 2017
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 strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 of ROSES and the reference therein. 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	NNH16ZDA001N-SGR
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 E-mail: ben.phillips@nasa.gov

A.49 ICEBRIDGE SCIENCE TEAM

1. Program Overview

1.1 Background

IceBridge (http://www.nasa.gov/mission_pages/icebridge/index.html) is a NASA airborne mission to bridge the gap between NASA's ICESat (2003-2009) and ICESat-2 satellite missions that use laser altimetry to characterize the Earth's polar ice sheets. IceBridge has improved our knowledge of the contribution of the world's major land-based ice sheets and glaciers in Greenland, Antarctica, and Alaska to sea level rise, while making fundamental contributions to understanding changes occurring in the extent and thickness of the polar sea ice.

The IceBridge mission began in 2009 and will continue for at least one year past the launch of ICESat-2, currently planned for launch in late-2017. In addition to laser altimetery, IceBridge employs radar and other methods to monitor and characterize the polar ice. All data collected by IceBridge are available at https://nsidc.org/data/icebridge.

1.2 Scope of Program

This program element supports participation in the IceBridge Science Team (IST) during the third and final phase of IceBridge data collection during Fiscal Year (FY) 2017—2019 to provide advice to the IceBridge project office on flight planning. For this final phase of IceBridge, the mission focuses on ensuring that its observations are set to build a bridge of altimetry measurements from the ICESat to ICESat-2 satellites to develop a multidecadal time series.

The IceBridge mission will consist of two major airborne data collection campaigns per year; with one in the Antarctic—including the Antarctic ice sheet and Southern Ocean sea ice—and another in the Arctic—including the Greenland ice sheet, Arctic sea ice, and Alaskan mountain glaciers—in their respective spring seasons. One smaller campaign may also occur over the Arctic sea ice and parts of Greenland in the northern hemisphere fall.

The sensor suite (http://www.nasa.gov/mission_pages/icebridge/instruments/) includes: lidars to map ice elevation and sea ice freeboard; ice-penetrating radars to map the underlying bed; snow and surface radars to map snow and firn depth; and gravimeters and magnetometers to characterize regional geology and map the continental shelf and water depth variations that underlie ice shelves.

The specific measurement and science goals for IceBridge are summarized as follows:

- Make airborne altimetry measurements over the ice sheets and sea ice to extend the record of observations begun by ICESat.
- Link the measurements made by ICESat and ICESat-2, and where possible CryoSat-2 (http://www.esa.int/Our_Activities/Observing_the_Earth/The_Living_Planet_Programme/Earth_Explorers/CryoSat-2), to allow accurate comparison and production of a long-term, ice altimetry record.

- Use airborne altimetry to monitor key, rapidly changing areas of ice in the Arctic and Antarctic to maintain a long term observation record, improve understanding of glacial dynamics, and improve predictive models of sea level rise and sea ice cover.
- In conjunction with altimetry measurements, collect other remotely sensed data to improve predictive models of sea level rise and changes in sea ice cover, especially the following:
    - Snow thickness, especially over Arctic sea ice;
    - Ice thickness and structure;
    - Bed topography underlying land-based ice;
    - Bathymetry beneath floating ice shelves;
    - Snow accumulation and firn structure; and
    - Other geophysical constraints that will improve estimates of the geothermal and oceanic heat flux.

2. Proposal Information

The proposals solicited here are to support participation in the IceBridge Science Team, which provides expert scientific guidance to the IceBridge project that aids in mission planning. To fulfill that role, proposals must include the following sections: 1) the PI's role as a team member; 2) a small research program based on IceBridge altimetry measurements that supports mission planning and bridging ICESat and ICESat-2; and 3) an optional team leader section. Details on each section are discussed below.

Proposals are encouraged from researchers at any stage in their career, as well as modelers actively using IceBridge data. Proposals from international scientists with related research interests will be considered at no cost to the program.

2.1 IceBridge Science Team Structure, Responsibilities, and Meeting Plans

Proposals must discuss how the proposer's expertise and work plans would facilitate contributing to the team in consideration of the team's structure, responsibilities, and meeting plans.

The IceBridge Science Team (IST) will consist of approximately six scientists. All team members will have expertise in utilization of altimetry measurements over polar ice. Desirable, but not required, expertise includes radar sounding of ice, snow, and the ice-sheet bed; development and utility of datasets to support modeling studies; sea ice in the Arctic and Southern ocean; and the land ice of Greenland and Antarctica.

The IST will have two Co-leads representing the two principal scientific disciplines of the Greenland and Antarctic Ice Sheets and the sea ice of the Arctic and Southern Ocean. The remaining members will include representatives from these principal disciplines.

The IST will work closely with the IceBridge Project Office to provide expert scientific guidance in the areas of flight line planning, measurement strategies, and data quality and product development.

In addition, the members of the IST will be responsible for:

- Ensuring that observations from space by ICESat and ICESat 2, and where possible CryoSat-2, can be successfully interlinked into a time series by IceBridge's aircraft measurements;
- Developing a strategy to integrate IceBridge measurements with ICESat 2 calibration and validation plans;
- Making revisions to the IceBridge Science Definition Documents, as required;
- Evaluating the IceBridge mission designs in achieving the goals defined by the Science Definition Documents as requested by the NASA Program Scientist;
- Supporting the IceBridge Program Scientist and Project Scientist in the development of the required analyses, documentation, and reporting during the IceBridge mission;
- Considering science-of-opportunity or science-during-transit opportunities for their synergies with or impacts on the mission; and
- Helping produce a final report on the IceBridge mission when it is completed in 2019.

The IST will conduct its business through regular meetings with additional teleconference calls and E-mail, as required. The proposed budget should include funds to participate in two IST meetings per year lasting three days each, with one at the NASA Goddard Space Flight Center and one at the NASA Jet Propulsion Laboratory.

2.2 IceBridge Altimetry Research

This solicitation will support small research programs focused on altimetry to achieve the following two goals: 1) to ensure that the final IceBridge campaigns are optimally devised to bridge the altimetry measurements of the ICESat and ICESat-2 satellites to develop a multidecadal time series; and 2) to foster research that will improve the initial scientific returns from ICESat-2.

The nature of the research program is not prescribed, but must be substantially based on altimetry and focus either on answering key NASA cryospheric science questions or specifically assessing factors affecting the interpretation of altimetry measurements.

The proposals must also discuss how the proposed research would specifically support IceBridge mission planning.

2.3 IST Lead Proposal Content

Proposers interested in being a Co-lead should indicate their candidacy by answering the relevant cover sheet question and including a Team Leader section within their proposal.

The Team Leader section can use up to two additional pages and should include the following: the focus area (Sea ice or Greenland and Antarctic Ice Sheets), the qualifications that make the proposer a prime candidate for IST co-leadership, the vision for participating in IceBridge mission planning and other team roles. Team Leader activities should not be included in the proposal budget. Team leaders will receive an additional $30,000 per year to support their leader activities, and the successful proposer will revise their budget during final award negotiations.

3. Programmatic Information

Results from investigations supported under this solicitation are expected to advance the goals articulated in one or more of the Science Mission Directorate's Science Focus Area roadmaps (see http://nasascience.nasa.gov/about-us/science-strategy/), as well as a number of Presidential Mandates and associated Federal research objectives, especially the U.S. Global Change Research Program (see http://www.globalchange.gov/) and its strategic plan, which address aspects on understanding the role of glaciers, ice sheets, and sea ice within the Earth system; and the Interagency Arctic Policy Committee (http://www.nsf.gov/od/opp/arctic/iarpc/start.jsp) and its research plan.

4. Evaluation Criteria

The three basic evaluation criteria are given in the *ROSES Summary of Solicitation* Section VI (a) and Section C.2 of the *NASA Guidebook for Proposers* and they are Relevance, Merit, and Cost. Clarifications specific and to this program element are:

The second evaluation criterion "intrinsic merit" specifically includes:

- how the proposer's expertise and work plans would contribute to the team, see Section 2.1 and
- how the proposed research would specifically support IceBridge mission planning, see Section 2.2.

5. Summary of Key Information

Expected program budget for first year of new awards	~ $1M in total for the first year
Number of new awards pending adequate proposals of merit	6
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	Six months after the proposal due date
Page limit for the central Science-Technical-Management section of proposal	10 pp, up to 2 additional pages for Team Leader proposals; 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	See the *NASA Guidebook for Proposers* at

submission of proposals	http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See 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	NNH16ZDA001N-ICEBST
NASA point of contact concerning this program	Thomas Wagner Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-4682 E-mail: thomas.wagner@nasa.gov

A.50 GROUP ON EARTH OBSERVATIONS WORK PROGRAMME

NOTICE: November 29, 2016. This amendment adds a new opportunity, in program element A.50, which had not previously been in ROSES-2016. Notices of Intent to propose are requested by January 13, 2017, and proposals are due February 28, 2017.

Overview

The NASA Earth Science Division (ESD) solicits proposals to advance specific elements of the Group on Earth Observations (GEO) Work Programme 2017-2019. NASA is especially interested in involving non-Federal domestic organizations in contributing to and achieving progress on the GEO Work Programme. The ESD Applied Sciences Program manages this call for proposals and the awards.

Work through this call for proposals includes projects, studies, workshops, trainings, and other activities, and it involves innovative communications work. For each particular GEO Work Programme element (see Section 3), there are other organizations around the world also involved with the element, and awardees will be expected to communicate and coordinate effectively with them.

Section 1 provides background information. Section 2 describes the purpose, objectives, and scope. Section 3 articulates the eligible GEO Work Programme elements. Section 4 describes available funding. Section 5 describes proposal content, review criteria, and reporting requirements. Section 6 provides a summary table of information.

1. Background Information

1.1 NASA Earth Science and Applied Sciences Program

Using the global vantage point of space, the Earth Science Division builds fundamental knowledge of how Earth works and how it is changing. ESD advances understanding of the planet as an integrated system and develops and tests applications that deliver direct societal benefit. ESD is organized around four programmatic areas: flight, research, applied sciences, and technology. Together these areas include programs and projects that are responsible for: conducting and sponsoring research to advance scientific understanding of Earth as a system, collecting and disseminating new observations, developing new technologies and computational models, and developing applications of Earth science observations.

The ESD Applied Sciences Program (hereinafter, the Program) promotes efforts to discover and demonstrate innovative, practical, and beneficial uses of Earth observations. The Program supports applied science research and applications projects to enable uses of Earth observations that inform organizations' decisions and resulting actions that identify and promote societal benefits from Earth observations[1] and that build 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 the Earth observations. The Applied Sciences Program has three primary lines of business: Applications, Capacity Building, and Satellite Mission Planning. For more information, visit the Applied Sciences Program website at http://AppliedSciences.NASA.gov/.

1.2 Group on Earth Observations

The Group on Earth Observations (GEO) is an intergovernmental organization working to improve the availability, access, and use of Earth observations to inform decisions and benefit society. GEO organizes efforts to coordinate observations from thousands of ground, airborne, in situ, and space-based instruments, and GEO is a strong proponent for full and open data.

GEO is comprised of Member Countries (i.e., national governments) and Participating Organizations (PO), which are international and regional organizations with a mandate in Earth observation or related activities. GEO has over 100 Members and over 100 POs. The GEO Secretariat is located in Geneva, Switzerland, and provides oversight, coordination, and administrative functions. NASA is a significant contributor to GEO both through the United States as a GEO Member Country and through involvement in POs, especially the Committee on Earth Observation Satellites (CEOS).

GEO engages with user communities and acts as a broker, connecting users, data providers, engineers, scientists and other relevant experts to create innovative solutions to global challenges that transcend both national and disciplinary boundaries. This role involves engagement with and understanding of communities in both developed and developing countries. The ultimate goal is to help create the innovative products, tools, and services required to produce the actionable information necessary to address critical global and regional challenges and opportunities.

GEO works across eight Societal Benefit Areas (SBA), including: Biodiversity and Ecosystem Sustainability; Disaster Resilience; Energy and Mineral Resources Management; Food Security and Sustainable Agriculture; Infrastructure and Transport Management; Public Health Surveillance; Sustainable Urban Development; and Water Resources Management. Notably, weather and climate are viewed as cross-cutting phenomena touching each and all of the SBAs.

More information about GEO is available at: http://earthobservations.org.

1.3 GEO Work Programme

GEO maintains a Work Programme, which articulates the activities that the GEO community commits to perform. Activities range from substantial global efforts with large stakeholder communities to single-focus activities in small groups. The GEO Work Programme includes 67 elements across four implementation categories: Community Activities, Initiatives, Flagships,

[1] Earth observations broadly includes a range of products and capabilities, including Earth-observing satellite measurements (NASA, other U.S. agencies, foreign, and commercial), outputs and predictive capabilities from Earth science models, algorithms, visualizations, knowledge about the Earth system, and other geospatial products.

and Foundational Tasks. Community Activities develop concepts and allow bottom-up efforts. Initiatives demonstrate and mature services and they have broad coordination and contributions. Flagships are based on a policy-relevant mandate, and they develop and implement near-operational services and are fully resourced. Foundational Tasks provide important support functions and enabling purposes. GEO Members and POs primarily manage the Community Activities, Initiatives, and Flagships; the GEO Secretariat primarily manages the Foundational Tasks. For the purposes of this call for proposals, NASA is using the GEO 2017-2019 Work Programme as the current version; it is available via the GEO website and under “Other Documents” on the NSPIRES webpage for this ROSES appendix.

1.4 United States Group on Earth Observations

The U.S. Group on Earth Observations (USGEO) is a Subcommittee of the Committee on Environment, Natural Resources, and Sustainability of the National Science and Technology Council. USGEO is comprised of thirteen Federal departments and agencies.[2] USGEO serves to coordinate, plan, and assess Federal Earth observation activities in cooperation with domestic stakeholders; foster improved Earth system data management and interoperability throughout the Federal Government; and engage international stakeholders by formulating the U.S. position for, and coordinating U.S. participation in GEO.

2. Purpose, Objectives, and Scope

2.1 Purpose and Objectives

NASA solicits proposals to support and advance specific elements of the GEO Work Programme 2017-2019. ESD, especially the Applied Sciences Program, has supported ad hoc projects and internal NASA activities related to past GEO Work Programmes. These past projects and activities have demonstrated a strong ability to support and advance GEO, to further U.S. and NASA interests, and to demonstrate U.S. and NASA commitments to GEO. The ESD Applied Sciences Program created this call for proposals to foster broader domestic involvement in a U.S. national approach to GEO and the Work Programme.

Key objectives include:

- Achieve demonstrable progress, results, and accomplishments in specific elements of the GEO Work Programme;
- Advance use of Earth observations to inform decisions and actions;
- Advance and broaden domestic involvement in the U.S. national support to GEO and the GEO Work Programme;
- Increase the uptake of Earth observations to inform decisions and actions and broaden the organizations routinely using them;
- Increase international collaboration and partnering across GEO and broaden the GEO community;

[2] Departments and agencies represented on USGEO include: Agriculture, Commerce, Defense, Energy, Homeland Security, Interior, State, Transportation, Environmental Protection Agency, NASA, National Science Foundation, Smithsonian Institution, and U.S. Agency for International Development.

- Advance communication of the benefits of Earth science and observations.

As a result of the awards from this call, NASA seeks to increase GEO's achievements, to enable greater uses of Earth observations, and to better articulate the import of, and return on investment from, Earth observations. Successful endeavors can expand the depth and breadth of understanding of the value of Earth observations with the private sector, civil society, academia, public sector, and the public at large.

Note: This call is for proposals addressing specific elements of the GEO Work Programme. Proposals that aim to conduct fundamental Earth science research or applications outside of the GEO Work Programme will be considered noncompliant. For such pursuits, the reader is referred to other ROSES-2016 Earth Science appendices or upcoming ROSES.

2.2 <u>Scope</u>

The GEO Work Programme includes a summary description of each element, such as the purpose, objectives, activities, and future plans. The scope includes work to advance the elements, and the specific type of work (e.g., projects, studies, workshops) depends on the element and NASA interests; Section 3 articulates the GEO Work Programme elements eligible for this call for proposals.

Numerous organizations globally may be involved in a GEO Work Programme element.[3] Awardees are expected to coordinate effectively and proactively with other organizations working on the element; proposal teams should describe how they will conduct their proposed work in coordination with them[4]. The work may be international in nature, so some foreign travel is likely required; proposal teams are expected to budget for travel accordingly. The scope allows for engagement and work with intermediary organizations (aka, boundary organizations), if appropriate to the particular element. In addition, the GEO community makes updates to the Work Programme annually, and the scope includes efforts to update and refine the element.

The scope includes the identification of possible data products (or refinements) that would advance the use of Earth observations by communities associated with the GEO Work Programme element and other communities. The scope includes applications development and applied research, if appropriate to the element; basic research is outside the scope of this call.[5] Proposers can include web services, application program interfaces, and other means to encourage broader discovery, access, and use of Earth observations.

NASA Earth Science is interested in showcasing the value and benefits of Earth observations across the range of Earth satellite missions and observation types. While the Program recognizes

[3] In developing a proposal for a specific GEO Work Programme element, NASA encourages proposal teams to consult with organizations (domestic or foreign) that are already involved with the element.

[4] Proposers are encouraged to coordinate as much as possible; however, not all of the proposed work for an element will necessarily require coordination and partnership. Proposers should articulate the work that will and will not be conducted in coordination with other organizations working on the element.

[5] During an award, awardees may identify basic research questions that arise, and awardees can either convey them to ESD and/or pursue the questions through other ROSES calls.

that some missions and observations are used more than others in applications, the Program encourages that proposed work show breadth in the satellite missions and observations covered. Teams can consider impacts from data products from non-NASA satellites, including non-U.S. and commercial satellites, if used in conjunction with some NASA observations, models, or capabilities.

The call for proposals includes efforts to examine experimental approaches, both technical and programmatic, to enable the objectives of the GEO Work Programme element. Experimentation with programmatic approaches (e.g, crowd sourcing, challenges) is strongly encouraged and expected. Proposal teams should offer some approaches in their proposal as examples.[6]

The scope includes significant external communications and outreach. NASA encourages teams to consider innovative and creative methods, graphic design, and other approaches as part of their efforts to convey and showcase progress, accomplishments, and benefits. NASA suggests that proposal teams consider both physical and virtual means of communications, including a social media presence if appropriate.

3. GEO Work Programme Elements

Applicants may propose to any of the elements listed below; there should be a primary focus on one element. Proposal teams interested in more than one element should submit a separate proposal for each element.[7] Element descriptions are paraphrased below, and the GEO Work Programme has a full description of each. Some elements have an implementation plan, which, if existent, are available via the GEO website.

All proposals are encouraged to incorporate aspects of relevant United Nations Sustainable Development Goals (aka, *Agenda 2030*), and teams should expect to engage national statistical offices, line ministries, or other appropriate entities in the respective countries where the proposed work is focused.

The elements below are listed in alphabetical order. All of the elements are of equal interest and importance; the amount of text for each does not imply any relative interest, importance, or priority.

3.1 AmeriGEOSS

This GEO Initiative promotes collaboration and coordination among GEO members of the Americas.[8] It focuses on four GEO SBAs: Food security and sustainable agriculture, Disaster resilience, Water resources management, and Biodiversity and ecosystem sustainability. It also

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[6] Awardees will not be limited to pursue only the example approaches offered in the proposal; they are primarily illustrative for purposes of the panel review.

[7] A proposal with a primary focus on one element may have alignments with other elements in Section 3; this alignment doesn't necessitate a separate proposal. Separate proposals are needed for when the primary focus is on different elements.

[8] Americas Caucus includes: Argentina, Bahamas, Belize, Brazil, Canada, Chile, Colombia, Costa Rica, Ecuador, Honduras, Mexico, Panama, Paraguay, Peru, U.S., and Uruguay; and observers Guatemala and Bolivia.

addresses foundational tasks, such as capacity building and data infrastructure. Through this initiative, GEO and others are joining to apply space-based and in-situ Earth observations for societal benefit for all in the region. The AmeriGEOSS implementation plan and other materials for reference are available via the GEO website.[9]

NASA requests proposals on one or more of four AmeriGEOSS items:

Needs Assessments. NASA requests proposals to work with in-region stakeholders to characterize current approaches to decisions and actions of the four focus SBAs; what and how Earth observations are used; characterization of Earth observation infrastructure; adequacy of existing products and services and the need for new or refined data, products, and services; and, related analyses. Such proposals should include efforts, such as gap analyses and comparative studies, to identify opportunities for AmeriGEOSS and for GEO flagships, initiatives, and community activities to address in the Americas.

AmeriGEOSS Webinar and On-site Trainings. NASA requests proposals for integrated webinar and on-site training series that build capacity to use Earth observations data, products, and tools to address decisions in the four focus SBAs. Such proposals should target nongovernmental organization (NGO), indigenous, government, or private sector decision-making communities at the national or multinational scale; team with targeted stakeholders, academia, and others in the proposed location; provide training and materials in English, Spanish, and/or Portuguese; train trainers, as appropriate; leverage best practices of the NASA Applied Remote Sensing Training program (ARSET);[10] and, use existing AmeriGEOSS communications tools (e.g., AmeriGEOSS Community Platform) to build awareness of the training.[11] Proposals for on-site trainings should articulate approaches to leverage in-region resources, such as facilities and participant travel.

AmeriGEOSS Demonstration and Pilot Projects. NASA requests proposals for specific pilot and demonstration projects in one or more of the four focus SBAs and aligned with other GEO Work Programme elements, particularly the ones listed here in Section 3. Such proposals should be in collaboration with stakeholders in the Americas; include co-design of projects; address user needs in using Earth observations in decisions, actions, and policies; include gap analysis to assess the adequacy of existing products and services and decision-making approaches and the need for the proposed new project; and, perform testing and validation for sustained uses.

AmeriGEOSS Integrated Watershed Projects. NASA requests proposals for integrated watershed management projects, including management plans for that watershed over the next 10 to 30 years to enable resilience, accounting for a changing climate and other factors. Such proposals should be developed in collaboration with stakeholders in the watershed, account for factors of the four focus SBAs, and identify and address decision trades and options that best enable resilience development of the watershed.

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[9] https://www.earthobservations.org/amerigeoss.php
[10] https://arset.gsfc.nasa.gov/all/webinars/best-practices-2016
[11] Proposals may include activities that align with NASA's ARSET training program; however, the ARSET project and staff should not be part of a proposal submission.

The point of contact for AmeriGEOSS inquiries is Nancy Searby, nancy.d.searby@nasa.gov, 202-358-0395.

3.2 Earth Observations for Ecosystem Accounting, EO4EA

This GEO Initiative seeks to enhance the use of Earth observations (EO) for the development of ecosystem accounts and contribute to the measurement and monitoring of natural capital and ecosystem services. It seeks to provide governments with tools to aid development planning and assessment and to inform management and policy options for any activity that will impact a country's natural capital or substantial natural capital flows and the ecosystem services arising from this natural capital and from the flows.

NASA requests proposals to address one or more of the initiative's four work streams: Overview of current ecosystem accounting efforts; EO contributions to monitoring and assessing ecosystem extent and condition for ecosystem accounting; EO contributions to the identification, measurement and monitoring of ecosystem services; Pilots to test improved data and methods of using EO for ecosystem accounting. Proposed work can include projects, studies, workshops, and other activities suitable for the respective stream(s).

Proposal teams interested in serving as the EO4EA Initiative Lead should articulate this interest, including its qualifications and its proposed approach to manage the initiative;[12] interested teams should propose a budget supplement for this role.

The point of contact for EO4EA inquiries is Woody Turner, woody.turner@nasa.gov, 202-358-1662.

3.3 Earth Observations for Health[13]

This Community Activity focuses on development and uses of Earth observations that improve the strategic and tactical capacities to anticipate, respond to, and reduce environment-related health risks, such as infectious diseases and vector-borne diseases. The element addresses combinations of Earth observations with social, demographic, and health information to enhance analysis, preparedness, and resilience. NASA recently resumed a leadership role in the GEO Health and Environment Community of Practice.

NASA requests proposals that connect Earth observations with vector-borne and infectious disease issues, challenges, and decision-making through active partnerships with public health managers and organizations, such as NGOs, that support them. Proposals should address topics related to vector-borne disease (e.g., malaria, zika, dengue fever, chik-v) and water-related disease (e.g., cholera). Proposed efforts may address: Applications projects; Feasibility studies, including testing and validation of proofs-of-concept of possible applications; Development of data-fusion products with strong applications and applied research potential; Demonstrations that complete the transition, adoption, and sustained use of Earth observations; training; Activities to

[12] Interested proposal teams are allowed one additional page (dedicated to EO4EA lead only), plus pages for budget and budget justification.

[13] This element will appear in an updated version of the GEO Work Programme 2017-2019 released on or about December 12, 2016.

demonstrate and enable uses of Earth observations to support the *Agenda 2030* Sustainable Development Goals*;* and, Studies on value of Earth observations for decision making, preparedness, response, or resilience. NASA particularly encourages proposals focused on AfriGEOSS and AmeriGEOSS member countries as well as on mosquito-borne disease in Central America, South America, and the Caribbean.

The point of contact for health inquiries is John Haynes, jhaynes@nasa.gov, 202-358-4665.

3.4 GEO Biodiversity Observation Network, GEO BON

This GEO Flagship is developing a global biodiversity observation network (BON) that contributes to effective management policies for the world's biodiversity and tracking changes in ecosystem services. It improves the acquisition, coordination, and delivery of observations of biodiversity and ecosystem services change to users, including decision makers and the scientific community in support of policy. As a network of networks, GEO BON facilitates the development and enhancement of national, regional, and thematic biodiversity observation networks. This Flagship has created the framework of Essential Biodiversity Variables (EBV) and developed BON in a Box, which is a capacity building and technology transfer mechanism that provides online tools allowing countries and regions to develop or enhance their biodiversity observation systems.

NASA requests proposals on one or more of three GEO BON items:

Applications of Essential Biodiversity Variables. NASA requests proposals to apply, test, demonstrate, and enable sustained uses of EO-enabled Essential Biodiversity Variables (EBV) to support countries' obligations under the Convention on Biological Diversity or Ramsar convention; activities under the Sustainable Development Goals; or, assessments under the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystems Services (IPBES). To accomplish this, proposal teams can use candidate EBVs or propose and develop new EBVs.[14] Proposal teams should identify prospective countries, and include them in the proposal development and in the projects.

BON in a Box. NASA requests proposals to develop and enable sustained uses of BON in a Box tools to support countries' obligations under the Convention on Biological Diversity or Ramsar convention; activities under the Sustainable Development Goals; or, assessments under IPBES. NASA particularly encourages proposals focused on AfriGEOSS, AOGEOSS, and AmeriGEOSS member countries.[15]

Biodiversity Observation Networks. NASA requests proposals to enhance the development of existing BONs[16] and/or support tools for the initiation, development, and implementation of new national, regional, or thematic BONs. These enhancements and tools should address the needs of users at a national or multinational level.

[14] Proposal teams should review the current list of EBVs and consult with the GEO BON Management Committee to discuss needs for EBVs; see http://geobon.org/ for information on EBVs and committee.
[15] Proposal teams should talk with the GEO BON personnel regarding current and potential BON in the Box tools.
[16] The GEO Work Programme 2017-2019 identifies existing BONs.

The point of contact for GEO BON inquiries is Woody Turner, woody.turner@nasa.gov, 202-358-1662.

3.5 GEO Global Water Sustainability, GEOGLOWS

This GEO Initiative addresses effective water management, planning, and support for policy development. It facilitates understanding and uses of Earth observation assets to enhance water sustainability and mitigate water shortages, excesses, and degraded quality. It covers the responsibility areas of member nations, as well as global overviews needed to make the connections between data and global or regional policy. There is a strong emphasis on projects, analyses, capacity building, and user engagement; collaboration with in-country ministries and organizations is expected to co-design appropriate and desired activities.

NASA requests proposals on one or more of four GEOGLOWS items below; efforts may include projects, studies, workshops, or other activities suitable for the respective GEOGLOWS item.

User Assessment. NASA requests proposals for user characterization analyses and user needs assessments for data, products, and services. Such proposals should include efforts, such as gap analyses, to evaluate global or regional data center holdings and to clarify the adequacy of existing products and services, as well as the need for new or refined data, products, and services.

Basin and Regional Risk. NASA requests proposals that apply Earth observations to minimize risk and improve response to water resource extremes (e.g., water quality degradation, drought, flooding) at basin and regional scales. Transboundary issues are allowed. Such proposals must include a plan for integration into an existing water resource management decision-making process, involving water management/policy personnel who will facilitate the transition to sustained operational use. Particular interest is in the scalability of solutions.

Essential Water Variables. NASA requests proposals that analyze essential water variables and develop indicators to support improved water management decisions, advance knowledge for water sustainability, and/or address specific, documented societal needs. Proposals should specify the stakeholder(s), decision-making process(es), or policy(s) that the indicators will impact. Innovative solutions are encouraged, and proposals must provide open and sustainable indicator processing solutions.

Capacity Development and Basin/Regional Engagement. NASA requests proposals for specific training and community engagement/outreach activities for water resource management organizations which leverage Earth observations, including NASA Earth science. These proposals should specify the communities of need, the water resource information needs, the training needs, and other community engagement plans.

There are connections between GEOGLOWS and the GEO Community Activity Earth Observations for the Water-Energy-Food Nexus; proposal teams may propose work aligned with and supporting both.

The point of contact for GEOGLOWS inquiries is Brad Doorn, bradley.doorn@nasa.gov, 202-255-7957.

3.6 GEO Vision for Energy, GEOVENER

This GEO Initiative supports the development of Earth observation products and services for energy management, including information to support end-to-end energy production systems (including planning, generation, transmission, distribution, and integrated operations). It has a particular focus on Earth observations for renewable energy systems and renewable energy policy.

NASA requests proposals for applying Earth observations to address renewable energy decision support needs, such as increased productivity and optimized investment decisions; all renewable energy types are appropriate. Efforts may include projects, feasibility studies, demonstrations, workshops, or other suitable activities. Some topical examples might include increasing confidence in solar forecast accuracy; improved grid integration of renewables; and prediction of significant ramping events from sudden wind or solar insolation changes. Also, ESD held an energy management workshop in April 2016, and proposals are encouraged to address items in the workshop report that align with GEOVENER.[17] Proposals addressing decision support on renewable energy must demonstrate significant interaction with and uptake of the products derived from this work with decision support tool developers, intermediary organizations, and/or downstream users (e.g., power plant developers, financers, insurers, utilities, grid operators) of these data.

The point of contact for GEOVENER inquiries is Richard Eckman, richard.s.eckman@nasa.gov, 757-272-5565.

3.7 Global Flood Risk Monitoring

This GEO Community Activity seeks to improve flood/inundation mapping and to support objective characterization (e.g., location, intensity and duration) of extreme flood events globally. It aims to use globally-consistent information from past events to its maximum utility in defining areas of flood risk, as well as during new floods to assist with their characterization. It pursues opportunities for early prediction and characterization of flood inundation in near real time, and it supports developing nations' efforts to directly identify hazardous land areas. It also addresses flood risk and stationarity of flood frequency distributions in light of a changing climate.

NASA requests proposals that: Advance flood/inundation extent mapping and damage mapping; Develop, test, and apply methods to use Earth observations with models and maps to estimate the location, intensity and duration of floods globally; Advance tools for situational awareness for effective response and tools to help assess risk and promote preparedness; Support intercomparison of global/regional flood and inundation models; or Test and validate the utility of products through scenario exercises and case studies. An emphasis is on the utility of satellite and other Earth observations to develop flood maps and decision tools in standard geospatial

[17] Workshop report is available at: http://wiki.esipfed.org/index.php/Energy_and_Climate.

information and web services. Particular interest is in the scalability of information and data products. The assistance and input of users from the response, relief, and recovery communities of practice is expected.

The point of contact for Global Flood Risk Monitoring inquiries is David Green, david.s.green@nasa.gov, 202-358-0032.

3.8 Global Wildfire Information System, GWIS

This GEO Initiative provides a platform for coordination and harmonized information among major national and regional fire information providers. GWIS relies on collaborative sharing of international EO data systems, as well as national and regional information sources (fire records, etc.). For countries and regions that do not maintain a comprehensive wildfire database, GWIS provides a gap-filler system; where wildfire information systems exist, GWIS provides a complementary source of data to national and regional sources. The GWIS web map tool serves information on wildfires indices (e.g., fire danger forecast, burned areas), and the GWIS web map service supports visualization of information. The initiative has four main items: Harmonized Fire Information Data Sets; International Networking; Workshop Training; and Cross-Platform Info Sharing at Common Scales.

NASA requests proposals on one or more of two items:

Data Compilation and Analysis. NASA requests proposals for GWIS enhancements and tools for on-demand statistics, tabular information, and graphical information at various spatial scales (subnational to continental) and temporal domains. Information on indices and fire variables would be derived from EO and other sources.

Workshops and Trainings. NASA requests proposals for webinars, workshops, and in-person trainings to increase awareness, familiarity, and use of GWIS, as well as to characterize users and identify needs. Such proposals should target NGO, indigenous, government, or commercial organizations. Proposals for onsite trainings and workshops should articulate approaches to leverage in-region resources, such as for training facilities and participant travel. NASA particularly encourages proposals focused on AfriGEOSS, AOGEOSS, and AmeriGEOSS member countries.

The point of contact for GWIS inquiries is Vincent Ambrosia, vincent.g.ambrosia@nasa.gov, 650-604-6565.

3.9 Human Planet

This GEO Initiative seeks to develop a new generation of measurements and information products that provide new scientific evidence and a comprehensive understanding of the human presence on the planet and that can support global policy processes. Human Planet plans to: Improve the state-of-the art of EO-derived global open data describing the physical infrastructures of human settlements; Improve the state-of-the art of global open and public data describing population in human settlements; Improve the integration of global open spatial data on population and physical infrastructures; and Test and demonstrate the use of new integrated global spatial data to support *Agenda 2030*.

NASA requests proposals on one or more of two items:

Accuracy Assessments. NASA requests proposals that advance accuracy assessments and global/regional validation of data related to this initiative. Proposals should address thematic, spatial, and/or temporal aspects and components; decametric and metric spatial resolution global and regional thematic products can be considered. Proposals can include crowd-sourcing approaches, and such proposals should articulate plans to effectively guide and manage crowd-sourced efforts to support validation.

Agenda 2030. NASA requests proposals to apply, test, demonstrate, and enable sustained uses Earth-observation derived data and integrated data on population and human settlements to support one or more of the Sustainable Development Goals (SDGs) and the associated Targets and Indicators. Proposals should 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. The primary objectives should be to enable sustained use of the data in measuring and reporting on the SDGs, tracking progress, supporting planning efforts, and informing policy and management decisions that contribute toward achieving the SDGs.

In either item, proposals can include efforts for across-sensor systematic information comparison activities, including issues such as bias and complementarity.

The point of contact for Human Planet inquiries is Lawrence Friedl, lfriedl@nasa.gov, 202-358-7200.

4. Award Information

Maximum Period of Performance	36 months
Expected Project Start Date	~Six months after the proposal due date
Total Amount of NASA Funding (FY17-20)	$8M
Anticipated Number of Awards	20-25
Expected Level of Awards	$30K-200K per year
Contributions from Other Organizations	See Sections 5.3 and 5.5. Note: Contributed funding is in addition to NASA funding; it does not count toward funding level guidelines.

ESD plans to post frequently asked questions (FAQ) under "Other Documents" on the NSPIRES web page for this call for proposals. Proposal teams are encouraged to check regularly the NSPIRES page associated with this call for the FAQs and any updates.

5. Amendments and Clarifications to the *Summary of Solicitation*

As permitted in the ROSES *Summary of Solicitation* in Section I(h), the following information provides clarifications or amendments that supersede direction provided in the respective sections of the *Summary of Solicitation*.

Potential participants in projects involving private sector organizations and/or proprietary products and services are strongly encouraged to read the definition of cooperative agreement in Section D.1.2 of the *Guidebook for Proposers* and NASA guidelines on cooperative agreements in the *Grant and Cooperative Agreement Manual*.

5.1 Eligibility Information: Changes to Section III(a) of the *Summary of Solicitation*

Multisectoral and transdisciplinary teams are strongly encouraged. A person or organization can be involved in and included on more than one proposal.

Representatives from USGEO member agencies are eligible to propose and/or be part of a proposal; see also Section 5.2.

5.2 Funding and Award Policies: Changes to Section II of the *Summary of Solicitation*

Representatives from USGEO member agencies (non-NASA) must be sponsored by their respective agency or otherwise provide their own financial resources. For this particular call for proposals, NASA will not provide funding to representatives from other (non-NASA) USGEO member agencies.

NASA may augment an award based on demonstration of results and characterization of additional opportunities.

Proposers are reminded of Section II(d) Rephasing of Award Budgets: NASA assesses the record of financial billing and uncosted carryover and may adjust the timing of funding renewals based on the history of costing.

5.3 Cost Sharing: Changes to Section III(d) of the *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 (see Section 5.6). The Program 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 the Program does not consider these as cost sharing or in-kind contributions for proposals to this solicitation. Ventures involving commercial organizations are encouraged to read Section D, §1274.204, "Costs and Payments" of the NASA grant and cooperative agreement manual.

5.4 Proposal Format and Contents: Changes to Section IV(b)(ii) of *the Summary of Solicitation*

Proposals should provide sufficient detail to allow reviewers to assess the viability and potential success. Section 2.3 of the *NASA Guidebook for Proposers* provides information on the proposal content. The following two items modify *NASA Guidebook* Section 2.3: The page limit for the Scientific/Technical/Management (STM) section of a proposal is 12 pages;[18] the STM section must include a discrete subsection on Anticipated Results.[19]

5.4.1 *Schedule*

Proposals should include and describe a schedule for the proposed work, including milestones. The page limit for this section is two pages.

5.4.2 *Letters of Reference*

As a modification to Section 2.3.9 of the *NASA Guidebook for Proposers,* proposals may, in addition to guidelines in that section, include up to four, one-page letters of reference from organizations about the proposal team or about the letter writer's interest in the results. The letters may include input from organizations or individuals involved in the GEO Work Programme element. All statements or letters must be delivered to the Principal Investigator (PI) and included in the proposal. Letters sent to NASA ESD or Applied Sciences (or delivered after the deadline) will not be considered in the review process.

5.5 Evaluation Criteria: Factors for Section VI(a) of the *Summary of Solicitation* and Section C.2 of the *NASA Guidebook for Proposers*

In addition to the factors given in the *NASA Guidebook for Proposers*, the evaluation criterion "cost realism and reasonableness" specifically includes the following factors:

- Overall approach and ability to manage the project cost effectively to achieve stated objectives;
- Sponsorship of a representative of USGEO member agencies (non NASA);
- Appropriate level of effort to meet the offered objectives cost-effectively.

Cost-sharing and external resource contributions to a consortium are not part of the evaluation criteria and are not included in the peer review scores. However, at the time of project selection, NASA may consider these contributions as one of the factors when deciding between proposals of otherwise equal merit.

NASA may use one or separate peer review panels for the GEO Work Programme elements listed in Section 3. NASA will assign proposals to a panel based on the element specified by the proposing team and NASA's assessment of the proposal content. While NASA is soliciting proposals for each of the elements, NASA reserves the right to select proposals in none, one, or several elements depending on the nature and distribution of proposals received and the outcome

[18] For proposals to the EO4EA element (Section 3.2), teams proposing to be the EO4EA Initiative Lead get one additional page.

[19] Anticipated Results must describe the expected progress over the current state of the GEO Work Programme element, as well as the expected accomplishments, outcomes, and benefits from the proposed work.

of the peer review process. NASA will notify all proposers of the outcome of the evaluation process.

5.6 Award Reporting Requirements: Changes to Section VII(c) of *the Summary of Solicitation*

If a team 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.

The awardees will be responsible for timely maintenance (via an online system) of information, status updates, highlights, and milestone achievements. NASA will coordinate with the PI at the time of the award to provide the necessary information for the online system to transmit the reports and presentation packages. The NASA Shared Services Center (NSSC) will also solicit and archive the annual progress reports and final report.

The following items are required of the awardees:

- Project and Costing Plan

Within 30 days of the award, awardees will produce a project plan to articulate activities, milestones, and other information on execution of the project. Included in this is a monthly financial costing plan (see Section 5.2) for the entire period of performance. The project plan and costing plan will be updated as needed throughout the period of performance.

- Periodic Reporting

Awardees will produce brief reports for NASA ESD on a quarterly basis. These brief reports should provide a summary of the work, activities, events, etc. from the past quarter; key highlights and achievements; progress or adjustments to milestones; major activities, events, and milestones in the next two quarters; and issues, problems, risks, and plans of action to address them.

Both USGEO and GEO periodically (two to four times per year) request information on the status, activities, progress, etc. of each GEO Work Programme element. Teams must respond timely and substantively to requests from the USGEO representative for such information. Teams must respond to and support the Lead for their GEO Work Programme element to provide timely and substantive input to GEO.[20]

- Annual Summary/Progress Report

The awardees will produce an annual summary of its activities, using information from the quarterly summaries and additional materials to highlight achievements for the year and changes in plans. The Applied Sciences Program will post a version on its website and will incorporate information into its own Annual Report. (Note: This item satisfies the requirement for Annual Progress Reports in Appendix D of the Guidebook for proposers). NASA may request a presentation (physical or virtual) of the annual summary.

[20] The information from the quarterly summary reports to NASA will likely serve a significant portion of the USGEO and GEO reporting.

- Communications, Outreach and Inreach

The scope includes communications activities, and these activities may require and involve the development of specialized materials, examples, briefings, articles, and other items. Proposal teams should budget for these accordingly.

Periodically, the Earth Science Division, Applied Sciences Program, USGEO, and/or GEO may request information about projects, achievements, and key events to support their respective communications and outreach activities. The awardees are expected to support such requests and should budget for these accordingly.

- Publications

The awardees are expected to publish their work with scholarly, grey, and popular literature, including online. On a semiannual basis (January-June and July-December), awardees will produce an annotated bibliography of all their publications directly associated with the award from the prior period.

- GEO Plenary and Work Programme Symposium

GEO conducts annual events, such as the Plenary and Work Programme Symposium, at which people gather and take stock of GEO's progress. These events often have side events and other activities to showcase results of particular items. Proposal teams should budget accordingly to attend one GEO-level event each year. (While the location will likely rotate, teams can use Geneva, Switzerland, as the location for budgetary purposes.)

- Final Report

The Final Report summarizes the overall activities of the award, including achievements, progress, impacts, smart practices, experimental practices, findings and conclusions, remaining issues to address, and other information to provide an appropriate documentation of the award. The report should also explain any variations in the anticipated results and a discussion of major problems (technical or other). The report should describe the state of the GEO Work Programme element at the end of the venture, and it should include lessons learned and recommendations. (Note: This final report, with the additions mentioned, is the same item referred to in Appendix D of the *Guidebook for Proposers*). The Program may request a presentation of the report, findings, recommendations, and achievements.

6. <u>Summary of Key Information</u>

Expected program budget	See Section 4
Number of new awards pending adequate proposals of merit	20-25
Maximum duration of awards	36 months
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*
Planning date for start of investigation	~Six months after the proposal due date
Page limit for the central Science-Technical-Management section of proposal	12 pp; see Section 5.4 of this document (EO4EA Initiative Lead proposals get one additional page, see Section 3.2)

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 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	NNH16ZDA001N-GEO
Main NASA point of contact concerning this activity Points of contact for inquiries about elements in Section 3	Lawrence Friedl Applied Sciences Program Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-7200 E-mail: kathryn.a.carroll@nasa.gov Submit all e-mail inquiries with "ROSES GEO WP Inquiry" in the subject line. AmeriGEOSS inquiries: Nancy Searby, nancy.d.searby@nasa.gov, 202-358-0395. EO4EA inquiries: Woody Turner, woody.turner@nasa.gov, 202-358-1662. Earth Observations for Health inquiries: John Haynes, jhaynes@nasa.gov, 202-358-4665. GEO BON inquiries: Woody Turner, woody.turner@nasa.gov, 202-358-1662. GEOGLOWS inquiries: Brad Doorn, bradley.doorn@nasa.gov, 202-255-7957.

	GEOVENER inquiries: Richard Eckman, richard.s.eckman@nasa.gov, 757-272-5565. Global Flood Risk Monitoring inquiries: David Green, david.s.green@nasa.gov, 202-358-0032. GWIS inquiries: Vincent Ambrosia, vincent.g.ambrosia@nasa.gov, 650.604.6565. Human Planet inquiries: Lawrence Friedl, lfriedl@nasa.gov, 202-358-7200.

APPENDIX B.   HELIOPHYSICS RESEARCH PROGRAM

NOTICE: May 31, 2016. The name of program element B.10 has been changed from "Principal" Investigator to "Participating" Investigator. New text is in bold, deleted text is struck through.

February 25, 2016. A clarification has been made in Section 2 to the description of the Heliophysics Guest Investigators open Program Element (B.4). The text of the program element is B.4 was correct, the change is only here in B.1. New text is in bold.

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. The Heliophysics Research Program is focused on achieving the goals as defined in the *NASA 2014 Science Plan* (available at http://nasascience.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). Heliophysics research addresses these recommendations by implementing a program to achieve three overarching science goals:

- Explore the physical processes in the space environment from the Sun to the Earth and throughout the solar system
- Advance our understanding of the connections that link the Sun, the Earth, planetary space environments, and the outer reaches of our solar system
- Develop the knowledge and capability to detect and predict extreme conditions in space to protect life and society and to safeguard human and robotic explorers beyond Earth

The program supports investigations in all subdisciplines of Heliophysics and also supports investigations that span the subdisciplines and address a systems approach — emphasizing the understanding of fundamental processes and interconnections across the traditional science disciplines. The program seeks to characterize these phenomena on a broad range of spatial and temporal scales, to understand the fundamental processes that drive them, to understand 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 atmosphere and the evolution and cyclic activity of the Sun. It supports investigations of the origin and behavior of the solar wind, 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 plasmas and particles with fields and waves, and coupling to the solar wind and ionospheres. It supports the physics of the terrestrial mesosphere, thermosphere, 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)
- B.6 Heliophysics Living With a Star Science (H-LWS)
- B.7 Heliophysics Data Environment Enhancements (H-DEE)
- B.8 Heliophysics Guest Investigators – Magnetospheric Multiscale **(**MMS) Opportunity (H-GI/MMS)
- B.9 Heliophysics Grand Challenges Research – Science Centers (H-GCR/SC)
- B.10 Heliophysics U.S. ~~Principal~~ **Participating** Investigator (H-USPI) **[Changed May 31, 2016]**

It is the overall objective of each of the program elements to contribute as effectively and directly as possible to the achievement of NASA Heliophysics strategic goals. Priority for selection is given to those proposals that most clearly demonstrate the potential for such contributions.

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, Sections 2.2 and 2.3 of B.7 H-DEE.

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 ROSES16 Heliophysics elements B.2 (H-SR), B.4 (H-GI Open), B.5 (H-GCR/TMS), B.6 (H-LWS), B.8 (H-GI/MMS), and B.9 (H-GCR/SC).

Proposal submission to all elements in Heliophysics will continue using a two-step process, in which the Notice of Intent is replaced by a required Step-1 proposal. 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 Encourage/Discourage evaluation of Step-1 proposals will not be in effect in ROSES-2016. All compliant proposals submitted to these calls will be invited to submit a Step-2 proposal. Proposers to H-GI and H-SR are limited to one Step-1 proposal per Principal Investigator (PI) per program element, i.e., they can submit one and only one proposal as PI to each.

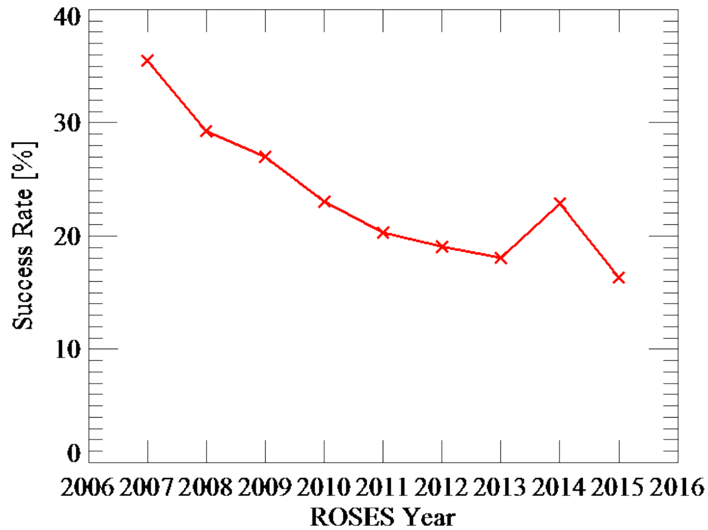
Proposers may not submit Step-2 proposals for the same or essentially the same work to more than one program element concurrently. This covers all program elements in Appendix B and also all cross-divisional ROSES program elements (Appendix E) supported by the Heliophysics Division. This prohibition is active for a particular submitted proposal until the PI is notified through NSPIRES that the proposal was declined or until the proposal is withdrawn. The prohibition on duplicate proposals applies across ROSES years as well (i.e., a duplicate of a pending ROSES-2015 proposal may not be submitted in response to ROSES-2016).

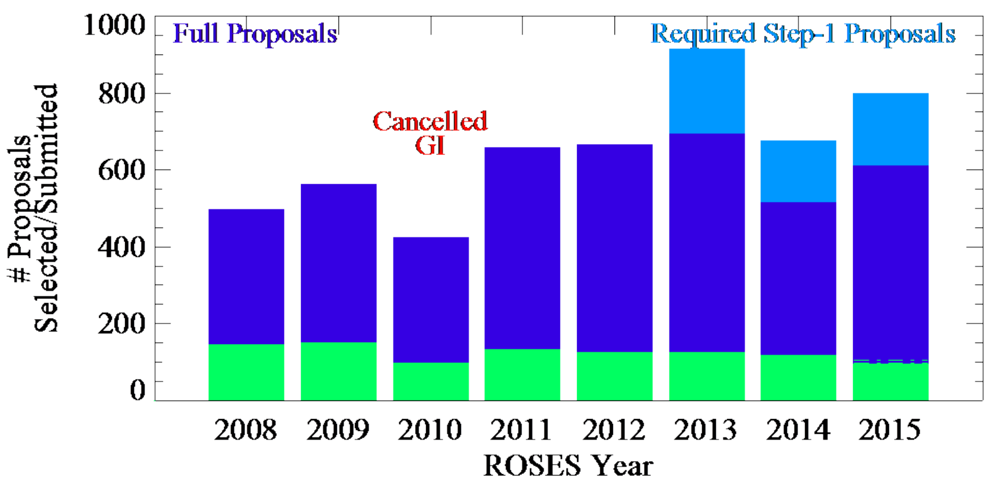
If a second proposal is submitted while a duplicate proposal is still pending in another program element, only the first proposal will be evaluated; the duplicate proposal may not be evaluated or considered and may be returned without review.

1.1 Recent Trends in Proposal Selection Rates

The number of active missions of the Heliophysics System Observatory (HSO) has increased through the recent successful launches of the four-spacecraft MMS missions and the longevity and ongoing high productivity of the missions in extended operations phase. The Heliophysics research budget that supports analysis of HSO observations 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 has declined. At the same time, funding for Heliophysics research has not kept up with inflation. While for ROSES-2014, full proposal submissions were down by ~26% as compared to ROSES-2013, the numbers for ROSES-2015 went up by 19%. Possible causes for high submission rates are sustained success rates under 25% since ROSES-2010. The ROSES-2014 drop in submissions could be explained by expanded use of the recently introduced encourage/discourage review process in Step 1, and one fewer solicited program overall in ROSES-2014. Success rates went up for ROSES-2014, as compared to ROSES-2013 to 23% (vs. 18%). The relative increase in success rates ROSES-2014 vs. ROSES-2013 seems to be a direct result of the lower number of submissions as it matches the magnitude of the drop in submissions (+27% vs. -26%). At the time of writing, the success rate for ROSES-2015 is expected to be ~17%, and that of ROSES-2016 will strongly depend on the number of submissions.

Figure 1, at right, shows the decrease of proposal selection rates over the ROSES years 2007-2013 (FY 2008-2014) and a light temporary recovery in ROSES-2014. Only full proposals (as compared to Step-1 proposals) are included in the selection rate. Figure 2, below, shows the numbers of Step-1 and full proposals submitted by ROSES year along with numbers of selections, where available. In the bar chart, the green shows the awards, the dark blue shows the Step-2 proposals, and the light blue show the Step-1 proposals.





2. 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 ROSES-2016, but there are changes, in particular to the scope of the H-SR program, a change of the former H-IDEE program to H-DEE, and changes to the Step-1/Step-2 proposal process for H-SR and H-GI. Please note also that there are infrequent opportunities added this year (B.5, B.8, B.9, and B.10). The intent of these 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.10.

Heliophysics Supporting Research (H-SR):

In order to avoid duplication and overlap of proposal opportunities, in particular between H-GI and H-SR, the expected scope of proposals submitted to the H-SR program is significantly increased. Heliophysics SR awards are research investigations that employ a variety of techniques, including theory, numerical simulation, modeling, analysis, and interpretation of space 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.

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 Guest Investigators MMS Special Opportunity (H-GI/MMS) is planned as an amendment later this ROSES year (see Program Element B.8). This Special Opportunity is intended for proposals that focus on analysis of MMS observations, therefore, proposals based primarily on MMS data analysis would be better suited to B.8 HGI/MMS; MMS observations will be publicly released in early 2016. The Heliophysics Supporting Research program is described in Program Element B.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's programs 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), CubeSats, 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; and (iii) laboratory research.

The H-TIDeS program element has three 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, commercial reusable suborbital rockets, CubeSats, 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 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, and nuclear measurements that support spacecraft measurements and atmospheric models.

The Heliophysics Technology and Instrument Development for Science program with subelements Low-Cost Access to Space (LCAS), Instrument and Technology Development (ITD), and Laboratory Nuclear, Atomic and Plasma Physics (LNAPP) are described in Program Element B.3.

Heliophysics Guest Investigators (H-GI/OPEN and H-GI/MMS):
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 ROSES-2016:

The Heliophysics Guest Investigators open program (H-GI/OPEN) is described in Program Element B.4. Proposals using Magnetosphere Multiscale (MMS) mission observations **as primary emphasis** are excluded from this program element. **[Added February 25, 2016]**

The Heliophysics Guest Investigators MMS Special Opportunity (H-GI/MMS) is planned as an amendment later this ROSES year (See Program Element B.8). Proposals that focus on the analysis of MMS observations should be submitted to this Special Opportunity. The MMS observations will be publicly released in early 2016.

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 between 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-2016. Two program elements are planned, the Theory, Modeling, and Simulations (TMS) element and an amendment offering Heliophysics Science Centers (SC). The TMS element is described here and the SC element will be described in an amendment later this ROSES year.

The former Heliophysics Theory Program provides the foundation of the TMS element (H-GCR/TMS). Increasingly, as computing power becomes more affordable and more available, numerical simulations and modeling become tools that can and have been used synergistically with data analyses and rigorous theory development to solve the fundamental problems of Heliophysics. They lead the way to new understanding and drive science concepts for future strategic missions. The ultimate goal of such investigations is to provide a complete chain of reasoning extending from the basic laws of nature to comparison with observation to the identification of future quantitative tests of the behavior of the environment. The Heliophysics Grand Challenges Research Science Centers program element (H-GCR/SC) will be offered for the first time as part of the ROSES-2016. The particulars of this program will be described in an amendment later in this ROSES year (see Program Element B.9).

The Heliophysics Grand Challenges Research elements are described in program elements B.5 and B.9.

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. Strategic Capabilities are the development and integration of such models for all the various components of this system.

The details of the Living With a Star Science program for ROSES-2016 will be described in an amendment that will be released later in this ROSES year (see Program Element B.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 Sections 2.2 and 2.3 of B.7 H-DEE.

The Heliophysics Data Environment Enhancement program is described in Program Element B.7.

*Heliophysics U.S. ~~Principal~~ **Participating** Investigator (H-USPI)*

The Heliophysics U.S. ~~Principal~~ **Participating** Investigator (H-USPI) will be offered as part of ROSES-2016. The particulars of this program will be described in an amendment later in this ROSES year (see Program Element B.10). **[title changed May 31, 2016]**

B.2 HELIOPHYSICS SUPPORTING RESEARCH

NOTICE: In order to avoid duplication and overlap of proposal opportunities, in particular between Heliophysics Guest Investigators (H-GI) and Heliophysics Supporting Research (H-SR), the expected scope of proposals submitted to this program is significantly increased. See Sections 1 and 2 for details.

Proposals to this program will continue to be taken by the two-step process in which the Notice of Intent is replaced by a required Step-1 proposal submitted by an Authorized Organizational Representative (AOR). Only proposers who submit a Step-1 proposal are eligible to submit a Step-2 (full) proposal. The title, science goals, and investigators may not be changed between the Step-1 and Step-2 proposals. Step-1 proposals will be checked for compliance, but will not be peer reviewed. All Step-1 proposers will be permitted to submit a Step-2 proposal, unless the Step-1 proposal has been determined to be noncompliant with program requirements. See Section 3 for details. Proposals based primarily on Magnetospheric Multiscale (MMS) data analysis would be better suited to B.8 HGI-MMS.

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/year – \$250K/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 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 Solar, 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) 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 a full 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;
- Proposals based primarily on MMS data analysis would be better suited to B.8 HGI-MMS;
- Use of non-NASA data as ancillary data supporting the investigation is allowed, but the proposed investigation should not be focused on such data.

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.

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 notified by E-mail 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.

3.3 Step-2 Proposal Format

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 is appropriate to address the science objectives and (2) that the methodology is both appropriate and feasible to make substantial progress on the science objectives;
- The relevance of the proposed work to 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 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 Evaluation Criteria

Step-2 proposals that are not compliant with format requirements may be rejected without review. See 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 Section C.2 of 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 requested in the *Guidebook for Proposers*, cost realism/reasonableness will be evaluated based on 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 ~$4M available in Fiscal Year (FY) 2016 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	~$4M
Number of new awards pending adequate proposals of merit	~17-20
Maximum duration of awards	3 years
Due date for Step-1 proposal	See Tables 2 and 3 in the *ROSES Summary of Solicitation.*
Due date for full proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
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 Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the Heliophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.

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 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	NNH16ZDA001N-HSR
NASA point of contact concerning this program for Sun and Heliosphere	Arik Posner Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358 0727 E-mail: arik.posner@nasa.gov
NASA point of contact concerning this program for Magnetospheres and ITM	Elsayed Talaat Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358 3804 E-mail: elsayed.r.talaat@nasa.gov

B.3 HELIOPHYSICS TECHNOLOGY AND INSTRUMENT DEVELOPMENT FOR SCIENCE

NOTICE: Proposal submission to all calls in Heliophysics 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). Only proposers who submit a Step-1 proposal are eligible to submit a Step-2 (full) proposal. The title, science goals, and investigators may not be changed between the Step-1 and Step-2 proposals. Step-1 proposals will be checked for compliance, but will not be peer reviewed. All Step-1 proposers will be permitted to submit a Step-2 proposal, unless the Step-1 proposal has been determined to be noncompliant with program requirements. See Section 2.2 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, and Geospace (Magnetosphere-Ionosphere-Thermosphere-Mesosphere (Mag-ITM)) Science Supporting Research and Technology programs.

Supporting Research studies are found under ROSES Program Element B.2 Heliophysics Supporting Research (H-SR). Guest Investigator studies are found under ROSES Program Element B.4 Heliophysics Guest Investigators.

H-TIDeS seeks to investigate key Heliophysics science questions through three separate subelements. These subelements are also established for the purpose of organizing the evaluation and peer review process.

- Low-Cost Access to Space (LCAS): science and/or technology investigations that can be carried out with instruments flown on suborbital sounding rockets, stratospheric balloons, CubeSats, suborbital reusable launch vehicles, or other platforms, collectively referred to as Low-Cost Access to Space (see Section 1.2 below)
- Instrument and Technology Development (ITD): state-of-the-art instrument technology development for instruments that may be proposed as candidate experiments for future space flight opportunities, called Instrument and Technology Development, which may be carried out in the laboratory and/or observatory (see Section 1.3 below)
- Laboratory Nuclear, Atomic, and Plasma Physics (LNAPP): laboratory research designated as enabling Laboratory Nuclear, Atomic, and Plasma Physics studies (see Section 1.4 below).

Advancement in Heliophysics science requires the development and application of new technologies that will yield the next generation of innovative instruments. Laboratory research can be a relevant supplement to instrumentation and to the science of Heliophysics. The ability to achieve significant progress toward the scientific and technical challenges in Heliophysics in the coming years is greatly enhanced through the H-TIDeS program.

These 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* (http://nasascience.nasa.gov/about-us/science-strategy).

Proposals to all H-TIDeS programs shall link the proposed work to the NASA Heliophysics science plan in a three-step process:

1) NASA Heliophysics Science Goal(s)
2) The science questions to be answered in achieving the science goals
3) The proposed investigation objective(s) required to address the science goals (either technological or observational or both)

The three Heliophysics Science Goals (described in the *2014 NASA Science Plan*) 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 objectives (technological and/or observational); however, the investigation might only make progress toward their proposed science question(s) and toward the top science goal(s) 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.

1.2 Low-Cost Access to Space

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. The LCAS and ITD programs are expected to continue 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.

LCAS Investigation 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 LCAS program funding (Section 4)
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.

1.2.1 LCAS Step-2 Proposal Content

Proposals for the LCAS 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 above, LCAS 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 section of proposals is restricted to twenty pages, except for CubeSats and Flights of Opportunity, which are permitted twenty three pages (see below). The Scientific/Technical/Management 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. Postdoctorals and students do not need to be named.
- A discussion of the plan for management, analysis, interpretation, and public dissemination of the data. Note: Level zero observational data from a LCAS flight must be deposited in a NASA-approved data center within 60 days of being obtained and calibrated observational data must be deposited in the same location before the end of the investigation.

Performance characteristics (which shall be considered as requirements on the flight system) shall include mass, power, volume, data rate(s), thermal, pointing (such as control, stability, jitter, drift, accuracy, etc.), spatial and spectral resolution, observable precision, retrieved parameter sensitivity and accuracy, and calibration requirements. This section shall demonstrate that the instrumentation can meet the measurement requirements, including factors such as retrieval results for each remote sensor, error analysis of the information in all sensors, vertical and horizontal resolution, signal-to-noise (S/N) calculations, and any other aspects of the instrumentation upon which the observations depend.

The mission requirements that the science goals and investigation objectives impose on the mission design elements, including mission design, instrument accommodation, platform design, required launch vehicle capability, ground systems, communications approach, and mission operations plan, shall be provided in tabular form and supported by narrative discussion. Table B2 provides an example of a tabular Mission Traceability Matrix, with examples of matrix elements. Specific information that describes how the science investigation imposes unique requirements on these mission design elements shall be included.

All LCAS investigations are conducted under the NASA Suborbital-Class program plan. 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 LCAS 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 LCAS program 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. 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. 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 based on ISS spaceflight must include a statement from the NASA Johnson Space Center ISS Research Integration Office/OZ indicating the feasibility of accommodating the investigation. 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.

Budgets are expected to cover complete investigations, including payload development and construction, instrument calibration, launch, and data analysis. 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.

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.

Data returned from LCAS 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.

Additional requirements for the proposal content are provided in Section 2.3.1.

1.2.2 Export Control Laws specific to the Sounding Rocket Program

Export licenses are required for all foreign nationals accessing sounding rocket-class hardware. LCAS program Principal Investigators (PIs) should contact the Sounding Rocket 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. Questions concerning U.S. Export Control Laws and Regulations for sounding rocket-class missions may be addressed to Philip.J.Eberspeaker@nasa.gov of the Sounding Rocket Program Office.

1.2.3 LCAS Proposals from Multiple Institutions

The LCAS program no longer makes 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 the *NASA Guidebook for Proposers*, Section 2.3.10(c)), 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.

1.3 Instrument and Technology Development (ITD)

The ITD program supports the development of instrument or 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, 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 without significant additional technology development.

Either new measurement concepts or methods to improve the performance of existing instruments or 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 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.

1.3.1 ITD Step-2 Proposal Content

Proposals to the ITD 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 development is a necessary precursor to solving specific scientific problems. However, the proposers are not necessarily expected to apply the results of their efforts to the science problems within the time period of the proposed effort.

Additional requirements for the proposal content are provided in Section 2.3.1.

1.4 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.

1.4.1 LNAPP Step-2 Proposal Content

Proposals for LNAPP 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. Proposals to LNAPP must demonstrate 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.

Additional requirements for the proposal content are provided in Section 2.3.1.

2. <u>Submission and Evaluation Guidelines</u>

2.1 <u>General Considerations</u>

Each Principal Investigator is allowed to submit one and only one Step-1 proposal to each subelement (LCAS, ITD, LNAPP) of this solicitation. In that proposal, 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 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-TIDeS program or if they fail to meet submission guidelines specified below (2.2 and 2.3).

2.2 <u>Step-1 Proposals</u>

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-2016 *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-2016 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. An Authorized Organizational Representative (AOR) from the PI's institution must submit the Step-1 proposal. No budget is required (see below). Only proposers who submit a Step-1 proposal are eligible to submit a full proposal. 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, Co-Investigators, Collaborators, Consultants, and Other Professionals) may not be changed between in 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. Each Principal Investigator is allowed to submit one and only one Step-1 proposal for each subelement described in Section 1 above.

2.2.1 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 E-mail when they are able to submit their Step-2 proposals.

2.2.2 Step-1 Evaluation Criteria

Step-1 proposals will be declared noncompliant if the proposed work is outside the scope of the H-TIDeS program, as described 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. All who submit a compliant Step-1 proposal will be invited to submit a corresponding Step-2 proposal.

2.2.3 Request for Reviewer Names

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.

2.3 Step-2 Proposals

A Step-2 (full) proposal must be submitted electronically by the Step-2 due date (see below and Tables 2 and 3 in the *ROSES Summary of Solicitation*). 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, 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 and investigation objectives proposed in the Step-1 proposal. Each Principal Investigator is allowed to submit only one proposal for each subelement.

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.

2.3.1 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 of the *ROSES Summary of Solicitation*.

Proposals to the H-TIDeS program must contain the following elements.

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.

Traceability 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. Projected instrument performance shall be compared to instrument performance requirements. Table B1 of this appendix provides an example of a tabular Science Traceability Matrix, with examples of matrix elements. This matrix provides the reference points and tools needed to track overall mission requirements and provides systems engineers with fundamental requirements needed to design the mission.

The proposal shall describe the instrumentation and the rationale for its selection. It shall identify the instrument systems (i.e., individual instruments), instrument subsystems, and instrument components, including their characteristics and requirements, and indicate items that are proposed for development, as well as any existing instrumentation or design/flight heritage. It shall provide a clear understanding of how the concept will provide the required data.

A 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. Special requirements for public release of observational data obtained through the LCAS subelement are noted in Section 1.2. 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.

Additional requirements for the proposal content are provided in Sections 1.2, 1.3, and 1.4.

2.3.2 Step-2 Evaluation Criteria

Step-2 proposals that are not compliant with format requirements may be rejected without review. See Section IV (b) ii of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers* for details. Proposers must select the subelement that is appropriate for their proposal. 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 Section VI. (a) of the *ROSES Summary of Solicitation* and C.2 of the *NASA Guidebook for Proposers*. These criteria are intrinsic scientific and technical merit, relevance to NASA's objectives, and cost realism/reasonableness.

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 Co-Investigators and Collaborators with specific roles in the investigation should be included and their roles must be clearly laid out. Proposals should not include Collaborators whose only role is advisory.

Proposals will be evaluated for scientific and technical merit based on the following:

1. The importance of the proposed investigation objectives and science question(s) in relationship to the Heliophysics Science goals, including
    a. the unique value of the investigation to make scientific progress in the context of current understanding in the field,
    b. the importance of carrying out the investigation now;
2. The feasibility of the proposed investigation objectives in answering the science questions and achieving the required technology demonstration and/or observations, including the appropriateness of
    a. data and/or models,
    b. facilities,
    c. instrumentation,
    d. flight systems

Based on these two factors, the evaluation will consider the overall potential science impact and probable success of the investigation.

Note: Proposals are not required to obtain full closure on the science question(s) during the investigation. However, if the investigation does not obtain closure on the science question(s), the proposal must demonstrate the viability of answering those science question(s) through subsequent flights and/or future orbital missions relying on the proposed technologies. Closure on the individual investigation objectives (technology development and/or observations) is required.

Additionally, though not required, the degree to which the proposed effort advances the readiness of junior researchers or graduate students to assume leadership roles on future NASA space flight missions will be considered.

3. <u>Available Funds</u>

A total of about $4.5M-5.0M program funds next fiscal year will allow the selection of about twelve new awards. ITD and LNAPP proposals of exceptional scientific merit will be considered for funding, within the constraints of the budget.

It is anticipated that approximately $3.5M in next fiscal year funds will be available to support three to eight new selections for LCAS.

It is anticipated that approximately $0.8M in next fiscal year funds will be available to support two to five new selections for ITD.

It is anticipated that approximately $0.4M in next fiscal year funds will be available to support one to three new selections for LNAPP.

4. <u>Maximum Duration of Awards</u>

The maximum duration of ITD and LNAPP awards is three years. Although most LCAS 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.

5. <u>Summary of Key Information</u>

Expected program budget for first year of new awards	~$4.5M-5.0M Total, $3.5M LCAS, $0.8M ITD, $0.4M LNAPP
Number of new awards pending adequate proposals of merit	~12 for LCAS, ITD, LNAPP combined
Maximum duration of awards	LCAS – 4 Years; ITD, LNAPP – 3 years.
Due date for Step-1 Proposal	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for Step-2 (full) proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
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: 20 Pages
	LCAS CubeSat & Flight of Opportunity: 23 pages
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 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	NNH16ZDA001N-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 E-mail: dan.moses@nasa.gov

TABLE B1
EXAMPLE SCIENCE TRACEABILITY MATRIX
(REQUIRED FOR ALL H-TIDeS PROPOSALS)

Science Goals	**Science Objectives**	**Scientific Measurement Requirements**		**Investigation Functional Requirements**		**Projected Performance**	**Mission Functional Requirements (Top Level)**
Goal 1	Objective 1	Absorption line	Column density of absorber	Alt. Range	XX km	ZZ km	Observing strategies: requires yaw and elevation maneuvers
Goal 2		Emission line	Density and temperature of emitter				Launch window: to meet nadir and limb overlap requirement. Window applies day to day
Etc.			Size of features	Vert. Resol.	XX km	ZZ km	Need AA seasons to trace evolution of phenomena
		Morphological feature		Horiz. Resol.	XX deg x XX lat x XX long	ZZ deg x ZZ lat x ZZ long	
			Rise time of eruptive phenomenon	Temp. Resol.	XX min	ZZ min.	Need AA months of observation to observe variability of phenomena
		Rate of change of observable phenomenon		Precision	XX K	ZZ K	
				Accuracy	XX K	ZZ K	
	Objective 2 to N			Repeat above categories			

TABLE B2
EXAMPLE MISSION TRACEABILITY MATRIX
(REQUIRED FOR LCAS PROPOSALS)

Mission Functional Requirements	Mission Design Requirements	Spacecraft/Payload Requirements	Ground System Requirements	Operations Requirements
From Table B1	Rocket type Launch date: Mission length Orbit altitude requirement and rationale Geographic coverage and how it drives orbit requirement Orbit local time and rationale for the requirement Type of orbit, e.g. Sun synchronous, precessing, Lagrangian point, other Other	Spinning, stabilized Mass Power Volume: Data Rate Temperature Range for spacecraft systems Pointing Control: Knowledge, Stability, Jitter, Drift , Other Detector radiation shielding requirements and rationale Other	Passes per day and duration Assumed antenna size Data volume per day Real time data transmission requirements Transmit frequency Power available for comm (Watts) Downlink data rate Number of data dumps per day Spacecraft data destination (e.g., mission operations center) Science data destination (e.g., science operations center) Other	General spacecraft maneuver requirements and frequency Special maneuvers requirements Rationale for maneuvers Ephemeris requirements Changes in viewing modes and directions per orbit, per day or over longer time periods. Rationale for these changes Other
Msn Functional Req or Instrument Accommodation (from Table B1)	Mission	Spacecraft	Ground System	Operations
Four different observing strategies: Solar, limb, nadir, zenith; requires yaw and elevation maneuvers		Agility requirements Slew rate = y deg/sec Settle = stability < .001 deg/sec after 30 secs		Target planning on 3 day centers Ephemeris accuracy of x with updates every 2 days
Instrument X precision of 5K		Thermal stability of 1 deg/hr S/C bus stability of .01 deg over 10 secs	Bit error rate < 1e-5 Time correlation to 2 msec over 1 week	Weekly time correlation

B.4 Heliophysics Guest Investigators - Open

NOTICE: 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). Only proposers who submit a Step-1 proposal are eligible to submit a Step-2 (full) proposal. Step-1 proposals will be checked for compliance but will not be reviewed. See Section 3 for details. Step-2 proposals will be limited to ten (10) pages. Investigations focused on Magnetospheric Multiscale (MMS) data are not permitted; these investigations should be submitted under B.8 Special MMS Guest Investigators.

Check for NASA spacecraft mission data compliance as specified in the overview B.1.

1. Scope of Program

The Heliophysics Guest Investigator (H-GI) "Open" program is intended to maximize the scientific return from operating Heliophysics 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-2016, this primary H-GI element is offered as a single "open" program element, although there are plans to include a Magnetospheric Multiscale Guest Investigators (MMS-GI) call in program element B.8, later in ROSES-2016 by Amendment.

1.1 Overview

The H-GI Open program is for investigations whose primary emphasis is the analysis of data from currently operating missions of the Heliophysics System Observatory (HSO). 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) on whose data 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* www.nap.edu/catalog.php?record_id=13060):

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 NASA's HSO data, but only as a secondary emphasis. However, 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:
http://science.nasa.gov/heliophysics/missions/operating/

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 will be available during the period of the award. Most Heliophysics data may be found in one or more of the NASA active archives and Virtual Observatories (VOs).

Archive		URL
Solar Data Analysis Center	SDAC	http://umbra.nascom.nasa.gov
Space Physics Data Facility	SPDF	http://spdf.gsfc.nasa.gov
Virtual Solar Observatory	VSO	http://sdac.virtualsolar.org/
Heliophysics Data Portal	formerly VSPO	http://vspo.gsfc.nasa.gov/websearch/dispatcher
Virtual Magnetospheric Observatory	VMO	http://vmo.nasa.gov
Virtual Heliospheric Observatory	VHO	http://vho.nasa.gov
Virtual Radiation Belt Observatory	ViRBO	http://virbo.org
Virtual Ionosphere Thermosphere Mesosphere Observatory	VITMO	http://vitmo.jhuapl.edu
Virtual Wave Observatory	VWO	http://vwo.gsfc.nasa.gov

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 Solar, Heliosphere, Magnetosphere, and Ionosphere-Thermosphere-Mesosphere (ITM). Each PI will have to choose one of the four as the focus of their investigation. 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.

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, 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 must invest a substantial portion of their time, of the order of 10-20%, to 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 Magnetospheric Multiscale (MMS) data. MMS data may be used as a secondary resource, but 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's Authorized Organizational Representative (AOR). No budget or other elements are required. Only proposers who submit a Step-1 proposal are eligible to submit a 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 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 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 E-mail when they are able to submit their Step-2 proposals.

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's 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 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*.

Proposals are restricted to ten (10) pages for the Scientific/Technical/Management section and must include the following sections with the preferred order:

- The science objectives and perceived impact of the proposed work to the state of knowledge in the field; references to existing work in the field should be limited to that which is needed to justify the value of the science proposed;
- The data and methodology to be employed in conducting the proposed research; the proposal must demonstrate (1) that the data are appropriate to address the science objectives and (2) that the methodology is both appropriate and feasible to make substantial progress on the science objectives;
- The relevance of the proposed work to the 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 named.

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.

3.4 Step-2 Evaluation Criteria

Step-2 proposals that are not compliant with format requirements may be rejected without review. See 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 Section C.2 of the *NASA Guidebook for Proposers*. These criteria are intrinsic scientific and technical merit, relevance, 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 science and technical factors, the evaluation will consider the overall potential science impact and probable success of the investigation.

Relevance to and priority within the H-GI program 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 $2.5M available in Fiscal Year (FY) 2017 to support new Heliophysics GI investigations selected through this solicitation. Annual funding is expected in the range ~$125-150K per investigation per year.

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 first year of new awards	~$2.5M; See Section 4
Number of new awards pending adequate proposals of merit	~18
Maximum duration of awards	3 years; shorter-term proposals are encouraged.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Page limit for the central Science-Technical-Management section of proposals	10 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Planning date for start of investigation	8 months after proposal due date.
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	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 in 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 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	NNH16ZDA001N-HGIO
NASA point of contact concerning this program	William R. Paterson Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358 0991 E-mail: william.r.paterson@nasa.gov

B.5 HELIOPHYSICS GRAND CHALLENGES RESEARCH-THEORY, MODELING, SIMULATIONS

NOTICE: Amended August 25, 2016. Use of MMS data is allowed in the TMS element. New text is in bold and deleted text is struck through. Step-1 proposals for this program element are now due October 13, 2016, and Step-2 proposals are now due November 23, 2016.

Proposal submission to all calls in Heliophysics, including this one, are performed by a two-step process, in which a Notice of Intent is replaced by a required Step-1 proposal submitted by an Authorized Organizational Representative (AOR). Only proposers who submit a Step-1 proposal are eligible to submit a Step-2 (full) proposal. Step-1 proposals will be checked for compliance but will not be reviewed. See Sections 2.3 and 2.4 for details.

Check for NASA spacecraft mission data compliance, as specified in the overview B.1.

1. Scope of Program

The Heliophysics Grand Challenges Research (H-GCR) program is a component of the Heliophysics Research Program. Proposers interested in this program element are encouraged to see the overview of the Heliophysics Research Program in Appendix B.1 of this ROSES NRA.

1.1 Overview

The Heliophysics Grand Challenges Research (H-GCR) program currently includes just one element: the former Heliophysics ROSES element called "Heliophysics Theory Program" (HTP, last competed in ROSES 2013 Appendix B.5). The former HTP is now referred to as the Theory, Modeling, and Simulations (TMS) element in the H-GCR program. A GCR-Science Center program element will be offered later this year by amendment to ROSES-2016 as B.9.

The goals of the Heliophysics Grand Challenges Research 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 between 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.

1.2 Theory, Modeling, and Simulations (TMS)

The former Heliophysics Theory Program provides the foundation of the TMS element. Increasingly, as computing power becomes more affordable and more available, numerical simulations and modeling become tools that can and have been used synergistically with data analyses and rigorous theory development to solve the fundamental problems of Heliophysics. They lead the way to new understanding and drive science concepts for future strategic missions. The ultimate goal of **TMS** ~~such~~ investigations is to provide a complete chain of reasoning extending from the basic laws of nature to comparison with observation to the identification of future quantitative tests of the behavior of the environment. NASA acknowledges this and renames the element "Theory, Modeling, and Simulations."

TMS investigations should address one of the four high level science goals from the Heliophysics Decadal survey (*Solar and Space Physics: A Science for a Technological Society* www.nap.edu/catalog.php?record_id=13060) 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.

Proposals that serve only as an umbrella for a variety of separate research tasks, even though they each may be related by a common theme and may each be of high scientific merit, are not appropriate for the TMS element. Efforts of sufficient scope and breadth and focused on those aspects of Heliophysics that directly affect life and society are not appropriate for the TMS element. **Proposals requiring the use of Magnetospheric Multiscale (MMS) data are permitted. [Amended August 25, 2016]**

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 is expected to invest a substantial portion of his/her time, 10-30%, to the investigation. Co-Investigators (Co-Is) must each have a specific and defined task in the project, and the task 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-GCR 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 CGR-TMS include the following:

- Proposals for the same or essentially the same work submitted concurrently to other program elements in Appendix B or E, as specified in B.1 Section 1;
- Work for which the proposing organization (or investigators) are already funded by NASA. Where projects might appear to overlap, proposals must show that the proposed effort does not duplicate other awards.
- ~~Proposals requiring the use of Magnetospheric Multiscale (MMS) data are not solicited.~~

2.3 Step-1 Proposals

To streamline the proposal process (submission, evaluation, and administration), this program uses a two-step proposal submission process. For a general overview of the two-step 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 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.

2.3.1 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 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 E-mail when they are able to submit their Step-2 proposals.

2.3.2 Step-1 Evaluation Criteria

Step-1 proposals may be declared noncompliant if outside the scope of the H-GCR program as described 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.

2.4 Step-2 Proposals

A Step-2 (full) proposal must be submitted electronically by the Step-2 due date (see Tables 2 and 3 in the *ROSES Summary of Solicitation*). The Step-2 proposal must be submitted via NSPIRES 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 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.

2.4.1 Step-2 Proposal Format

Guidelines for submitting Step-2 full proposals are specified in Table 1 of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers*.

Owing to the larger scope of the TMS proposals, the page limit for the Science/Technical/ Management section is revised from the default standard of 15 pages to 20 pages. Proposals 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 methodology to be employed in conducting the proposed research; the proposal must demonstrate that the methodology is both appropriate and feasible to make substantial progress on the science objectives; TMS studies must be substantiated using appropriate data, primarily from NASA missions.
- 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. Postdoctorals and students do not need to be named.

Historically, proposals that are focused on a specific compelling science question have been more successful at constructing methodologies that clearly address a single target question than those that propose to address a large number of science questions or that are directed at a broad science topic, rather than a specific question.

2.4.2 Step-2 Evaluation Criteria

Step-2 proposals that are not compliant with format requirements may be rejected without review. See 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 Section VI (a) of the *ROSES Summary of Solicitation* and C.2 of 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 primarily on these two factors within merit, the evaluation will consider the overall potential science impact and probable success of the investigation.

Relevance to and priority within the H-GCR program 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 will be evaluated by considering 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 roles in the investigation must be clearly laid out. Use of Collaborators whose only role is advisory is discouraged.

3. <u>Available Funds</u>

Selections for H-GCR TMS from this program element are for three-year periods of performance with annual funding contingent on submission of satisfactory progress reports and available funding. The total annual budget for this program element is about $4M, and the expected funding award from the last Heliophysics Theory Program call is approximately $400-450K.

4. <u>Summary of Key Information</u>

Expected program budget for first year of new awards	$4M
Number of new awards pending adequate proposals of merit	8-10
Maximum duration of awards	3 years
Due date for Step-1 Proposal	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for full proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.

Planning date for start of investigation	6 months after proposal due date.
Page limit for the central Science-Technical-Management section of proposal	20 pp.; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the Heliophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
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 Step 1 and Step 2 proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH16ZDA001N-GCR
NASA point of contact concerning this program	Mona Kessel Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0064 E-mail: mona.kessel@nasa.gov

B.6 HELIOPHYSICS LIVING WITH A STAR SCIENCE

Amended August 1, 2016: Final text released. The Strategic Capabilities element is not being competed in ROSES-2016. Targeted Science Team proposals, whereby a single large proposal covers the entire breadth of a Focus Science Topic, will not be permitted in ROSES-2016. The Cross-Discipline Infrastructure Building element is not being competed in ROSES-2016.

Proposal submission to all calls in Heliophysics will be done by a two-step process, in which a Notice of Intent is replaced by a required Step-1 proposal. The proposal title, science goals and objectives, and investigators cannot be changed between the Step-1 and Step-2 proposals. See Section 5 for details.

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 5 for details.

1. Scope of Program

The Living With a Star (LWS) Program emphasizes the science necessary to understand those aspects of the Sun and Earth's space environment that affect life and society. The ultimate goal of the LWS program is to provide a scientific understanding of the system, almost to the point of predictability, of the space weather conditions at Earth and the interplanetary medium, as well as the Sun-climate connection.

The LWS program objectives are based on these goals and are as follows:

1. Understand solar variability and its effects on the space and Earth environments with an ultimate goal of a reliable predictive capability of solar variability and response.
2. Obtain scientific knowledge relevant to mitigation or accommodation of undesirable effects of solar variability on humans and human technology on the ground and in space.
3. Understand how solar variability affects hardware performance and operations in space.

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 program elements, 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 *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).

2. Strategic Capabilities

NOTICE: The Strategic Capabilities element will not be competed in 2016. In its previous guise as "Living With a Star Targeted Research and Technology: NASA/NSF Partnership for Collaborative Space Weather Modeling," it is fully subscribed this year with awards from ROSES-2011 and will not be recompeted until ROSES-2017, at the earliest.

3. 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 must tackle large-scale problems that cross discipline and technique boundaries (e.g., data analysis, theory, modeling, etc.); and second, the program must identify how this new understanding will have a direct impact on life and society. Over time, the Targeted Investigations provide advances in scientific understanding to address these challenges.

The Targeted Investigations element this year consists of three Focused Science Topics (FSTs).

3.1. Focused Science Topics

The Focused Science Topics (FST) permitted as the objectives for proposals to this LWS Science solicitation are as follows:

1) Advances Toward a Near Real Time Description of the Solar Atmosphere and Inner Heliosphere;
2) Characterization of the Earth's Radiation Environment;
3) Studies of the Global Electrodynamics of Ionospheric Disturbances.

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 2013 and 2014, 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 Focus Science Topic. However, such TSTs will not be permitted in ROSES-2016. Instead, LWS Science will adopt 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 be in the range of \$200k – \$250k. (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, up to six selections will be made for each Focused Science Topic. The expected duration of FST awards is four years.

Once selected, these investigators will form a team in order to coordinate their research programs. Due to the collaborations that will arise from coordination of 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.

3.1.1 Advances toward a Near Real Time Description of the Solar Atmosphere and Inner Heliosphere

Target Description: The Sun's atmosphere (photosphere, chromosphere, transition region, and corona) and solar wind play a critical role in space weather. Understanding of the global state of the solar atmosphere and inner heliosphere to 1 AU thus underlies nearly all of the LWS Strategic Science Areas (SSAs, and especially SSA-1 (Physics-based Geomagnetic Forecasting Capability), SSA-3 (Physics-based Solar Energetic Particle Forecasting Capability), and SSA-4 (Physics-based TEC Forecasting Capability).

Currently, models of the solar atmosphere and solar wind rely primarily on maps of the photospheric magnetic field, available from a number of ground-based and space-based observatories, to generate steady state solutions. Remote observations of the Sun (such as images and spectra in the ultraviolet, visible, and infrared), as well as *in situ* measurements of solar wind properties, are used to validate theoretical explanations and test model solutions. This topic focuses on the innovative creation and use of heliophysics data products to address the time-dependent state of the inner heliosphere- from the solar surface to 1 AU. Methods such as "data assimilation," and "ensemble modeling," which are used in the meteorological community, can be highly beneficial in this context. However, the nature and sparseness of some heliophysics data implies that these techniques may not be directly translatable to the solar/heliospheric environment, but must be adapted using novel techniques. Examples include, but are not limited to, (1) the innovative use of sequences of magnetograms and/or magnetic maps in combination with other data products for the purposes of predicting the state of the solar atmosphere and/or solar wind parameters, (2) the use and planning for multiviewpoint magnetograms, solar disk and heliospheric images, and solar wind measurements from existing NASA spacecraft (e.g., Solar and Heliospheric Observatory (SOHO), Solar Terrestrial Relations Observatories (STEREO), Advanced Composition Explorer (ACE), Wind, etc.). Planning for data from future missions may be presented as a long-term benefit of the proposed study, but the use of existing data sets must be the primary focus of the proposed study.

Goals and Measures of Success: The goal of this focus topic will be to develop quantitative methods for incorporating heliophysics data into models and developing improved data products for use in such models. The goal of these products and techniques is that they can eventually be used to produce a (near) real-time description of the solar atmosphere and inner heliosphere, consistent with available data and suitable for modeling other processes (such as the propagation of CMEs, other transients, etc.). All studies must address uncertainty analysis and describe the propagation of errors from the input data and theoretical assumptions and how these impact the uncertainty of the results.

Types of investigations: Investigations could include, but are not limited to:

- Studies that utilize extreme ultraviolet, white light, radio, Interplanetary Scintillation (IPS), and other space-based or ground- based data to modify/improve/correct model estimates of relevant parameters, such as values at L1.
- Studies that innovatively use magnetograms/magnetic maps, either space or ground-based, to drive models or develop improved magnetic maps or source surface parameters that can be used to drive these models.
- Studies that develop mathematical techniques for incorporating data into solar atmosphere/solar wind models (e.g., assimilation, data driving, etc.)
- Studies that derive solar atmosphere/solar wind state quantities (i.e., density, temperature, velocity) such that they could be used to drive/modify/improve/correct models of the solar atmosphere and/or solar wind.

It is sufficient to demonstrate the above concepts in simple models; the use of a sophisticated model may be desirable, but is not required. It is anticipated that selected PIs will collaborate and identify specific time periods to model, for comparison between and validation of the different approaches.

Interactions with User Communities: To facilitate useful validation activities and communication of the results to user communities, the LWS Program Officer will contact relevant modeling/operational centers to identify liaisons for the project. Liaison(s) will be encouraged to participate in the annual meetings.

3.1.2 Characterization of the Earth's Radiation Environment

Target Description: The Radiation Environment Strategic Science Area (SSA-6) and the Geomagnetic Variability Strategic Science Area (SSA-1) outline broad needs for advancing the characterization of the science of the radiation environment in a varying environment. The radiation environment between the troposphere and outer magnetosphere can change rapidly due to varying galactic cosmic ray (GCR) and solar energetic particle (SEP) influx. This environment can also be affected by solar wind pressure effects due to high-speed streams (HSS), coronal mass ejections (CME), and periods of southward interplanetary magnetic field (IMF). The GCR background is typically variable on the timescale of days with a long-term trend that changes slowly and is modulated by the solar IMF varying with the approximate eleven-year solar cycle. The SEP environment can be highly time variable, with impulsive, order of magnitude changes associated with solar eruptive events occurring in a matter of seconds to minutes. HSS, CME, and solar wind pressure increases cause changes to the radiation belt environment on a scale of tens of minutes to days with the probability of occurrence of these events being dependent on the solar cycle. Together, the effect of these phenomena on the Earth's Magnetosphere–Ionosphere–Thermosphere (M-I-T) system, create the "weather" of the radiation environment.

Recent observations and modeling developments have permitted substantial progress in understanding the drivers and responses of the radiation environment. However, the variability and prediction potential of the coupled systems describing this radiation environment are not yet well quantified and this remains a long-term community research goal. First principles and empirically based models, combined with new data streams, are needed to achieve substantial progress toward future predictability. In the near-term, there is great value in comparing existing models and observational data sets for validation, leading to an ability to conduct ensemble modeling so as to characterize uncertainty in the radiation environment.

Goals and Measures of Success: The primary goal of this FST is to promote existing data–model comparisons for the global radiation environment, ranging from the lower atmosphere through the inner magnetosphere during quiet, active, and extreme conditions. An additional goal is to promote the continued innovative expansion, as well as development of calibrated data sources that can help understand the dynamic variation of this radiation environment in near real-time. A critical measure of success for investigations through this FST will be the demonstrated comparison of the temporal, spatial, and magnitude variability in the radiation environment, from tropospheric altitudes through the radiation belts, using observations and existing models reported with appropriate metrics of uncertainty.

Types of Investigations: This FST intends to bring together modelers and observers who can make significant progress toward validating existing modeling systems. This solicitation does not encourage the development of fundamentally new models at this time. Rather, the user communities, including Government agencies, international partners, and commercial airlines, have expressed strong interest in understanding the accuracy and uncertainty of existing models and data.

- This FST encourages proposers to make results of these comparisons available to users. Individual proposals may show how they support the FST with a systematic approach for comparing and validating modeling approaches that lead to model/observational validations.
- Investigations that can also validate calibrated dose and dose rate measurements at various altitudes and orbits for helping with these comparisons are especially solicited.
- Proposals that improve our understanding of radiation variability are particularly useful for improving future modeling and defining the sources of uncertainty.

Interactions with User Communities: NASA will facilitate interaction between selected teams and user communities. FST proposals should identify how research elements enable predictive developments that would be significant to specific user communities.

3.1.3 Studies of the Global Electrodynamics of Ionospheric Disturbances

Target Description: The large-scale electrodynamics of Earth's ionosphere reflects the state of magnetosphere–ionosphere convection, energy transport between the magnetosphere and ionosphere, and plays a key role in the dynamics of the ionosphere and thermosphere. This includes transport and heating of ionospheric plasma and the neutral atmosphere. At high latitudes the electrodynamics reflect magnetospheric convection and energy dissipation both via Joule heating and mechanical acceleration of the neutral gas. At middle and low latitudes, the electric field is largely generated by the thermospheric winds although during storm times the high-latitude dynamics can substantially impact the low- to mid-latitude ionosphere through penetration electric fields and storm-time dynamo winds. Ionospheric electrodynamics determine the energy dissipation that drives thermospheric upwelling, reflects the convection driver for plasmaspheric plumes and TEC evolution, and governs where intense ionospheric electric fields occur that drive a range of ionospheric irregularities causing scintillation. In addition, violent changes in the near space electric currents systems such as ionospheric currents, magnetopause current, and ring current drive rapid variations of the magnetic field on the surface of the Earth. These externally driven ground magnetic field fluctuations, or dB/dt, induce a geoelectric field on the surface of the Earth. The geoelectric field that is strongly dependent on, for example, local ground conductivity conditions drive geomagnetically induced currents (GIC) that can flow in power grids, pipelines, and railway systems. Large dB/dt can also hamper geophysical exploration surveys.

Deriving ionospheric electrodynamics applicable for storm times is, therefore, of particular importance to: LWS SSA-2 Physics-based Satellite Drag Forecasting Capability; SSA-4 Physics-based TEC Forecasting Capability; and SSA-5 Physics-based Scintillation Forecasting Capability.

Most existing theories and models of the global electric field in the ionosphere focus on regional scales (e.g., limited latitudinal ranges), assume equipotential field lines, and/or impose ad hoc or statistical boundary conditions that do not apply generally and, in particular, not to storm conditions. Quantifying dissipation and neutral wind dynamics, distinguishing between heating and mechanical acceleration, and understanding the relationships of electrodynamics to particle precipitation require concurrent knowledge of ionospheric conductivities. Measurement of the global electric field, field aligned currents, and ground magnetometer equivalent ionospheric currents can be used to solve ionospheric electrodynamics to infer the effective conductivities. However, in practice, differences in spatial and temporal coverage, and sampling cadence require use of assimilative approaches, including as much information as possible for the conductivities and electrodynamics in under-sampled regions. In addition, the role of interhemispheric connectivity is often overlooked despite evidence of conjugate effects at subauroral latitudes. To advance SSA-2, 3, and 5, it is critical to quantitatively characterize storm-time ionospheric electrodynamics observationally and validate existing empirical and physics-based models against the most complete suite of observations possible.

Now is an opportune time to focus attention on this topic and overcome the deficiencies noted above, given recent advances in modern computer technology and computational algorithms, and contemporaneous observations from space- and ground-based resources. This Focused Science Topic targets the determination of storm-time ionospheric electrodynamics from observations as fully as possible using these recent data sets and quantitatively testing existing empirical and physics-based models, and deriving advances in modeling capabilities to improve quantitative predictive capability.

This FST should motivate future research into the roles of neutral winds and auroral structuring for ionospheric electrodynamics. In particular, characterizing the role of neutral winds in modifying energy transport and dissipation, and the contributions of smaller scale field and precipitation structures (below ≈10s of km) in altering energy dissipation and creating density irregularities may be significant.

Goals and Measures of Success: The goals of this FST are to provide an improved understanding that would enable a predictive capability of storm-time ionospheric electrodynamics. Specifically: (1) assess storm-time ionospheric electrodynamics from observations including the ionospheric conductivity, currents, and electric fields; (2) quantify the validity of existing empirical and physics-based models of ionospheric electrodynamics; (3) identify key areas of discrepancy and assess techniques, including potentially data-assimilation, to incorporate available data into ionospheric/thermospheric models and to infer external forcing where not well measured. All studies must consider uncertainty analysis and how the sources of error impact the results.

Types of Investigations: This FST intends to bring together modelers and observers who can make progress toward deriving storm-time ionospheric electrodynamics, validating existing models, and identifying and/or substantially improving existing modeling systems. Efforts are solicited in several areas: a) derivation of ionospheric electrodynamics from the broadest available suite of observations; b) empirical and/or first-principle theory and modeling of the global electrodynamics of the ionosphere for comparison against the observationally constrained electrodynamics; c) further development/assimilation of global data sets into the models to advance the capability to predict storm-time ionospheric electrodynamics; d) studies that translate modeled or observed global electrodynamics to magnetometer and/or GIC measurements that can be validated on the ground.

Interactions with User Communities: NASA will facilitate interaction between selected teams and user communities. FST proposals should identify how research elements enable predictive developments that would be significant to specific user communities.

4. Cross-Discipline Infrastructure Building Programs

The Cross-Discipline Infrastructure Building element, which includes summer schools, postdoctoral fellowship programs, and community workshops, is fully subscribed from ROSES-15 and will not be competed in ROSES-2016. Focused Science Topics proposals should not include workshop support or other travel beyond necessary team intercollaboration.

5. Submission and Evaluation Process

5.1 Step-1 Proposals

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 *Summary of Solicitation Section IV. (b) vii*).

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’s Authorized Organizational Representative (AOR). No budget or other elements are required. Only proposers who submit a Step-1 proposal are eligible to submit a 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.

5.1.1 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 Focus Team Effort."

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 E-mail when they are able to submit their Step-2 proposals.

5.2. <u>Step-2 Proposals</u>

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, 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 noncompliant letter are not eligible to submit a Step-2 proposal.

5.2.1 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 7 below).
- 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. The criterion for relevance includes relevance to one of the Focused Science Topics in Section 3 and is an essential requirement for selection. As such, NASA has instituted a compliance check as described below.

In order to be compliant with this ROSES element, each FST Step-2 proposal submitted must contain a section that must be entitled "Proposed Contributions to the Focus Team Effort" and identified in the proposal's table of contents. Failure to include this section will result in the proposal being judged noncompliant, and the proposal will be returned without review. This section must include the following three items:

- The relevance of the proposal to the scientific objectives of the Focused Topic.
- The potential contributions (e.g., data sets, simulation results, understanding of physical mechanisms, etc.) from the proposed effort to the Focused Science Team's effort.
- Metrics and milestones for determining the successful progress and outcome of the proposed research.

5.2.2 Step-2 Evaluation Criteria

Compliant proposals will be evaluated according to the criteria specified in Section VI(a) of the *ROSES Summary of Solicitation* and section C.2 of the *NASA Guidebook for Proposers*. These criteria are (1) intrinsic scientific/technical merit and (2) work effort realism/reasonableness. In addition, the relevance of the proposed science goals and objectives to those of the FST will be evaluated.

Work effort 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. 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."

For Focus Science Topics described in Section 3.1, the evaluation for relevance is dependent on the particular Focus Science Topic. Each proposal must demonstrate that the investigation is appropriate for the FST selected. This will be strictly enforced. In addition, each proposal submitted must contain a section, entitled "Proposed Contributions to the Focus Team Effort" and it must be identified in the proposal's table of contents. Failure to include this section may result in the proposal being returned without review.

6. 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 Summary of Solicitation*, Section II (a).

7. Summary of Key Information

Expected annual program budget for new awards	~$3.75 M
Number of new awards pending adequate proposals of merit	~15-20
Maximum duration of awards	Focused Science Topics: 4 years
Due date for Step-1 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for Step-2 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
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 Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the Heliophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA. Responses to the FSTs must also show relevance to the specific FST described in section 3.
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 Section 3.3 of 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	NNH16ZDA001N-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 E-mail: jeff.s.morrill@nasa.gov Elsayed Talaat Heliophysics Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-3804 E-mail: elsayed.r.talaat@nasa.gov

B.7 HELIOPHYSICS DATA ENVIRONMENT ENHANCEMENTS

NOTICE: Proposals to this program will continue to be taken by the two-step process in which the Notice of Intent is replaced by a required Step-1 proposal submitted by an Authorized Organizational Representative (AOR). Only proposers who submit a Step-1 proposal are eligible to submit a Step-2 (full) proposal. The title, science goals, and investigators cannot be changed between the Step-1 and Step-2 proposals. Step-1 proposals will be checked for compliance, but will not be peer reviewed. All Step-1 proposers will be permitted to submit a Step-2 proposal, unless the Step-1 proposal has been determined to be noncompliant with program requirements. See Section 3 for details.

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 Sections 2.2 and 2.3, 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 goal of the H-DEE program is to enable breakthrough research in Heliophysics by providing both a state of the art data environment necessary to maximize the scientific return of the NASA missions.

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* (http://nasascience.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 dealing with the "DRIVE" initiative, more specifically "R" and "I," and the discussion in Appendix B of the Decadal linked above.

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. <u>Heliophysics Data Environment Enhancements (H-DEE)</u>

The basic building blocks of the NASA Heliophysics Data Environment 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 by recent missions in a variety of ways from specialized web sites. One aspect of this call solicits proposals to upgrade older datasets that are of continuing value (Data Upgrades) and to support the continued serving of data from recent missions in the context of groups that understand the data and can help with its use (Resident Archives). As NASA mission data become better documented and formatted in standard ways, the need for Resident Archives continues to decrease, although in cases where data use is still demonstrably high and the products are complex, there may still be utility in supporting these intermediate archives for some time before the data transition to a Final Archive.

As detailed in the Heliophysics Scientific Data Management Policy (found at http://hpde.gsfc.nasa.gov), which gives further information about the Heliophysics Data Environment (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. 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 recent years, NASA HP has developed standard ways of registering, 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. Registration 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 will require SPASE descriptions and, as needed, contact the SPASE group or the HP Data Archives to develop a plan 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 generally 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. Resident Archives should work toward these formats as well, and some portion of their budget may be devoted to this.

In summary, the Data Upgrades subelement of this program solicits proposals designed to upgrade existing Heliophysics data products to improve the quality, utility, and accessibility of datasets relevant to Heliophysics research. Possible upgrades could include (but are not limited to) placing datasets online, translating datasets into more readily accessible hardware and/or software formats, improving the data quality, providing data access and interpretation tools, and improving metadata. Note that the term "dataset" can apply not only to data products derived directly from NASA-funded instruments or other instrumentation, but also to higher-level datasets derived from the results of data analyses, data assimilation, and modeling.

Also solicited are proposals for Resident Archives (RAs), which would typically have a period of award no longer than two (2) years, featuring data from Heliophysics missions that have terminated or will soon terminate. These are intended to continue access to data with expert help until the data are sufficiently documented for independent use and are moved to a Final Archive. When RA access is no longer deemed necessary, the final legacy data files will be served from one of the Final Archives, namely the Space Physics Data Facility (SPDF) and the Solar Data Analysis Center (SDAC—see above). The increasingly common practice of entering mission data into HP final archives in standard formats before the mission is over has reduced the need for RAs, which were primarily intended to avoid the loss of access to data that had often occurred when past HP missions terminated. Arguments for the need for RAs should be framed in this context.

Returning this year after a number of years' absence is a call for Value Added Enhancements to the HPDE. The HPDE infrastructure, established over the last decade by the HP Archives and the "VxOs" (Virtual Observatory for subfield "x"; e.g., Virtual Solar Observatory), is now making possible enhanced capabilities such as the Internet retrieval of most datasets directly by user applications; the uniform plotting and manipulation of data from many sources in a single application; the retrieval and plotting of data in a wide range of formats; the search for datasets by time, region, measurement type, time resolution, etc., and their subsequent retrieval; the direct comparison of measured and simulated quantities; and the generation of multisource movies of events using Internet data sources. Some of these capabilities have become established and are now funded as infrastructure. However, other applications are possible, and this call invites innovate plans for exploiting current and planned HPDE capabilities. Much is still to be done, for example, to efficiently exploit the huge data volumes being generated by current spacecraft and simulations. There will be no restrictions on the type of enhancement or its scope, except to say that it must fit within the funding guidelines, it must make use of existing or planned HPDE infrastructure, and the wider the range of researchers likely to use the capability the better.

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 anticipated readiness of needed technologies, 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 or other resources supported or enhanced;
c. Metadata and documentation of products and required ancillary data or enhancements;
d. Infrastructure and constraints assumed in place at the time of implementation;
e. Use of standard data formats; and
f. Compatibility with the Space Physics Archive Search and Extract (SPASE) Data Model.

All proposals are expected to result in significant enhancements and products within the grant period. The total funding available for awards will be approximately $1M, with about half of the money going toward Value Added Enhancements. It is expected that Data Upgrades will be for up to $50K for one year and Resident Archives up to $50K per year for two years. Proposals requesting higher levels of funding and/or longer periods of performance must show sufficient justification for such requests. It should be noted that although the allotment for RAs is up to $50K, it will not be practical to support each instrument on all the NASA HP missions as they retire at this level; efforts should be made to use economies of scale (e.g., combining with existing or other proposed RAs), the resources of the Final Archives, and other means to contain costs. Value Added Enhancement proposals can be for up to three years, and they must clearly justify whatever level of funding is requested.

Submitting a proposal to this solicitation implies that if an award is made, a copy of any data product will be made public, preferably via one of the two discipline archives: the Space Physics Data Facility (SPDF), or the Solar Data Analysis Center (SDAC). Any proposal that would create a data product should include a brief data sharing plan regarding how it would be publicly archived. Proposers that include a plan to archive data should allocate suitable time for this task.

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 Sections 2.2 and 2.3, below.

2.2 Data Upgrades Proposals

Funding in this area 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, 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 original PI team.
- *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 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.
- *Data Description*: 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 data center, 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.
- *Need for Resources*: A discussion that demonstrates that the requested resources are necessary and sufficient for success in achieving the proposed upgrade. If the product is ongoing, the plan for supporting the continuation should be stated.

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 titles of proposals submitted to this portion of the solicitation must contain the words "Data Upgrade." The Scientific/Technical/Management section (including figures) of proposals submitted to this portion of the solicitation shall be no more than five pages.

2.3 Resident Archive Proposals

Funding will support modest awards, typically for up to two years, to continue existing data services, in "Resident Archives." A Resident Archive (RA) will be created to continue to serve mission data or a subset of a mission’s data (e.g., data products for a single instrument) after the mission has ended. This arrangement is intended to keep those most familiar with the data and its caveats involved such that a user will have access to expert assistance in using the data for research. There is no restriction (other than those for this solicitation) on who can apply for an RA for a particular set of products or on possible arrangements with other RAs or data centers.

A Resident Archive proposal must include:

- A statement of the scope of the RA, including the data products and services to be included.

- Arguments for why the data should still be served by the Principal Investigator (PI) team or a closely associated team knowledgeable about the data, rather than directly deposited in a Final Archive. These should demonstrate the science value of the data to qualitatively significant ongoing or future investigations as indicated, e.g., by refereed publications, specific research project suggestions, and/or the use of the data by researchers outside the proposing team.
- A description of how the RA will ensure that the mission data are served to the general community in an efficient and scientifically useful manner consistent with the community data environment guidelines. While level zero data plus on-the-fly processing may be used for serving, it is expected that a set of "legacy products" in physical units and accessible formats will also be available and served.
- A plan to maintain the integrity of the data by safeguarding against data loss; this could be achieved by a number of approaches, including the use of mirror sites, backup storage at the HP Data Archives or elsewhere, as well as with such tools as checksums. (See the criteria for a good archive in the HP Data Policy, Appendix F, Section F.4.)
- A statement of the relationship of the RA to the HPDE and of the related plan to produce SPASE descriptions of products.
- A statement of the type and amount of expert assistance with data issues to be provided.
- An inventory of documentation to be provided for data, calibration, and validation methods; and for the mission, observatory, and instrument(s), along with a demonstration that these are adequate to assure the data will be independently usable.
- Considerations of potential cost-savings and increased utility through collaboration with others, including other investigator teams, existing or proposed RAs, NASA Data Archives, or other data centers.
- A plan to obtain community input to ensure success and make improvements.
- A plan for transitioning the data to a Final Archive.
- A demonstration that the resources requested will be necessary and sufficient to perform the RA functions. Proposals are expected to make use of economies of scale, when appropriate, by combining related serving functions across related data products (related by, e.g., mission, data type, institution, personnel, etc.).

Activities that are not to be proposed for a Resident Archive would be the generation of significant upgrades to the datasets, reprocessing data, upgrading data processing algorithms, or providing new data products derived from the resident data. These types of postmission data activities need to be funded from other sources (in some cases, this could be through a separate Data Upgrade). However, the functions of a Resident Archive could include "loading" newly derived data products into the archive with appropriate changes to metadata, documentation, web interfaces, etc.

The proposal should maintain reserves such that, if the Resident Archive award is not renewed or is subsumed under another RA structure, the RA would transfer the data to the other RA or a Final Archive. The RA proposal shall include a plan for such transfer to a Final Archive in a manner that will still allow data access to at least the basic legacy data files.

The titles of proposals submitted to this portion of the solicitation must contain the words Resident Archive. The Scientific/Technical/Management section (including figures) of proposals submitted to this portion of the solicitation should be no more than ten pages.

2.4 Value Added Enhancement Proposals

Proposals in this area will be for periods of performance from one to three years. The number of value-added enhancement proposals awarded will be consistent with available funding and the levels requested in the selected investigations.

A proposal for a value-added enhancement to the HPDE should include:

- An argument for why the enhancement is scientifically important to a broad range Heliophysics researchers.
- Evidence that the enhancement is new and will likely be used, with use cases and supporting evidence.
- A clear link to the HP Data Environment and in particular the details of how the enhancement will inherently use the capabilities of the HDPE infrastructure (i.e., standard formats for data and metadata and existing or planned data access and service APIs). The relationship of the enhancement to the SPASE data model should be stated.
- Evidence that the enhancement is required and would not, for example, be better done as a one-time effort by a data provider and that it is not already being implemented by another project (including possibly at another agency or in another country) or by an HP Data Archive.
- An argument for why the enhancement is located at provider sites, some other site(s), or would be a downloadable tool; any or all of the above are possible.
- A plan with an estimate of associated costs that states what capabilities would be provided for the long term (beyond the grant period), including assurances of longevity. This could involve using a continuing non-NASA site or the integration with HP Data Archives.
- A plan for implementation of the enhancement that will lead to useful results within the proposed time and that states why the requested resources are necessary and sufficient for success. It is expected that the project will produce results that the community can use and test well before the end of the project, both to be helpful to the community and to assure that the development meets real user needs.
- A plan for community input and feedback on the utility and functionality of the enhancement and for the incorporation of the feedback into the development process.

The titles of proposals submitted to this portion of the NRA should contain the words "Value Added Enhancements." The Scientific/Technical Management Section (including figures) of proposals submitted to this portion of the NRA should be no more than 15 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.

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 E-mail 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 noncompliant letter 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 is important to get the additional mail-in reviews to cover all proposals fairly.

3.2.1 Step-2 Proposal Format

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 *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation*.

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 ground-based data, upgraded data, or archived data in conjunction with other HSO resources (2) the importance of the problems, and (3) the details of the technical approach to providing the promised data or archival enhancements. Proposals should be clear on how data will be made to conform to the Heliophysics Data Policy.

3.2.2 Step-2 Evaluation Criteria

Step-2 proposals that are not complaint with format requirements may be rejected without review. See Section IV (b) ii of the *ROSES Summary of Solicitation* and the *NASA Guidebook for Proposers* for details. (1) If applicable for this solicitation, proposers must select the subelement that is appropriate for their intended proposal; proposals that are not appropriate for the chosen subelement may be declared noncompliant. (2) Proposals outside the scope of this solicitation may be declared noncompliant.

Compliant proposals will be evaluated according to the criteria specified in Section C.2 of 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 and appropriate for future investigations, 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 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 the particular activity: Data Upgrade vs. Resident Archive vs. Value-Added Enhancements. Each proposal must demonstrate that the investigation is appropriate for the specific activity selected.

Cost realism/reasonableness will include 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 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 $1M will be made available to support new selections for Data Environment Enhancements, to be divided more-or-less equally between Upgrades/RAs and Value Added Enhancements. It is expected that about 10-12 new selections will be made with funds of the next fiscal year, with between one and four being for Value Added Enhancements (VAEs).

5. Summary of Key Information

Expected program budget for first year of new awards	$1M H-DEE
Number of new awards pending adequate proposals of merit	~10-12
Maximum duration of awards	For Data Upgrades: 1 year For Resident Archives: 2 years For Value Added Enhancements: 3 years (but a shorter duration is encouraged).
Due date for Step-1 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.

Due date for full Step-2 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
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	H-DEE: See Section 2.; see also Chapter 2 of the *NASA Guidebook for Proposers.* Data Upgrade Proposals: 5 pages; Resident Archive Proposals: 10 pages; Value Added Enhancement Proposals: 15 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	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 Step 1 and Step 2 proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposals via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH16ZDA001N-HDEE
NASA points of contact concerning H-DEE Call	Jeffrey J. E. Hayes Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0353 E-mail: jhayes@nasa.gov and D. Aaron Roberts Heliophysics Science Division Code 672 Goddard Space Flight Center Greenbelt MD 20771 Telephone: (301) 286-5606 E-mail: aaron.roberts@nasa.gov

B.8 MAGNETOSPHERIC MULTISCALE GUEST INVESTIGATORS (MMS-GI)

NOTICE: This program will accept proposals 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). Only proposers who submit a Step-1 proposal are eligible to submit a Step-2 (full) proposal. Step-1 proposals will be checked for compliance, but will not be reviewed. See Section 3 for details. Step-2 proposals will be limited to ten pages. Only investigations focused on Magnetospheric Multiscale (MMS) data are permitted.

1. Scope of Program

The Heliophysics Guest Investigators program is a component of the Heliophysics Research Program. Heliophysics Guest Investigators consists of two ROSES program elements. The Open Heliophysics Guest Investigator (H-GI program element B.4) is offered for investigations that draw extensively upon the data sets from the missions of the Heliophysics System Observatory (HSO). This program element, the Magnetospheric Multiscale Guest Investigator (MMS-GI) program (B.8), is offered only for investigations that primarily use data from the Magnetospheric Multiscale (MMS) Mission, which was launched in March 2015 and is in the second year of its two-year primary mission phase.

1.1 Overview

Five Heliophysics Senior Review panels and the recent Decadal Survey have reviewed the H-GI program in the context of the activities of the operating missions. The reviews have uniformly endorsed a strong H-GI program to complement the mission-sponsored investigations (See http://science.nasa.gov/heliophysics/senior-review/for the reports of the Senior Review panels). Additionally, the most recent decadal survey (See http://www.nap.edu/catalog.php?record_id=13060) endorsed a substantial increase in resources for mission specific calls under the GI program. Those are and will be solicited through this program element, this year called the MMS-GI program. This call is part of the implementation of the Diversify, Realize, Integrate, Venture, Educate (DRIVE) initiative recommended in the aforementioned decadal survey.

This particular ROSES element supports investigations whose primary focus is the analysis of MMS data. Proposals should use primarily MMS data to address (1) the goals of the MMS mission (found at https://mms.gsfc.nasa.gov/about_mms.html) or (2) any of the relevant goals of the Heliophysics Decadal survey (Solar and Space Physics: A Science for a Technological Society http://www.nap.edu/catalog.php?record_id=13060):

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.

This program is intended to maximize the scientific return from this recently launched mission by providing support for research of a breadth and complexity beyond presently funded investigations. As with the open element of the H-GI program, investigations may employ theory, models, and data from other sources, as needed, to interpret and analyze NASA's MMS data, but only as a secondary emphasis. That is, in any such instance, the proposal must clearly demonstrate that the theory, models, and/or data in question are necessary for interpretation of the MMS data and are not themselves the primary object of the investigation. Development of new models and theories is not solicited.

The MMS mission relies on four spacecraft with an identical set of 11 instruments comprised of 25 sensors. The four spacecraft fly in an adjustable, pyramid formation that enables them to observe the three-dimensional structure of magnetic reconnection. Four spacecraft give MMS the necessary observational perspectives to determine whether reconnection events occur in an isolated locale, everywhere within a larger region at once, or traveling across space. In addition to crossing the dayside magnetopause in search of reconnection, MMS has captured ~400 crossings of Earth's bow shock and has spent time in the near magnetotail observing e.g., dipolarization events and injections. See https://mms.gsfc.nasa.gov/ for additional information on the mission.

1.2 Avoidance of Duplicate Investigations

Proposers should be aware that the mission science teams are already funded to do a substantial amount of research. Proposals whose intent or purpose is to duplicate or directly supplement existing investigations already funded for approved space flight missions or other Heliophysics research programs are not appropriate for either element of the H-GI program. However, it should be noted that proposals aiming at providing independent analysis of investigations conducted by the mission team are compliant with all elements of the H-GI program. A Principal Investigator (PI) or a Co-Investigator (Co-I) on MMS may also propose as a PI or Co-I to this program element. However, such Heliophysics mission personnel must include in their proposal a description of their mission duties and clearly distinguish the proposed new activity from their existing responsibilities for mission operations and data analysis.

1.3 Data Availability

To be compliant with data availability requirements outlined in B.1, investigations proposed to this ROSES element must only propose to use MMS data products that are publicly available. Proposals that intend to or can only be completed with data products that are not publicly available will be declared noncompliant. Data products from all other missions fall under the requirements specified in B.1 and must, therefore, be available in a public archive 30 days prior to the Step-2 deadline.

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. Proposals utilizing a Science PI must mark that individual as such in NSPIRES and the individual must be named. Co-investigators (Co-Is) must each have a specific and defined task in the project, and the task must be essential to completion of the project. Use of collaborators is discouraged. Proposals may be declared noncompliant based on either the Step-1 or Step-2 proposal if they a) do not adhere to the requirements outlined above, b) are outside the scope of the MMS-GI program (see Section 2.2 below), or c) fail to meet submission guidelines specified below (Section 3)

2.2 Limitations and Scope

Proposals outside the scope of MMS-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 MMS;
- 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.

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 program by using MMS data to address 1) the goals of the MMS mission or 2) the relevant 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 E-mail when they are able to submit their Step-2 proposals.

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.

3.3 Step-2 Proposal Format

The process for preparation and submission of the Step-2 (full) proposals is the same for any other ROSES proposal. Guidelines for content and formatting full proposals are specified in Table 1 of ROSES and the *NASA Guidebook for Proposers* and the *ROSES Summary of Solicitation*.

Proposals are restricted to ten (10) pages for the Scientific/Technical/Management section and must include the following sections with the preferred order:

- The science objectives and perceived impact of the proposed work to the state of knowledge in the field; references to existing work in the field should be limited to that which is needed to justify the value of the science proposed;
- The data and methodology to be employed in conducting the proposed research; the proposal must demonstrate (1) that the data is appropriate to address the science

objectives and (2) that the methodology is both appropriate and feasible to make substantial progress on the science objectives;

- The relevance of the proposed work to the goals of the program. This section must demonstrate how the proposed work uses MMS data to address 1) the goals of the MMS mission or 2) the relevant Decadal survey goals.
- 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 length specified in this Program Element (See Section 7 below).
- 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 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 Section C.2 of the *NASA Guidebook for Proposers* and they are Relevance, Merit, and Cost. Clarifications and additions specific to this program element are listed below.

The evaluation of scientific and technical merit will include the following:

- Compelling nature and scientific priority of the proposed investigation's science goals and objectives, including the importance of the problem within the broad field of Heliophysics, the unique value of the investigation to make scientific progress in the context of current understanding in the field, and the importance of carrying out the investigation now.
- Appropriateness and feasibility of the methodology, including the appropriateness of the selected data, models, and analysis for completing the investigation and the feasibility of the methodology for ensuring scientific success.

Based on these two science and technical factors, the evaluation will consider the overall potential science impact and probability of success of the investigation.

Relevance to and priority within the MMS-GI program will be assessed based on criteria discussed above. 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. <u>Available Funds</u>

It is expected that there will be approximately ~$1.3M available in Fiscal Year (FY) 2017 to support new Heliophysics GI MMS investigations selected through this solicitation. Annual funding is expected in the range ~$125-175K per investigation per year.

5. <u>Award Types</u>

As begun in 2013, the MMS-GI program will primarily award funds through three vehicles: (1) grants, (2) interagency transfers, and (3) awards to NASA Centers. The MMS-GI program will not award contracts, because it is not appropriate given the nature of the work solicited. An institution that has received a contract previously can receive funds as a grant by not charging a fee.

6. <u>Summary of Key Information</u>

Expected annual program budget for first year of new awards	~$1.3M; See Section 4
Number of new awards pending adequate proposals of merit	~8-10
Maximum duration of awards	3 years; shorter-term proposals are allowed

Due date for Step-1 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for full Step-2 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Page limit for the central Science-Technical-Management section of proposals	10 pp; see also Chapter 2 of 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	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguide book/.
Submission medium	Electronic proposal submission is required; no hard copy is permitted. See also Section IV in the *ROSES Summary of Solicitation* and Section 3.3 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 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	NNH16ZDA001N-MMSGI
NASA point of contact concerning this program	Errol J. Summerlin Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358 1257 E-mail: errol.summerlin@nasa.gov

B.9 HELIOPHYSICS GRAND CHALLENGES RESEARCH-SCIENCE CENTERS

NOTICE: The Heliophysics Division no longer plans to offer Heliophysics Grand Challenges Research Program Science Centers as program element B.9 of ROSES-2016. Instead, NASA anticipates that this program element will be included in ROSES-2017.

Contact Information

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B.10 HELIOPHYSICS U.S. PARTICIPATING INVESTIGATOR

NOTICE: Amended on August 9, 2016. This amendment delays the Step-1 proposal due date for B.10 Heliophysics U.S. Participating Investigator from August 16, 2016, to August 19, 2016 to coincide with the corresponding SALMON-2 due date and give time for Step-1 proposal preparation after the preproposal conference on August 15, 2016. The Step-2 proposals due date remains unchanged, at October 14, 2016.

Amended on July 13, 2016. This amendment presents a new program element in ROSES-2016: B.10 Heliophysics U.S. Participating Investigator (H-USPI) Program, released in conjunction with the SALMON-2 AO PEA Q: Heliophysics Explorer Mission of Opportunity. Step-1 proposals are due by August ~~16~~ 19, 2016, and Step-2 proposals are due October 14, 2016.

1. Scope of Program

1.1 Introduction

This ROSES program element for Heliophysics Explorer U.S. Participating Investigator (H-USPI) is released in conjunction with the Second Stand Alone Mission of Opportunity Notice (SALMON-2) Announcement of Opportunity (AO) Program Element Appendix (PEA) Q: 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 this program element must comply with the requirements in this ROSES-2016 NASA Research Announcement (NRA) and in this Heliophysics Explorer USPI program element. Proposals submitted in response to this solicitation are not required to comply with the requirements in the SALMON-2 AO.

Proposals submitted in response to the SALMON-2 AO PEA Q 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://nasascience.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).

1.2 Science and Program Objectives

NASA solicits proposals for Explorer USPI investigations that address any heliophysics objective as outlined in Section 1.1 of this program element. Investigations that address NASA goals in other areas, such as Earth science, planetary science, or astrophysics, are not solicited in this program element.

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 as a Partner Mission of Opportunity (PMO) proposal through the Heliophysics Explorer Mission of Opportunity described in Program Element Appendix Q of the SALMON-2 AO.

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. Submission and Evaluation Process

3.1 General Considerations

Each Principal Investigator (PI) is allowed to submit one and only one proposal to this solicitation. In that proposal, the Principal Investigator must invest a substantial portion of his/her time, of order 10-20%, to the investigation. Co-Investigators must each have a specific and defined task in the project, and the task must be essential to completion of the project. Use of collaborators is discouraged. Proposals may be declared noncompliant based on either the Step-1 or Step-2 proposal if they are outside the scope of the USPI program (3.2 below) or if they fail to meet submission guidelines specified below (3.2, 3.3, and 3.4).

3.2 Step-1 Proposals

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 *Summary of Solicitation Section IV. (b) vii*).

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. Full (Step-2) proposals must contain the same scientific goals proposed in the Step-1 proposal. The Step-1 proposal title, Principal Investigator, and all co-investigators, collaborators, and consultants cannot be adjusted between in 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.

3.2.1 Step-1 Proposal Format

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 notified by E-mail 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-USPI 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.

3.2.2 Step-1 Evaluation Criteria

Step-1 proposals may be declared noncompliant if they are outside the scope of the H-USPI program as described 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.

3.2.3 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 can be supplied through NSPIRES Program Specific Data Questions when submitting a Step-1 proposal.

3.3 <u>Step-2 Proposals</u>

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 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, and consultants 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 noncompliant letter are not eligible to submit a Step-2 proposal.

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.

3.3.1 Step-2 Proposal Format

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 is appropriate to address the science objectives and (2) that the methodology is both appropriate and feasible to make substantial progress on the science objectives;
- The relevance of the proposed work to science goals 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 named.

3.3.2 Step-2 Evaluation Criteria

Step-2 proposals that are not compliant with format requirements may be rejected without review. See 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 Section C.2 of 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-USPI program will be assessed based on criteria discussed in Section 1. Each proposal must demonstrate that the investigation is relevant and of high priority. As requested in the Guidebook for Proposers, cost realism/reasonableness will be evaluated based on the amount of work to be accomplished versus the amount of time proposed

3.4 <u>Technical Requirements and Constraints</u>

In addition to the requirements given in ROSES, all proposed investigations must also demonstrate: (1) their formal relationship with the sponsoring agency's mission (e.g., selected participant, invited participant, or proposed participant); (2) the status of the mission within the sponsoring agency (i.e., Preliminary Study (Pre-Phase A); Concept Study and Technology Development (Phase A); Preliminary Design and Technology Completion (Phase B); Final Design and Fabrication (Phase C); System Assembly, Integration and Test, and Launch (Phase D); Operations and Sustainment (Phase E)), including the level of commitment that the sponsoring agency has made to complete development; (3) a description of the type and the characteristics of the data from this investigation, as well as any ancillary science data, that will be archived as part of this investigation, and a description of the arrangements and resources included in the proposal to ensure the timely delivery of the necessary data in the required format; and (4) a detailed explanation of how the heliophysics science community benefits from this participation.

4. Available Funds

For individual investigators, the cost for selected proposals is expected to be on the order of $125K per selected investigation per year through the prime science mission phase, plus one year for additional data analysis and archiving for the baseline scientific investigation. For a team of investigators, the cost is expected to be on the order of $125K per investigator per year, up to a maximum combined team total of on the order of $500K per year, through the prime science mission phase, plus one year for additional data analysis and archiving.

Proposals must include archiving data such as raw data, reduced data (Level 2), instrument calibration data, observation geometry ancillary data, and derived products at an appropriate data archive.

NASA reserves the right to make no selection if there are no proposals of appropriate merit.

5. Maximum Duration of Awards

Proposals should be for the entire duration of the proposed investigation. This may be no more than through the prime science mission, plus one year for additional data archiving for the baseline scientific investigation. The budget justification in the body of the proposal should cover this entire period. Note that proposers can only enter the first five years of budget into the cover page of the NSPIRES web interface, but this is simply an artifact of the NSPIRES system.

6. Award Management

Awards will likely be executed directly from NASA Headquarters, although NASA reserves the right to implement them through a NASA Center in order to facilitate coordination with related flight projects that the Center may be carrying out.

7. Summary of Key Information

Expected program budget for first year of new awards	See Section 4
Number of new awards pending adequate proposals of merit	Up to two awards

Maximum duration of awards	Through the end of the Prime Mission plus one year for data analysis and archiving, see Section 5.
Due date for Step-1 Proposal	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for Step-2 (full) proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
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	See Section 2. Relevance Criteria. 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	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 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	NNH16ZDA001N-HUSPI
NASA points of contact concerning this program	Dan Moses Heliophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0558 E-mail: dan.moses@nasa.gov

B.11 Interdisciplinary Science for Eclipse 2017

NOTICE: The final version of this program element was released via Amendment 33 on September 28, 2016. Please note that it is Appendix E.5 and thus the final text is found elsewhere in this document.

Scope of the Program

The purpose of this solicitation is to support the development of new research or enhancement of existing research that leverages the Interdisciplinary Science For Eclipse (ISE) concept. NASA is seeking proposals that would connect the 2017 solar eclipse to underlying principles of physics and astronomy; the physics of the Sun, Earth and Moon; and space science. Building on existing partnerships within the target communities is especially encouraged. All proposals must demonstrate linkages to the 2017 solar eclipse and this can be done using traditional science and/or citizen science.

Point of Contact

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C.1 PLANETARY SCIENCE RESEARCH PROGRAM OVERVIEW

NOTICE: Corrected, July 26, 2016. The last paragraph of Section 3.5.2 has been changed again to require a letter of support from the appropriate Discipline Node indicating that the PDS is willing to accept the submission. New text is bold and deleted text is struck through.

~~**March 2, 2016. The last paragraph of Section 3.5.2 has been clarified to indicate that confirmation from Planetary Data System Discipline Nodes is not mandatory. New text is bold and deleted text is struck through.**~~

Table of Contents

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 Last Year

NASA ROSES-2016 (Research Opportunities in Space and Earth Sciences-2016) Appendix C.1 (Planetary Science Research Overview), this document, has been substantially revised. Proposers are encouraged to read C.1 in its entirety. Several changes to Appendix C.1 are highlighted here:

- Section 2 (Two-Step Proposal Submission Process) has been revised to update information regarding required components of a Step-1 proposal.
- Section 3.1 includes a revised description regarding the prohibition of duplicate proposals.
- Updated information regarding Data Management Plans (DMPs) is provided in Section 3.5.1. Note the addition of 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 3.6).
- Information pertaining to Planetary Major Equipment (C.17), Early Career Fellowships (C.16), and Topical Workshops, Symposia, and Conferences (E.2) has been added to Appendix C.1.
- The Habitable Worlds program is now a Cross-Divisional program with the Astrophysics Division (see Appendix E.4).
- No contracts will be issued for Program Elements covered by Appendix C.1, 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-2016, as well as to the cross-divisional research Program Element E.4 Habitable Worlds, but not E.3 the Exoplanet Research Program.

2. Two-Step Proposal 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 Appendix C.1 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 an 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 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.

2.1 Step-1 Proposal

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 Appendix C.1.

A Step-1 proposal must cover the following topics:

- The goals and/or 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, the proposer will be notified through NSPIRES whether the Step-2 proposal is "encouraged" or "discouraged," at which point the proposer will be able to submit 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.

2.2 Step-2 Proposal

Table 1 within the NASA ROSES solicitation provides a checklist of required information to be included in Step-2 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 formatting rules. Proposals that violate the rules may be rejected without review or declined following review if violations are detected during the evaluation process.

Note the order of precedence guidelines described in Section I(h) of the ROSES Summary of Solicitation: Guidebook and ROSES instructions may be superseded or modified by this document (Appendix 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 2.2 of the *NASA Guidebook for Proposers*:

- 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

For the Program Elements that use the two-step submission process, the full proposals are the Step-2 proposals. For other Program Elements, full proposals are simply the final proposals submitted for evaluation.

3.1 Prohibition on Duplicate Proposals

Proposers may not submit Step-2 proposals for the same or essentially the same work to more than one Program Element covered by Appendix 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-2015 proposal may not be submitted in response to ROSES-2016).

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.

Substantive changes to a proposed project or investigation that would result in it not being considered a duplicate proposal include aspects of the proposal that are covered by the Intrinsic Merit evaluation, e.g.,

- The proposing institution
- Funded investigators and unfunded Co-Investigators (Co-Is) who are performing a significant portion of the work
- Concepts, ideas, goals, and objectives
- Implementation (methods, approaches, instrumentation)
- Target (i.e., of measurements, observations, modeling)

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 either the technical officer of the current award or the point of contact for the Program Element most likely to be appropriate for the proposal.

3.2 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 and sufficiently 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 an explicit discussion of why it is impractical or impossible to complete such tasks within three years.

Note that no contracts will be issued for Program Elements covered by Appendix C.1 unless otherwise noted in the individual Program Element, e.g., C.13 MatISSE.

3.3 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. Investigators who are funded by the missions producing data to be used in the proposal must demonstrate how the proposed work does not overlap with data analysis, duties, or responsibilities already funded by their mission team(s).

3.4 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 Appendix 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 to which they have been submitted. Proposers are urged to consult the appropriate appendix for the program to which they are proposing for detailed information on whether an explicit relevance statement is required and/or how relevance will be evaluated.

3.5 Data Management Plans and Archiving

3.5.1 *Data Management Plans (DMPs)*

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, Appendix 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, and C.17) do not require DMPs.

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 3.5.2 of this document) must be included in the Statements of Commitment and Letters of Support, Feasibility and Endorsement (see ROSES Summary of Solicitation, Table 1). [Added July 26, 2016]**

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.

For proposals that use nonmission 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 physical objects (e.g., astromaterials or analog specimens, experimental run products, etc.), 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-2016, which will appear under "Other Documents" on the NSPIRES webpage for the Planetary Science Division Program Elements.

3.5.2 *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 ~~who are new to the process~~ 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-2016 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 the section for Statements of Commitment and Letters of Support, Feasibility and Endorsement (see ROSES Summary of Solicitation, Table 1).** ~~**Proposals must demonstrate an understanding of the work involved in preparing data for the PDS. This can be done through many avenues, including referencing past experience, but those who are new to the PDS are strongly encouraged to**~~ ~~obtain and include 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. **[This paragraph was updated March 2, 2016 and then again on July 26, 2016]**

3.6 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.

3.6.1 *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 mapping 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).

3.6.2 *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.

3.7 Access to the Antarctic

The National Science Foundation (NSF) manages the U.S. Antarctic Program. NASA, therefore, collaborates with the NSF in evaluating the logistics needs of research programs that request access to Antarctic field sites. To that end:

- Proposals requesting access to Antarctic field sites must justify their request on the grounds that Antarctica is the best or only location for their research.

- Proposals must include, as an appendix, a Logistical Requirements and Field Plan, which will be subject to peer review, outlining the PI's logistical requests associated with the proposed fieldwork. Proposals with fieldwork that lack this Plan are subject to return without review. The Logistical Requirements and Field Plan must include the following elements and should be limited to one page of text and one page of figures (if needed):
  - Brief statement of research objectives;
  - List of field sites and the geographic region where they are located. For remote sites, investigators should consider providing a map of proposed field sites;
  - Description of proposed field activities, including major logistical resources required (i.e., fixed-wing aircraft, vessels, helicopter support);
  - Description and justification of the desired deployment schedule;
  - Projected numbers of deploying personnel;
  - Description of any needs for facility construction, alteration, or instrument installation.

Further information on the U.S. Antarctic Program may be found at http://www.nsf.gov/geo/plr/ant/index.jsp.

Due to the scheduling of NASA and NSF review cycles, proposals requesting access to Antarctica should expect that their first field season would start six to twelve months after award. Proposals requiring Antarctic access in their first performance year may suggest a start date commensurate with this schedule.

3.8 Additional Funding for Relevant Instrumentation Construction or Upgrade

The Planetary Major Equipment (PME) Program Element described in 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 $40,000, must be requested according to the PME guidelines in C.17. Two types of instrumentation requests are permitted: (1) a PME request may be made as a special section that is appended to a new research proposal in an eligible program; or (2) a stand-alone PME proposal may be prepared and submitted to an eligible program. See C.17 for details on how to prepare both types of PME requests. Programs elements eligible for PME are:

- Emerging Worlds (C.2)
- Solar System Workings (C.3)
- Exobiology (C.5)
- Solar System Observations (C.6)
- Planetary Science and Technology from Analog Research (C.14)
- Planetary Protection Research (C.15)
- Laboratory Analysis of Returned Samples (C.18)
- Habitable Worlds (E.4)

3.9 Planetary Science Division Early Career Fellowship Program

The purpose of the Planetary Science Division (PSD) Early Career Fellowships (ECF) program (described in Program Element C.16) 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.

Proposers may request consideration for an ECF when proposing to participating PSD research Program Elements. To do so, the applicant may extend their Curriculum Vitae by up to one additional page to provide information that can be used by reviewers to evaluate the PI's future research contributions and the potential for leadership within the scientific community. Please see Program Element C.16 for more information on how to apply to the ECF program and the criteria for evaluating candidates.

3.10 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 nearest facility in care of the Director, Regional Planetary Image Facility. 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);

- o 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) Hayabusa1 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 Section 2.3 of 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/pal/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 research proposed to NASA sponsored programs through the ROSES-2016 announcement requires acquisition of new spectra 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: This Program Element continues to use a two-step proposal submission process described in Section 2 of Appendix C.1.

Research in the area of "Emerging Worlds" aims to answer the fundamental science question of how the Solar System formed and evolved, which may be addressed through studies of our Solar System, as well as planetary systems in general. 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.

1. Scope of Program

The Emerging Worlds program solicits research proposals to conduct scientific investigations related to understanding the formation and early evolution of our Solar System. It covers the physics and chemistry of events and materials that are relevant to the formation of planets, satellites, and minor bodies, including dust, and to the early history of these bodies.

For the purposes of this solicitation, formation encompasses events and processes that result in a significant change to the physical or chemical structure of the Solar System, the inventory of bodies in the Solar System (planets, satellites, minor bodies, rings, and dust), or the distribution of bodies in the Solar System. This includes, but is not limited to:

- Protoplanetary disk formation and evolution;
- Nebular transport mechanisms;
- Large-scale chemical and isotopic fractionation processes;
- Chemical and physical processing of gas, dust, and ice;
- Formation of organic molecules in space;
- Formation, accretion, and stability of Solar System bodies;
- The bulk properties of Solar System bodies;
- The chemical and physical properties of ancient materials (including asteroids and comets);
- The origins of meteorites and meteorite groups.

Early evolution includes, but is not limited to:

- Dynamical evolution of the Solar System;
- Early thermal and chemical processes occurring on small bodies regardless of whether or when they differentiated;

- Global differentiation — processes that result in the separation of bodies into compositionally distinct layers (including their atmospheres, cryospheres, and hydrospheres);
- Processes that occur on Solar-System bodies during the period of global differentiation;
- Planetary-scale events that affect global differentiation.

Also covered is the delivery of organic molecules and volatiles to planetary surfaces, including their abundances and preservation in accreting matter and their survival through the accretion process.

The types of studies that may be supported include:

- Theoretical investigations;
- Modeling investigations;
- Laboratory studies;
- Studies of chemical and isotopic properties of planetary materials;
- Studies of radiometric ages, magnetism, or radiation exposure effects;
- Mineralogical and petrologic studies of planetary materials;
- Studies of the bulk chemical and physical properties of small bodies.

2. <u>Programmatic Information</u>

2.1 <u>Exclusions</u>

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.

2.1.1 *Studies of Exoplanets*:

Most proposals to develop general theories or models of planets or planetary systems, as well as those focused on understanding exoplanetary systems, should be submitted to the Exoplanet Research Program (Program Element E.3). Only those proposals specifically focused on understanding our Solar System should be submitted to the Emerging Worlds Program Element.

2.1.2 *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).

2.1.3 *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.

2.1.4 *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), listed below. 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.

- *Moon*: Proposals using data from recent lunar missions may be appropriate for the Lunar Data Analysis Program (see Program Element C.8).
- *Mars*: Proposals using Mars mission data may be appropriate for the Mars Data Analysis Program (see Program Element C.9).
- *Cassini:* Proposals using data from the Cassini mission may be appropriate for the Cassini Data Analysis Program (see Program Element C.10).
- *Discovery*: Proposals that use Discovery mission data may be appropriate for the Discovery Data Analysis Program (see Program Element C.11).
- *New Frontiers*: Proposals that use New Frontiers mission data may be appropriate for the New Frontiers Data Analysis Program (see Program Element C.19).

2.1.5 *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, Hayabusa1), and on the development of analytical methods for samples returned from these or future 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.)

2.1.6 *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).

2.1.7 *Solar System Workings*:

Investigations into processes that occur late in the history of small bodies and after global differentiation on other bodies should be submitted to Solar System Workings (Program Element C.3).

2.2 Interdisciplinary Work

The Emerging Worlds program values the potential of interdisciplinary efforts to solve key scientific questions. To achieve this goal, proposals involving joint research efforts by investigators from different scientific communities are encouraged. Note, for interdisciplinary proposals involving observational studies of planetary systems outside our Solar System, tasks for those observations must only be a minor component of the proposed work; otherwise, such proposals should be submitted to the Exoplanet Research Program (Program Element E.3).

2.3 Duration and Size of Awards

Typical proposals to Emerging Worlds seek three years of funding or fewer. Please refer to Appendix C.1, §3.2, 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 two years of its existence (selections made from ROSES-2014 and ROSES-2015 proposals) averaged ~$160,000 per year, but with a wide range, depending on the nature of the work proposed. The 2014 and 2015 Emerging Worlds selections will be 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. Proposers should request what they actually need to conduct the research proposed.

Since this is a relatively new program with a new scope, the budget and expected number of new awards is somewhat uncertain, and it may depend on the distribution of topics proposed and the number of proposals submitted to each program. Of course, the number of new awards will also depend on the available budget. Awards resulting from proposals submitted to this program will be funded with Fiscal Year (FY) 2017 dollars.

2.4 Additional Funding for Relevant Instrumentation Construction or Upgrade

Proposers to Emerging Worlds are eligible to request funds for Planetary Major Equipment (PME). See Program Element C.17 for information on how to append a PME request to a regular Emerging Worlds research proposal or submit a stand-alone PME proposal to supplement an existing Emerging Worlds award.

2.5 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.

2.6 Planetary Science Division Early Career Fellowship Program

Proposals to this Program Element may include an application for an Early Career Fellowships (ECF). See Program Element C.16 for a description of the application and evaluation process.

2.7. Mission data, facilities, and resources

Refer to ROSES-2016 Appendix C.1, §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.

2.8 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.

2.9 Statement of Relevance.

Proposals to this Program Element do not require a separate or explicit statement of relevance. As stated in Appendix C.1, §3.4, all proposals, including those submitted to this Program Element, will be evaluated for relevance to the solicitation. Consequently, proposers are strongly encouraged to address the question of relevance in the Scientific/Technical/Management portion of the proposal.

2.10 Data Management Plans (DMPs)

Proposals submitted to this Program Element must include a Data Management Plan (see Appendix C.1, Section 3.5). 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.

2.11 Geologic Maps

Proposers who plan investigations involving geologic mapping should consult Appendix C.1, Section 3.6, 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.

2.12 Access to the Antarctic

Proposals to this Program Element must follow the rules given in Appendix C.1, §3.7, when requesting access to Antarctica.

3. Proposal Submission Process

This Program Element uses a two-step proposal submission process described in Appendix C.1, §2.

Proposers are reminded that Step-1 proposals are mandatory and must be submitted by the proposing organization

Proposals must follow all formatting requirements described Appendix C.1 and in Chapter 2 of the *NASA Guidebook for Proposers*. Note that these requirements have been updated in 2016. Violation of these rules is sufficient ground for a proposal to be rejected.

4. Summary of Key Information

Expected program budget for first year of new awards	~$4.5M
Number of new awards pending adequate proposals of merit	~28, see section 2.3
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 in the *Summary of Solicitation* of this NRA.
Due date for Step-2 proposals	See Tables 2 and 3 in the *Summary of Solicitation* of this 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 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 required. See also Section IV in the *ROSES Summary of Solicitation* and Chapter 3 of 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	NNH16ZDA001N-EW
NASA point of contact concerning this program	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: This Program Element requires an explicit statement of relevance, which will be collected in a mandatory (4000-character) text box on the cover pages via the NSPIRES web interface. See Section 3, below.

This Program Element continues to use a two-step proposal submission process described in Section 2 of Appendix C.1.

The calls for the Planetary Science Division's Data Analysis Programs have been clarified and, in some cases, slightly expanded in ROSES-2016. Proposers are expected to read the DAP solicitations before submitting to this Program Element any proposal that uses planetary mission data.

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. A wide range of investigations will be covered, including theoretical studies, analytical and numerical modeling, sample-based studies of extraterrestrial materials, field work, laboratory studies, and data synthesis relevant to the physical and chemical processes affecting planetary systems.

1. Scope of Program

The Solar System Workings program solicits proposals for innovative scientific research related to understanding the atmospheric, climatological, dynamical, geologic, physical, and chemical processes occurring within the Solar System. This 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 include data synthesis, 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, or theoretical 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 nonexhaustive list of areas of research called for in this solicitation 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 time scales.
- 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 nongravitational 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 the Emerging Worlds Program (Program Element C.2). 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 (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), listed below. Solar System Workings 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.

- *Moon*: Proposals using data from recent lunar missions may be appropriate for the Lunar Data Analysis Program (see Program Element C.8).
- *Mars*: Proposals using Mars mission data may be appropriate for the Mars Data Analysis Program (see Program Element C.9).
- *Cassini*: Proposals using data from the Cassini mission may be appropriate for the Cassini Data Analysis Program (see Program Element C.10).

- *Discovery*: Proposals that use Discovery mission data may be appropriate for the Discovery Data Analysis Program (see Program Element C.11).
- *New Frontiers*: Proposals that use New Frontiers mission data may be appropriate for the New Frontiers Data Analysis Program (see Program Element C.19).

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. Most proposals to develop general theories or models of planets or planetary systems, as well as those focused on understanding exoplanetary systems, should be submitted to the Exoplanet Research Program (Program Element E.3).

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 the Planetary Data Archiving, Restoration, and Tools (PDART) Program (Program Element C.7).

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 <u>Duration of Awards</u>

Typical proposals to Solar System Workings seek three years of funding or fewer. Please refer to Appendix C.1, Section 3.2, 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 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 Planetary Major Equipment (PME). See Program Element C.17 for information on how to append a PME request to a regular Solar Systems Workings research proposal or submit a stand-alone PME proposal to supplement an existing Solar System Workings award.

2.4 Planetary Science Division Early Career Fellowship Program

Proposals to this Program Element may include an application for Early Career Fellowships (ECF). See Program Element C.16 for a description of the application and evaluation process.

2.5 Relevance Statement Requirement

Step-2 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 Section 2.3.5 of 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. Proposal Submission Process

This Program Element uses the two-step proposal submission process outlined 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 in Chapter 2 of the *NASA Guidebook for Proposers*. Note that these requirements have been updated in 2016. 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 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

4.2 Facilities and Data Sources Available to Proposers

Please refer to ROSES Appendix C.1, Section 4, for a detailed list of the data and astromaterials resources, and facilities available to proposers to this Program Element, and how to use them. If their use is anticipated, this should be discussed and justified in the submitted proposals (especially note the provision for such discussion in the proposal section entitled Facilities and Equipment). Also note that, per the directions in Section 2.3 of 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 Appendix C.1, Section 3.5). 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 Appendix C.1, Section 3.6, 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 Access to the Antarctic

Proposals to this Program Element must follow the rules given in Appendix C.1, Section 3.7, when requesting access to 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 Step-1 proposals	See Tables 2 and 3 in the *Summary of Solicitation* of this NRA.
Due date for Step-2 proposals	See Tables 2 and 3 in the *Summary of Solicitation* of this 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 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. See Section 2.6 of this solicitation 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	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. See also Section IV in the *ROSES Summary of Solicitation* and Chapter 3 of 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	NNH16ZDA001N-SSW
Main E-mail address to which correspondence regarding this program may be directed	hq-ssw@mail.nasa.gov

NASA points of contacts concerning this program, all of whom share the following postal address: Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001	Mary Voytek Telephone: (202) 358-1577 E-mail: mvoytek@hq.nasa.gov Mitchell Schulte Telephone: (202) 358-2127 E-mail: mitchell.d.schulte@nasa.gov Jared Leisner Telephone: (202) 358-2016 E-mail: jared.s.leisner@nasa.gov William Cook Telephone: (202) 358-0976 E-mail: william.b.cook@nasa.gov Jennifer Stern Telephone: (301) 614-6062 E-mail: jennifer.c.stern@nasa.gov

C.4 HABITABLE WORLDS

NOTICE: The Habitable Worlds program is now a cross division program between Planetary Science and Astrophysics and, starting in ROSES-2016, 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
E-mail: mitchell.d.schulte@nasa.gov

C.5 EXOBIOLOGY

NOTICE: This Program Element continues to use a two-step proposal submission process described in Section 2 of Appendix C.1.

Proposals to this Program Element are subject to a relevance requirement in addition to and that supersedes those detailed in the ROSES-2016 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 roadmap, which can be found on the Astrobiology web page http://astrobiology.nasa.gov/roadmap.

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. 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 (Program Element 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 (Program Element 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 this program are eligible to request funds for Planetary Major Equipment (PME). See Program Element C.17 for information on how to append a PME request to a regular Exobiology research proposal or submit a stand-alone PME proposal to supplement an existing 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) Program (for technology readiness levels [TRLs] 1-3+) or the

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 Planetary Science and Technology from Analog Research (PSTAR) program (see Appendix C.14 and potential amendments thereto).

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 Section 2.3.5 of the *NASA Guidebook for Proposers* and the *ROSES-2016 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 Appendix C.1, §3.2, 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

Proposals to this Program Element may include an application for an Early Career Fellowships (ECF). See Program Element C.16 for a description of the application and evaluation process.

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 Access to the Antarctic

Proposals to this Program Element must follow the rules given in Appendix C.1, §3.7, when requesting access to Antarctica.

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

Refer to ROSES-2016 Appendix C.1, §4, for a detailed list of the data and astromaterials resources, and facilities available to proposers to this Program Element, and how to use them. If their use is anticipated, this should be discussed and justified in the submitted proposals (especially note the provision for such discussion in the proposal section entitled Facilities and Equipment). Also note that, per the directions in Section 2.3 of 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 Appendix C.1, Section 3.5). 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 Appendix C.1, Section 3.6, 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 Appendix C.1, §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 Appendix C.1 and in Chapter 2 of the *NASA Guidebook for Proposers*. Note that these requirements have been updated in 2016. 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	~$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 Step-1 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for Step-2 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
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	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. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
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	NNH16ZDA001N-EXO

NASA point of contact concerning this program	Michael H. New Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1766 E-mail: michael.h.new@nasa.gov

C.6 SOLAR SYSTEM OBSERVATIONS

NOTICE: This Program Element continues to use a two-step proposal submission process described in Section 2 of Appendix C.1.

1. Scope of Program

Solar System Observations 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, Solar System Observations 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.

Solar System Observations contains two primary components: Planetary Astronomy and Near Earth Object Observations.

1.1 Planetary Astronomy (PAST)

Planetary Astronomy investigations must contain a primary element of new Solar System observation and must support those NASA Solar System program objectives that cannot be met by current spacecraft missions or that directly support specific flight missions. The proposal 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. Support for investigations proposing to use existing airborne or space-based assets is 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 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 Planetary Major Equipment (PME). See Program Element C.17 for information on how to append a PME request to a regular Solar System Observations research proposal or submit a stand-alone PME proposal to supplement an existing 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

Proposals to this Program Element may include an application for an Early Career Fellowship (ECF). See Program Element C.16 for a description of the application and evaluation process.

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

Please refer to ROSES Appendix C.1, §4, for a detailed list of the data and astromaterials resources, and facilities available to proposers to this Program Element, and how to use them. If their use is anticipated, this should be discussed and justified in the submitted proposals (especially note the provision for such discussion in the proposal section entitled Facilities and Equipment). Also note that, per the directions in Section 2.3 of 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 Appendix C.1, Section 3.5). 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 Appendix C.1, Section 3.6, 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 Appendix C.1, §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 Appendix C.1 and in Chapter 2 of the *NASA Guidebook for Proposers*. Note that these requirements have been updated in 2016. 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	~$1M (PAST) ~$4M (NEOO)
Number of new awards pending adequate proposals of merit	~8-10 (PAST) ~10-12 (NEOO)
Maximum duration of awards	Typically 3 years. Up to 5 years permitted.
Due date for Step-1 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for Step-2 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
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.
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. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
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	NNH16ZDA001N-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 E-mail: kelly.e.fast@nasa.gov

C.7 PLANETARY DATA ARCHIVING, RESTORATION, AND TOOLS

NOTICE: This Program Element continues to use a two-step proposal submission process described in Section 2 of Appendix C.1.

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 higher-order data products than those that currently exist are encouraged. Source data may be derived from NASA or other spaceflight missions, astronomical observations, sample analyses, or other sources. The 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 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 proposer 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 proposer 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

This Program Element encourages 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). 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 proposer 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

This Program Element supports the development and dissemination of 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. 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 does 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.

Proposals to develop tools that would enhance the usability of, and access to, the PDS4 file format are particularly encouraged. Of special interest are tools for converting PDS4-formated files into other popular file formats (e.g., FITS, CDF).

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 Section 2.3.5 of 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 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* (Appendix C). 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.
2. The uniqueness and/or time criticality of the proposed new products, datasets, or tools. For this factor, historical significance may also be considered.

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 2.2).
4. Any applicable work-specific 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 to have the following features:

1. Archive should conduct independent peer reviews of data to assess usability and completeness of data packages. (Peer Review)
2. 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). If you are proposing an archive other than PDS or one of those listed here, your 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 C.6).

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-2016 E.2 Topical Workshops, Symposia, and Conferences.

2.5 Duration and Size of Awards

The maximum duration of awards from C.7 is three years (not including no cost extensions). 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.

Since this is still 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 Fiscal Year (FY) 2017 budget.

NASA does not have much historical data to rely on, but the 2015 PDART selections are posted to the spreadsheet on the SARA grant stats web page. The average year-one award size in 2015 was ~$110K, but the award sizes spanned a very wide range, depending on the nature of the work proposed. Proposers are encouraged to request what is actually needed to conduct the proposed work.

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 Appendix C.1, §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 Appendix C.1 and in Chapter 2 of the *NASA Guidebook for Proposers*. Note that these requirements have been updated in 2016. Violation of these rules is sufficient ground 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.

Investigators funded by spacecraft missions which wish to apply must clearly demonstrate how the proposed research does not overlap and is not redundant with duties or responsibilities already funded by their respective mission(s). See Appendix C.1, The Planetary Science Division Research Program Overview, for more information.

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 advised to read C.1 The Planetary Science Division Research Program Overview, for information on facilities and data sources that are available to supported investigators. If their use is anticipated, this should be discussed and justified in the submitted proposals (especially note the provision for such discussion in the proposal section entitled Facilities and Equipment). Also note that, per the directions in Section 2.3 of the *NASA Guidebook for Proposers,* a letter of support may be required from any facility required for the proposed effort.

4.3 Data Archiving and Map Publication

Selected investigations are expected to result in data products that are of broad use to the science community, including maps, data with improved calibrations, etc. PDART requires that such data be archived in the Planetary Data System (http://pds.nasa.gov/), or an equivalent public 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 your proposed data. Proposers intending to archive data or products in the PDS must obtain and include 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 in the *Summary of Solicitation* of this NRA.
Due date for Step-2 proposals	See Tables 2 and 3 in the *Summary of Solicitation* of this 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 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 required or permitted. See 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 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	NNH16ZDA001N-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 E-mail: sarah.noble-1@nasa.gov Michael New – Discipline Scientist Telephone: (202) 358-1766 E-mail: michael.h.new@nasa.gov Jared Leisner – Discipline Scientist Telephone: (202) 358-2016 E-mail: jared.s.leisner@nasa.gov

C.8 LUNAR DATA ANALYSIS PROGRAM

NOTICE: Amended on August 2, 2016. This amendment delays the proposal due dates for this program. Step-1 proposals are now due September 8, 2016, and Step-2 proposals are now due by November 10, 2016.

This Program Element continues to use a two-step proposal submission process described in Section 2 of Appendix C.1.

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) nondata-analysis tasks that require the use of lunar mission data, and 3) nondata-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. Nondata-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 nondata-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 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 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 (C.7 PDART). Proposers who plan investigations involving geologic mapping should consult Appendix C.1, Section 3.6, 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 Appendix C.1, Section 3.5). 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	E-mail
William Knopf	Program Executive	william.knopf@nasa.gov
Edwin Grayzeck	Program Manager	edwin.j.grayzeck@nasa.gov

2. Programmatic Information

2.1 Planetary Science Division Early Career Fellowship Program

Proposals to this Program Element may include an application for an Early Career Fellowships (ECF). See Program Element C.16 for a description of the application and evaluation process.

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 Appendix C.1, §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 Appendix C.1 and in Chapter 2 of the *NASA Guidebook for Proposers*. Note that these requirements have been updated in 2016. Violation of these rules is sufficient ground 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 Appendix C.1, §3.2, 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 was ~$100K per year, but with a wide range, depending on the nature of the work proposed. When the 2015 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 Appendix C.1, §4, for a detailed list of the data and astromaterials resources, and facilities available to proposers to this Program Element, and how to use them. If their use is anticipated, this should be discussed and justified in the submitted proposals (especially note the provision for such discussion in the proposal section entitled Facilities and Equipment). Also note that, per the directions in Section 2.3 of 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 in the *ROSES Summary of Solicitation*.
Due date for Step-2 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
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 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 required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of 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	NNH16ZDA001N-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 E-mail: rfogel@nasa.gov

C.9 MARS DATA ANALYSIS

NOTICE: Clarified August 1, 2016. Proposals to analyze neutron and gamma ray datasets from Mars Odyssey are encouraged. New text is in bold.

Amended on April 11, 2016. This amendment delays the Step-2 due date for this program. Step-1 proposals are still due August 26, 2016, but Step-2 proposals are now due by October 28, 2016.

This Program Element continues to use a two-step proposal submission process described in Section 2 of Appendix C.1.

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 (MERs), Mars Express (MEX), Mars Reconnaissance Orbiter (MRO), Phoenix (PHX), Mars Science Laboratory (MSL), and Mars Atmosphere and Volatile EvolutioN (MAVEN). 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.jpl.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. 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.

An investigator may also propose in the following high-priority areas of Mars research that support planning for future Mars missions:

- 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 PDS. [Added August 1, 2016]

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 core programs of this NRA for 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.

Investigators who wish to propose to produce 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 C.7 Planetary Data Archiving, Restoration and Tools (PDART).

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 Section 2.3.5 of 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

Proposers to this Program Element may apply for Early Career Fellowships (ECFs). See Program Element C.16 for a description of the application and evaluation process.

2.4 Data Management Plans (DMPs)

Appendix C.1, §3.5, 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.

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 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.

3.2 Facilities and Data Sources Available to Proposers

Refer to ROSES Appendix C.1, §4, for a detailed list of the data and astromaterials resources, and facilities available to proposers to this Program Element, and how to use them.
If their use is anticipated, this should be discussed and justified in the submitted proposal (especially note the provision for such discussion in the proposal section entitled Facilities and Equipment). Also note that, per the directions in Section 2.3 of 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] and
- 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
- *An Astrobiology Strategy for the Exploration of Mars* [2007], by the Space Studies Board (SSB) of the National Research Council (NRC) (http://www.nap.edu/catalog.php?record_id=11937).

Additional information is available on the MEP web site at: http://mars.jpl.nasa.gov/.

3.3 Geologic Maps

Proposers who plan investigations involving geologic mapping should consult Appendix C.1, Section 3.6, 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 Appendix C.1.

Proposers are reminded that Step-1 proposals are mandatory and must be submitted by the proposing organization.

Proposals must follow all formatting requirements that are described Appendix C.1 and in Chapter 2 of the *NASA Guidebook for Proposers*. Note that these requirements have been updated in 2016. 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	~ $3.0M
Number of new awards pending adequate proposals of merit	~ 25-30
Maximum duration of awards	4 years
Due date for Step-1 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for Step-2 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
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	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. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
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	NNH16ZDA001N-MDAP
NASA point of contact concerning this program	Mitch Schulte Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-2127 E-mail: mitchell.d.schulte@nasa.gov

C.10 CASSINI DATA ANALYSIS PROGRAM

NOTICE: This Program Element continues to use a two-step proposal submission process described in Section 2 of Appendix C.1.

The Cassini Participating Scientist Program's final year was ROSES 2015 and it is no longer accepting proposals. With this change, those proposal allowances particular to the Cassini PSP (5-page appendix, request for membership on a Cassini science team, ability to use future mission data) are no longer in this call.

The scope of this Program has been clarified and slightly modified in ROSES-2016. Proposers are expected to carefully read the solicitation and should E-mail the program point of contact with any questions sufficiently ahead of the Step-1 proposal deadline. In addition, the NSPIRES page has a Frequently Asked Questions (FAQs) section that contains the answers to common questions about this Program.

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 to supplement these data in a supporting role, but all proposals must require the use of data from the Cassini mission.

This Program solicits research proposals to conduct scientific investigations utilizing or enhancing the utilization of data obtained by the Cassini mission. For the purposes of this solicitation, "data" is understood to include both uncalibrated and calibrated data, as well as higher-order data products produced from the mission data. 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 4.3 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 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.

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 fifteen-page Scientific/Technical/Management Section and the relocation of the relevance discussion does not decrease that fifteen-page limit. This requirement supersedes Section 2.3.5 of 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 fifteen-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 Appendix C.1 The Planetary Science Division Research Program Overview, Section 3.3.

- 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/Tutorial_GSA2005.pdf

3.2 Facilities and Data Sources Available to Proposers

Proposers are advised to read Section 4 of Appendix 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 Section 2.3 of 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 Appendix C.1, Section 3.5). 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 Appendix 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 Appendix C.1, Sections 3.5-3.6, 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 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 Appendix C.1 and in Chapter 2 of the *NASA Guidebook for Proposers*. Note that these requirements have been updated in 2016. Violation of these rules is sufficient grounds for a proposal to be rejected.

5. Planetary Science Division Early Career Fellowship Program

Proposals to this Program Element may include an application for an Early Career Fellowship (ECF). See Program Element C.16 for a description of the application and evaluation process.

6. Summary of Key Information

Expected program budget for first year of new awards	~ $1.8-2.3 M/Year
Number of new awards pending adequate proposals of merit	~ 15-21 total
Maximum duration of awards	3 years
Due date for Step-1 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for Step-2 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
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 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 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 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	NNH16ZDA001N-CDAP
NASA point of contact concerning this program	Jared Leisner Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Email: HQ-CDAP@mail.nasa.gov Telephone: (202) 358-2016

C.11 DISCOVERY DATA ANALYSIS

NOTICE: August 11, 2016, the point of contact for this program has been changed to Thomas Statler. See Section 5 for more information.

Clarified on June 20, 2016. The requirements on the archiving of data products have been modified for clarity and to make them more consistent with requirements in the other Data Analysis program elements. See Section 1.2. The due dates are unchanged. New text is in bold, deleted text is struck through.

Amended on March 10, 2016. This program element has been modified to permit proposals for work on Kepler/K2 observations of solar system targets. See Sections 1.1 and 1.3. 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 Appendix C.1.

1. Scope of Program

The objective of the Discovery Data Analysis Program (DDAP) is to enhance the scientific return of Discovery Program missions by broadening the scientific participation in the analysis of data, both recent and archived, collected by Discovery missions.

1.1. Sources and Analysis of Mission Data

It is the responsibility of the proposers to DDAP to specifically identify any needed mission data and to ascertain that those data are publically available. Proposals dealing with mission data 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.

The following is a list of Discovery Missions for which archived data is available:

- NEAR
- Stardust
- Genesis
- Deep Impact
- MESSENGER
- Dawn
- **Kepler/K2 [Added March 10, 2016]**

The following is a list of Discovery Missions of Opportunity for which archived data is available:

- EPOXI

- Stardust-NExT

Please note, proposals focusing on data returned from Mars Pathfinder and ASPERA-3 should be submitted to C.9 Mars Data Analysis Program (MDAP), and proposals focusing on data from GRAIL, Lunar Prospector, and the Moon Mineralogy Mapper (M3) should be submitted to C.8 Lunar Data Analysis Program (LDAP). Proposals primarily focusing on data from these Martian and Lunar missions are not eligible for submission to DDAP.

Also note that DDAP investigations using Kepler/K2 data are limited to those using observations of Solar System objects. Proposals using Kepler/K2 observations of objects outside the Solar System are not eligible for submission to DDAP, and should be submitted to the Astrophysics Data Analysis Program (D.2). [Added March 10, 2016]

The DDAP supports investigations that use only data available in the Planetary Data System (PDS; http://pds.nasa.gov/) or equivalent publicly accessible archive(s), such as Genesis data at http://genesis.lanl.gov/plots/. The data must be archived and publicly available 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 ~~PDS~~ **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. 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.

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.

Proposals should make significant use of, or greatly enhance the use of, data returned by one or more Discovery Program missions. Proposals to work with Discovery Program data and also use ground-based or other data are acceptable, provided that the success of the proposal, as written, is dependent upon the Discovery data. 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, data from Discovery Program missions are also eligible. Such proposals that don’t directly analyze data, but are intended to amplify its interpretation, will be judged upon the perceived impact of the proposed work on the interpretation of data from the Discovery Program mission(s) emphasized.

It is the responsibility of the proposers to DDAP to specifically identify any needed data and to ascertain that these data are available. Proposals dealing with mission data 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~~ **Archiving of Data Products**

Data products produced by funded DDAP investigations must be **made publicly available, following the guidelines described in Section 4.3 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.** ~~archived in the Planetary Data System. When proposing the archiving of products into the PDS, an archive plan must be included, identifying schedule and budget to go through the PDS ingestion process. Data products should be submitted to the PDS by the end of the funded research period, unless the investigator explicitly makes a case in the proposal for a later date. For more information, please contact the Planetary Data System (http://pds.nasa.gov/). This requirement supersedes the general requirement found in Appendix C.1.~~ **[Text Updated June 20, 2016].**

1.3 Program Exclusions

The Discovery Data Analysis Program is not intended to overlap other active data analysis or core research and analysis programs. Therefore, the DDAP does not support the analysis of:

- Lunar data (see LDAP in C.8);
- Mars data obtained by missions to Mars (see MDAP in C.9);
- Data from Cassini (see the Cassini Data Analysis program in C.10);
- **Data from Kepler/K2 on objects outside the Solar System (see ADAP in D.2). [Added March 10, 2016]**

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.

Proposers to this Program Element should also note that DDAP is not intended to support:

- Investigations whose primary emphasis is fundamental theoretical research, the development of numerical models, laboratory measurements (unless clearly demonstrating the research would greatly increase the use of, or significantly facilitate the interpretation of, data from Discovery Program missions), or detector development (other NASA programs support these research activities);

- Investigations with a focus on Exoplanets (see E.3 Exoplanets Research for support of these research activities); and
- Proposals for organizing and/or hosting scientific meetings (which should be submitted to Topical Workshops, Symposia, and Conferences, E.2).

Spacecraft data that have not yet been obtained (i.e., future mission data), or those that have not been accepted into approved archives, as indicated above, may not be proposed for use in DDAP investigations.

Please note that Dawn VIR data in the three-micron region are currently unavailable because they have not been submitted for archiving in the PDS.

Members of Discovery Program mission 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, flight team members must clearly demonstrate how the proposed DDAP research does not overlap and is not redundant with data analysis duties, responsibilities already funded by their respective mission.

2. The Two-Step Submission Process

This Program Element uses a two-step proposal submission process described in Appendix C.1, §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 Appendix C.1 and in Chapter 2 of the *NASA Guidebook for Proposers*. Note that these requirements have been updated in 2016. Violation of these rules is sufficient ground 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 Appendix C.1, §3.2, for instructions on submitting requests for more than three years.

3.3 Planetary Science Division Early Career Fellowship Program

Early career researchers are encouraged to apply for the Early Career Fellowship (ECF) Program. See Section C.16 of ROSES for a description of the application and evaluation process.

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 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.

4.2 Data Management Plans (DMPs)

Proposals submitted to this Program Element must include a Data Management Plan (see Appendix C.1, Section 3.5). 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 Section 2.3 of the *NASA Guidebook for Proposers*, a letter of support may be required from any facility required for the proposed effort.

4.4 Geologic Maps

Proposers who plan investigations involving geologic mapping should consult Appendix C.1. Section 3.6, 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 in the *Summary of Solicitation* of this NRA.
Due date for Step-2 proposals	See Tables 2 and 3 in the *Summary of Solicitation* of this 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 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 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 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	NNH16ZDA001N-DDAP
NASA point of contact concerning this program	**Thomas Statler** Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 **Email: thomas.s.statler@nasa.gov** **Telephone: 202-358-0272** **[Updated, August 11, 2016]**

C.12 PLANETARY INSTRUMENT CONCEPTS FOR THE ADVANCEMENT OF SOLAR SYSTEM OBSERVATIONS

NOTICE: Amended on April 15, 2016: "Ocean Worlds" are especially of interest for this program element and will be considered for separate funding from the Outer Planets and Ocean Worlds Program, see Section 1.

This Program Element continues to use a two-step proposal submission process described in Section 2 of Appendix C.1. 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 semiannually. See Section 2.4 for more detail. No data management plan is requested for this Program Element.

1. Scope of Program

The Planetary Instrument Concepts for the Advancement of Solar System Observations (PICASSO) Program supports the development of spacecraft-based instrument systems that show promise for use in future planetary missions. The goal of the program is to conduct planetary and astrobiology science instrument feasibility studies, concept formation, proof of concept instruments, and advanced component technology development to the point where they may be proposed in response to C.13. Maturation of Instruments for Solar System Exploration (MatISSE) Program Therefore, the proposed instrument system or advanced components must address specific scientific objectives of likely future planetary science missions.

The PICASSO Program seeks proposals for development activities leading to instrument systems in support of the Science Mission Directorate's (SMD's) Planetary Science Division (PSD). The objective of the program is 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). 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.

While proposals relevant to all of the Planetary Science Division's strategic goals and objectives will be considered for this program element, instruments focused on the detection of extant life in the "Ocean Worlds" of the outer Solar System (e.g., Enceladus, Europa, and Titan) are especially of interest and will be considered for separate funding from the Outer Planets and Ocean Worlds Program. [added 04/15/2016]

The PICASSO Program is intended to enable timely and efficient technology infusion into the MatISSE Program and eventually into flight missions. 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. It is the responsibility of the proposer to justify the entry and exit level TRL of the proposed technology. This program will permit appropriate funding to be applied at this early stage to develop and demonstrate key and enabling new technologies for planetary science missions, such as instrument feasibility studies, concept formulation, proof of concept, laboratory demonstrations, and advanced component technology development.

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 the most recent Decadal Survey ("*Visions and Voyages for Planetary Science in the Decade 2013-2022*" http://solarsystem.nasa.gov/2013decadal/) and 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/. 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 not appropriate for PICASSO are brassboarding and testing of complete instruments in a relevant environment. These proposals should be submitted to C.13. MatISSE Program. In addition, PICASSO 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, platform technologies; such as materials and structures, Small Satellites 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 improved instrument measurements 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.

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 detailed description and justification for the entry technology readiness level (TRL) 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.
- How the proposed instrument system or component technology would address planetary protection requirements, as described in the NASA Procedural Requirements document, NPR 8020.12, Version D. Restrictions on operation and hardware cleanliness apply to all instrument systems that are intended to operate in environments where Earth life could proliferate – currently that is considered to be Mars, Europa, Enceladus, and anywhere in the solar system where warm ice or liquid water is possible and includes instrument systems or component technology associated with detection of signs of life or biosignatures. To address this requirement, the proposal shall, at a level appropriate to the exit TRL:
  - Establish whether the instrument will require planetary protection protocols.
  - If the instrument requires planetary protection protocols, describe which specific components could pose a challenge.
  - Describe possible mitigation strategies to meet planetary protection requirements.

  The instrument developer is encouraged to communicate informally with the Office of Planetary Protection regarding planetary protection categorization and associated requirements with a future mission interest, as they relate to instrument design and development. For additional information, proposers may contact the NASA Planetary Protection Officer, Dr. Catharine A. Conley (Telephone: 202-358-3912; E-mail: cassie.conley@nasa.gov) and cc james.r.gaier@nasa.gov.
- 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, 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 (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 PICASSO selection recommendations.

- The extent to which the proposed instrument system or subsystem is applicable to multiple Planetary Science missions;
- 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 necessity of embarking on a long lead-time development of a very important instrument contemplated for flight on a mission that is of high priority;
- The evaluation of cost will include the extent to which proposers leverage technology investments including, but not limited to, NASA programs such as the Planetary Instrument Definition and Development Program (PIDDP), Astrobiology Science and Technology for Instrument Development (ASTID), NASA Small Business Innovation Research (SBIR), and Game Changing Technologies.

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. 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 PICASSO solicitation shall be submitted to the web-based Planetary Science (PS) Award Administration e-Book. A user account on the PS e-Book will be provided to the Principal Investigator (PI) upon award. Due to NASA IT security requirements, all PIs must register with the Identity Management and Account Exchange (IdMAX) system before a user account on 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 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 *Semiannual Progress Report Deliverable*

The PI shall provide a written Semiannual 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 Semiannual 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. Summarize the cost and schedule status of the project, including any schedule slippage/acceleration;
4. Provide a summary of accomplishments and anticipated results at the end of the task;
5. Include an updated Summary Chart noting milestone changes, if any, and updates to the TRL;
6. Report any educational and outreach components of the project, e.g., graduate degrees, educational activities; technology infusion or patents applied for or granted; journal or conference publications; presentations at professional conferences, seminars, and symposia; demonstrations; media exposure; and, other activities that contributed to the overall success of the research project.

The release of the PI's annual budget allocation is contingent on the timely submission of the written Semiannual 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 Semiannual Report and includes all of the products required in the Semiannual 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:

    - 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

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

Proposals to this Program Element may include an application for an Early Career Fellowships (ECF). See Program Element C.16 for a description of the application and evaluation process.

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.

3.1 Facilities 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 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. §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 Appendix C.1 and in Chapter 2 of the *NASA Guidebook for Proposers*. Note that these requirements have been updated in 2016. 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 document. 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 in the *ROSES Summary of Solicitation*.
Due date for Step-2 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
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 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 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 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	NNH16ZDA001N-PICASSO

Main NASA point of contact concerning this program:	James R. Gaier NASA Program Officer Planetary Science Division Science Mission Directorate National Aeronautics and Space Administration Washington DC 20526-0001 Telephone: 260-579-3442 E-mail: james.r.gaier@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: Michael H. New Astrobiology Discipline Scientist Lead Discovery Program Scientist Telephone: 202-358-1766 E-mail: michael.h.new@nasa.gov Mary A. Voytek Senior Scientist for Astrobiology Telephone: 202-358-1577 E-mail: 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 E-mail: 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 E-mail: michael.a.meyer@nasa.gov

C.13 MATURATION OF INSTRUMENTS FOR SOLAR SYSTEM EXPLORATION

NOTICE: Amended on April 15, 2016: "Ocean Worlds" are especially of interest for this program element and will be considered for separate funding from the Outer Planets and Ocean Worlds Program, see Section 1. Step-1 proposals are now due by May 20, 2016, and Step-2 proposals are now due by July 21, 2016.

This Program Element continues to use a two-step proposal submission process described in Section 2 of Appendix C.1. 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 and astrobiology 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). 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.

While proposals relevant to all of the Planetary Science Division's strategic goals and objectives will be considered for this program element, instruments focused on the detection of extant life in the "Ocean Worlds" of the outer Solar System (e.g., Enceladus, Europa, and Titan) are especially of interest and will be considered for separate funding from the Outer Planets and Ocean Worlds Program. [added 04/15/2016]

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 3-6. 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" (http://solarsystem.nasa.gov/multimedia/downloads/Vision_and_Voyages-FINAL1.pdf) for the most recent Decadal Survey) and Science Plan for NASA's Science Mission Directorate 2007-2016 (http://science.nasa.gov/media/medialibrary/2010/03/31/Science_Plan_07.pdf) 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 Planetary Instrument Concepts for the Advancement of Solar System Observations (PICASSO) Program in ROSES-2016. Text for the PICASSO call can be downloaded from ROSES-2016, C.12. 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.

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 science objectives of the proposed instrument. The relationship between the science objectives and the instrumental capabilities must be clearly demonstrated. For those instruments 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 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.
- Technological advances 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 level, how the instrument design and material choices are compatible with 1) surface bioburden reduction techniques, 2) reduction of contamination by organic compounds, 3) recontamination prevention, and 4) the reduction of encapsulated bioburden. The instrument developer is encouraged to communicate informally with the Office of Planetary Protection regarding planetary protection categorization and associated requirements with a future mission interest as they relate to instrument design and development. For additional information, proposers may contact the NASA Planetary Protection Officer, Dr. Catharine A. Conley at cassie.conley@nasa.gov and cc william.b.cook@nasa.gov.
- 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, as well as discussions of how those tests or demonstrations will advance the technology readiness level of the instrument.
- 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 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;
- The necessity of embarking on a long lead-time development of a very important instrument contemplated for flight on a mission that is of high priority;
- The evaluation of cost will include the extent to which proposers leverage technology investments including, but not limited to, 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), NASA Small Business Innovation Research (SBIR), and Game Changing Technologies.

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 e-Book. 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 descoped. 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. <u>Technical status:</u> 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. <u>Schedule status:</u> The PI shall 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 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 E-mailed to the NSSC.

2.5 Planetary Science Division Early Career Fellowship Program

Proposals to this Program Element may include an application for an Early Career Fellowships (ECF). See Program Element C.16 for a description of the application and evaluation process.

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, §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, §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 in Chapter 2 of the *NASA Guidebook for Proposers*. Note that these requirements have been updated in 2016. 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	~ 6
Maximum duration of awards	4 Years, but see last bullet in Section 2.3
Due date for Step-1 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for Step-2 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
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 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 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	NNH16ZDA001N-MATISSE
NASA point of contact concerning this program	William B. Cook Acting NASA Program Officer Planetary Science Division Science Mission Directorate National Aeronautics and Space Administration Washington DC 20526-0001 Telephone: 202-358-0976 E-mail: william.b.cook@nasa.gov
NASA points of contact for related programs	Questions concerning Discovery or Astrobiology Program may be addressed to: Michael H. New Astrobiology Discipline Scientist Lead Discovery Program Scientist Planetary Science Division National Aeronautics and Space Administration Washington DC 20526-001 Telephone: 202-358-1766 E-mail: michael.n.new@nasa.gov Mary A. Voytek Senior Scientist for Astrobiology Science Mission Directorate National Aeronautics and Space Administration Washington DC 20526-001 Telephone: 202-358-1577 E-mail: mary.voytek-1@nasa.gov

NASA points of contact for related programs, continued	Questions concerning New Frontiers Program may be addressed to: Curt Niebur Program Scientist Cassini/Huygens Mission to Saturn Discovery 12 Mission New Frontiers Program Discipline Scientist Early Career Fellowship Program National Aeronautics and Space Administration Washington DC 20526-001 Telephone: 202-358-0390 E-mail: curt.neibur@nasa.gov
NASA points of contact for related programs, continued.	Questions concerning Mars Exploration Program may be addressed to: Michael A. Meyer Lead Scientist Mars Exploration Program National Aeronautics and Space Administration Washington DC 20526-001 Telephone: 202-358-0307 E-mail: michael.a.meyer@nasa.gov

C.14 PLANETARY SCIENCE AND TECHNOLOGY THROUGH ANALOG RESEARCH

NOTICE: Amended on April 15, 2016: "Ocean Worlds" are especially of interest for this program element and will be considered for separate funding from the Outer Planets and Ocean Worlds Program, see Section 1.

This Program Element continues to use a two-step proposal submission process described in Section 2 of Appendix C.1.

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.
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 testing, validation, or development 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.

3) Technology: PSTAR seeks the development 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.

While proposals relevant to all of the Planetary Science Division's strategic goals and objectives will be considered for this program element, science operations and technology focused on the detection of extant life in the "Ocean Worlds" of the outer Solar System (e.g., Enceladus, Europa, and Titan) are especially of interest and will be considered for separate funding from the Outer Planets and Ocean Worlds Program. [added 04/15/2016]

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. The description of the plan should be no more than one page and included as an addendum to the fifteen page technical proposal. Proposals that incorporate public engagement activities, through telepresence capabilities and involvement of professional educators and students nationwide in the fun and challenges of science and technology, are particularly encouraged. Proposers should also state in their proposals whether they are willing to host an outside public engagement activity arranged by NASA.

2. Programmatic Information

2.1 General Information

Proposals submitted in response to this call should be for new work that is not currently supported by the Planetary Sciences research and analysis program or for investigations that would extend to their next logical phase those tasks that have been funded, but whose periods of performance expired in 2016 or are expiring in the first half of 2017.

Proposers are strongly advised to read C.1 The Planetary Science Division Research Program Overview, for information on mandatory data management plans.

2.2 Special Requirements for Proposals

Proposals should follow the guidelines set for all ROSES-2016 proposals, as given in the *NASA Guidebook for Proposers*.

Proposals should also specify:

- Area(s) of fidelity (Science, Science Operations, and/or Technology, as described in Section 1) that are addressed by the project.
- Specific field activity, site(s), and dates being targeted for their investigation(s), as well as a clear schedule for field preparations, training, and deployment strategy.
- Justification for field site selection (see special case for access to Antarctica Section 2.4).
- If proposed investigation(s) are to be conducted in conjunction with established field campaign(s), proposers must provide evidence of coordination with field campaign leaders.
- Field resource requirements:
    - Duration, timing, and scheduling of investigations
    - Power requirements
    - Communications requirements (bandwidth, type of communications, etc.)
    - Logistics Support Requirements
    - Permits and/or land access/use requirements
- The science objectives and expected science return of the proposed investigation – type and amount of data, validation of science requirements, expected publications, etc.
- Specific deliverables at the conclusion of the field activity.
- Source, type, and amount of external funding already received or expected, if any, for the hardware, software, or operational concepts being tested.
- Risks to the investigation, including weather scrubs, hardware failures, power failures, etc., and a mitigation plan.
- Clear budget, including field deployment costs, logistics support, direct labor, overhead, subcontracts, special equipment, travel, Education and Public Outreach, other costs, General and Administrative Expenses, fees, etc.

- A plan for engaging the public and media during field deployment (this should be no more than one page and included as an addendum).

2.3 Development of Flight Instruments

This solicitation does not request proposals for the development of advanced instrument concepts and technologies as precursors to flight instruments. Such proposals should be submitted to either C.12 Planetary Instrument Concepts for the Advancement of Solar System Observations (PICASSO) or C.13 The Maturation of Instruments for Solar System Exploration (MatISSE) Program.

2.4 Access to the Antarctic

The National Science Foundation (NSF) manages the U.S. Antarctic Program. NASA, therefore, collaborates with the NSF in evaluating the logistics needs of research programs that request access to Antarctic field sites. To that end:

1. Proposals requesting access to Antarctic field sites must justify their request on the grounds that Antarctica is the best or only location for their research.
2. Proposals must include, as an appendix, a Logistical Requirements and Field Plan, which will be subject to peer review, outlining the PI's logistical requests associated with the proposed fieldwork. Proposals with fieldwork that lack this Plan are subject to return without review. The Logistical Requirements and Field Plan must include the elements listed below and should be limited to one page of text and one page of figures (if needed). These pages are in addition to the 15 page limit for the Science/Technical/Management section of the proposal.
    a. Brief statement of research objectives.
    b. List of field sites and the geographic region where they are located. For remote sites, investigators should consider providing a map of proposed field sites.
    c. Description of proposed field activities, including major logistical resources required (i.e., fixed-wing aircraft, vessels, helicopter support).
    d. Description and justification of the desired deployment schedule.
    e. Projected numbers of deploying personnel.
    f. Description of any needs for facility construction, alteration, or instrument installation.

Further information on the U.S. Antarctic Program may be found at http://www.nsf.gov/geo/plr/ant/index.jsp.

Due to the scheduling of NASA and NSF review cycles, proposals requesting access to Antarctica should expect that their first field season will start no sooner than late 2017/early 2018. Proposals requiring Antarctic access in their first performance year may suggest a start date commensurate with this schedule.

2.5 Instrumentation: Construction or Upgrade

Proposers to PSTAR are eligible to request funds for Planetary Major Equipment (PME). See Appendix C.17 for information on how to append a PME request to a regular PSTAR research proposal or submit a stand-alone PME proposal to supplement an existing PSTAR award.

2.6 Topical Workshops

The PSTAR program does not accept proposals for topical conferences, workshops, or symposia; such proposals may be submitted in response to Program Element E.2, "Topical Workshops, Symposia, and Conferences." Proposers should specifically identify the PSTAR program as the relevant SMD Program Element and refer to the goals and objectives of the PSTAR program in demonstrating relevance.

2.7 Planetary Science Division Early Career Fellowship Program

Proposers to this Program Element may apply for Early Career Fellowships (ECFs). See Program Element C.16 for a description of the application and evaluation process.

2.8 NASA Postdoctoral Program Fellows

Grantees of astrobiology-relevant awards in the program are eligible to serve as mentors to Astrobiology NASA Postdoctoral Program (NPP) Fellows. The tenure of a Fellow must begin before the end of the PSTAR award, but may extend beyond it. Proposals from potential Fellows must be submitted through the standard NPP process. The Astrobiology Program expects to select no more than two Fellows associated with PSTAR research in 2017. More information about the NASA Postdoctoral Program may be found at http://npp.usra.edu/.

2.9 Data Management Plans (DMPs)

Appendix C.1, §3.5, discusses the requirements for DMPs in proposals to this Program Element. Please note that DMPs are mandatory for this Program Element, and must be placed in a special section no longer than two pages in length, immediately following the References and Citations section for the Scientific/Technical/Management portion of the proposal.

2.10. Proposal Submission Process

This Program Element uses a two-step proposal submission process described in Section 2 of Appendix C.1.

Proposers are reminded that Step-1 proposals are mandatory and must be submitted by the proposing organization.

Proposals must follow all formatting requirements that are described in Appendix C.1 and in Chapter 2 of the *NASA Guidebook for Proposers*. Note that these requirements have been updated in 2016. Violation of these rules are sufficient grounds for a proposal to be rejected.

2.11 Duration and Size of Awards

The standard award duration is three years. NASA anticipates that most proposals will seek three years of funding. However, proposals for less than three years are highly encouraged for projects that can be completed on shorter timescales. On rare occasions, four-year projects can be considered, but appropriate justification must be provided. The appropriateness of the proposed funding period will be reviewed and adjustments may be requested. Programmatic balance may limit the opportunities for funding in some areas.

A wide range of award sizes is expected, depending on the nature and scope of the work proposed. We anticipate funding several larger-scope awards (typically $500K-1M per year) and several smaller-scope awards (typically $40-100K per year).

3. Summary of Key Information

Expected program budget for first year of new awards	~$5M
Number of new awards pending adequate proposals of merit	10-12, see Section 2.11
Maximum duration of awards	4 years
Due date for Step-1 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for Step-2 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	8 months after Step-2 proposal due date.
Page limit for the central Science/Technical/Management section of proposal	15 pp; see also 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 required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.

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	NNH16ZDA001N-PSTAR
NASA points of contact concerning this program	Sarah Noble and Mary Voytek Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone for Mary Voytek: (202) 358-1588 Telephone for Sarah Noble: (202) 358-2492 E-mail for Sarah Noble: sarah.noble-1@nasa.gov E-mail for Mary Voytek: mary.voytek-1@nasa.gov

C.15 PLANETARY PROTECTION RESEARCH

NOTICE: September 13, 2016. The Planetary Science Division is withdrawing program element C.15 Planetary Protection Research from ROSES-2016. However, NASA anticipates that this program element will be included in ROSES-2017.

1. Scope of Program

Planetary protection involves preventing biological contamination on both outbound and sample return missions to other planetary 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 organisms carried on spacecraft. Research is required to improve NASA's understanding of the potential for both forward and backward contamination, how to minimize it, and to set standards in these areas for spacecraft preparation and operating procedures. Improvements in technologies and methods for evaluating the potential for life in returned samples are also of interest. Many of these research areas derive directly from recent National Research Council (NRC) recommendations on planetary protection for solar system exploration missions (see http://planetaryprotection.nasa.gov/documents/ for online reports and a list of publications).

As a complement to the Exobiology program (see C.5), the Planetary Protection Research (PPR) program solicits research in the following areas:

- Characterize the limits of life in laboratory simulations of 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.
- Model planetary environmental conditions and transport processes that could permit mobilization of spacecraft-associated contaminants to locations in which Earth organisms might thrive, for example Mars Special Regions or the subsurface of icy bodies, such as Europa and other outer planet satellites.
- Develop or adapt modern molecular analytical methods to rapidly detect, classify, and/or enumerate the widest possible spectrum of 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 microbes with high potential for surviving spacecraft flight or planetary environmental conditions (e.g., anaerobes, psychrophiles, radiation-resistant organisms).
- Identify and provide proof-of-concept on new or improved methods, technologies, and procedures for spacecraft sterilization that are compatible with spacecraft materials and assemblies.

It should be noted that the evolving planetary protection requirements of NASA’s planetary exploration programs may affect the priorities for funding among these areas.

2. Programmatic 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.

2.1 Exclusions

Proposals are sought for new projects in planetary protection that are not within the scope of the Habitable Worlds (see E.4), Exobiology (see C.5), or Maturation of Instruments for Solar System Exploration (see C.13) 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 Planetary Protection that are currently funded, but whose periods of performance will expire this year.

2.2 Award Duration and Funding Available

Periods of performance from one to four years may be proposed, as appropriate, to the nature of the contemplated research. Approximately $300K per year of total funding is expected to be available to support approximately two research tasks selected from proposals responding to this solicitation.

2.3 Additional Funding for Relevant Instrumentation Construction or Upgrade

Proposers to Planetary Protection Research are eligible to request funds for Planetary Major Equipment (PME). See Program Element C.17 for information on how to append a PME request to a regular PPR research proposal or submit a stand-alone PME proposal to supplement an existing award.

2.4 Mission data, facilities, and resources

Please refer to ROSES Appendix C.1, §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.

2.5 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.

2.6 Data Management Plans (DMPs)

Proposals submitted to this program element must include a Data Management Plan (see Appendix C.1, Section 3.5). 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.

2.7 Geologic Maps

Proposers who plan investigations involving geologic mapping should consult Appendix C.1, Section 3.6, for guidance on submission and requirements for publication of U.S. Geological Survey (USGS) maps. The scientific goal of such a geologic map product should be clearly explained and justified.

3. Summary of Key Information

Expected program budget for first year of new awards	~~~ $300K~~
Number of new awards pending adequate proposals of merit	~~~ 2~~
Maximum duration of awards	~~4 years; shorter-term proposals are encouraged.~~
Due date for NOIs	**Not solicited in 2016. [Changed September 13, 2016].**
Due date for proposals	**Not solicited in 2016. [Changed September 13, 2016].**
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	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. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of 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	**Not solicited. [Changed September 13, 2016].**
NASA point of contact concerning this program	Catharine A. Conley Planetary Protection Officer Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-3912 E-mail: cassie.conley@nasa.gov

C.16 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 consists of two components with two different submission procedures: the first is the one-page application to be an "Early Career Fellow" (ECF) and the second is the subsequent submission of a seven-page proposal for start up funds by a previously selected ECF. Section 2 presents details on the former, the application to be an ECF. Section 3 presents details on the latter, the proposal in response to this program element by selected ECFs to apply for up to $100K in start up funds, once they obtain a permanent track position, which is defined in Section 4.3. See Section 3 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. Early Career Fellowship

This section describes the Early Career Fellow (ECF), the first component of this program element. The application to become an ECF does not involve a separate proposal to this program element. Rather, the ECF application is primarily a one-page addition to a normal (full, Step-2) proposal submitted to one of the ROSES-2016 Research Program elements listed in Section 2.4. The designation of the Principal Investigator (PI) as a fellow based on this one-page ECF application does not immediately result in funding; rather, the Early Career Fellow designation confers on the PI an opportunity to apply for start up funds in the future, as described in Section 3.

2.1 Eligibility for Early Career Fellowship

To be eligible to apply for an ECF one must have received their Ph.D. (or equivalent degree such as D.Phil) within seven calendar years of the year of the submission of the research proposal to the participating program element listed below, in Section 2.4. However, see also Section 4.2.

To be eligible to be named an Early Career Fellow, an individual may not already be in either a "permanent" or a "permanent track" position at the time of submission of their ECF application. The definitions of "permanent" and "permanent track" positions are provided at the end of this program element in Section 4.3.

2.2 Fellowship Application Procedure

The process for applying to be a Fellow is as follows:

1. Be PI (or Science PI, see Section 4.1) on a (normal, full, Step-2) proposal submitted to one of the participating ROSES-2016 program elements listed in Section 2.4,
2. Check the Early Career Fellowship checkbox on the NSPIRES Cover Pages of that proposal,
3. Include in that proposal an additional one-page application with the Curriculum Vitae to allow the evaluation of the potential Fellow,
4. Meet the eligibility requirements in Section 2.1, and
5. Receive an award letter for the proposal to which the ECF application was appended.

Selection of the ROSES-2016 proposal by the participating program is a prerequisite for consideration as an Early Career Fellow, but does not ensure selection as an Early Career Fellow. Only a small number of funded PIs in those participating programs are also named as Early Career Fellows. Those who are named as Early Career Fellows will receive an award letter explicitly stating that they have been named an Early Career Fellow.

As always, the ROSES-2016 proposal to which the ECF application is tied must adhere strictly to the deadlines and instructions for the participating ROSES-2016 program element to which it was submitted. Thus, the length of the proposal and any other rules defined in the participating ROSES-2016 program element must 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

ECF applications will be separately evaluated for merit, relevance, and also an additional community participation and leadership criterion unique to this program.

2.3.1 *ECF Merit Evaluation*

The ECF evaluation of merit aligns well with that generally employed in ROSES-2016. It includes assessment of the novelty of the 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 ECF*

It is to be expected that the ECF evaluation of relevance may differ from the relevance to the parent research program with which it is associated, because the scope and goals of the ECF differ from the parent research programs listed in Section 2.4. For example, Program Elements E.3 and E.4 are cross-division programs run and funded by both the Planetary Science and Astrophysics Divisions. A research proposal to one of these programs and selected for funding primarily because of its relevance to Astrophysics, yet the affiliated ECF proposal might be rejected because it is not relevant to this Planetary Science Division ECF program.

2.3.3 *Evaluation of Community Participation and Leadership*

In addition to the standard Relevance and Merit criteria above, the applicant's potential for future leadership in their scientific community will also be evaluated based on their engagement in their field. Examples of information of interest might include invited and/or public lectures, awards received, scientific program committees, conference or workshop organization, professional society activities, special international or industrial partnerships, reviewing or editorship activities, and significant Education and Public Outreach activities.

2.4 Participating ROSES-2016 Program Elements for Early Career Fellowship Applications

ROSES-2016 programs that participate in the ECF program are identified in Tables 2 and 3 of the solicitation by a "[3]" after the solicitation title. At the time this program element was released, the program elements listed below are participating in this program by allowing proposers to include an ECF application with their research proposal:

- Emerging Worlds (C.2);
- Solar System Workings (C.3);
- Exobiology (C.5);
- Solar System Observations (C.6);
- Lunar Data Analysis (C.8);
- Mars Data Analysis (C.9);
- Cassini Data Analysis and Participating Scientists (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) (planetary science relevance only)

3 Fellowship Start Up Funds

The application for start up funds is the second component of this program. The request for up to $100K of start up funds for those who meet the eligibility requirements in Section 3.1 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).

3.1 Eligibility for Start Up Funds

To be eligible for start up funds, the PI must have previously been named an Early Career Fellow, see Section 2, above.

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 4.2.

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 4.3.

Please note that this new definition does not affect Fellows who applied under the prior definition. Proposals submitted in advance of the November 17, 2015 change to this program fall under the rules laid out in the ECF program element that was active at the time the proposal was submitted (for more recent ROSES programs this includes the Step-1 proposal). Proposers who applied to be fellows after November 17, 2015, including all ROSES-2016 proposals, are eligible to apply for start up funds only if they hold a permanent track position that satisfies the new definition. 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.

3.2 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 3.1 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 4.3.

Proposals for start up funds must adhere strictly to the rules for ROSES-2016 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.

3.3 Evaluation Criteria for Start-Up Proposals

Proposals for start up funds will be evaluated vs. the three standard criteria given in ROSES-2016: merit, relevance, and cost realism and reasonableness. The evaluation of start up proposals vs. these criteria will be completely independent of any prior evaluation of the application to be an ECF and its affiliated ROSES-2016 proposal (described in Section 2).

4. Programmatic Information

4.1 Role of Fellow on Proposal vs. Organizational rules

Some institutions do not allow nontenured researchers to independently apply for NASA grants, which might prevent potential PIs from proposing to this program. At either the application for the Early Career Fellowship or the proposal for start up funds, 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).

4.2 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 or 3.1. These applicants should write to the ECF point of contact given in Section 5 prior to proposal submission.

4.3. 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 equivalent positions include, but are not limited to, tenure track faculty and certain term civil service appointments.

4.4 Duration of Awards

The application to be named an ECF is affiliated with a ROSES-2016 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 ECF. The fellowship lasts either until the fellow has passed beyond ten years since Ph.D., (stipulated in Section 3 for start up funds) without having applied for and won start up funds or, if they have won start up funds, the end of the start up award is the end of the Fellowship.

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 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, see also Section 4.4
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 a Fellow (new applicants), submit a proposal to the participating program element by the deadline specified in Tables 2 and 3 in the *ROSES Summary of Solicitation*. Proposals from Fellows selected in prior years for start-up funds may be submitted at any time in response to this program element.
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 Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	Proposals must be relevant to the Planetary Science Division. See also Section 2.3.2.
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/
For Additional Information	See the Frequently Asked Questions.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See 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	NNH16ZDA001N-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	Doris Daou Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1686 E-mail: Doris.Daou@nasa.gov

C.17 PLANETARY MAJOR EQUIPMENT

NOTICE: May 19, 2016. Paragraph (f) of Section 4.1.2 on Data Management Plans has been clarified and a typo corrected. New text is bold and deleted text is struck through. The due dates have not changed.

1. Overview

1.1 Changes from last year

This solicitation has been rewritten for ROSES-2016 to provide additional details on the preparation, evaluation, and selection of Planetary Major Equipment (PME) proposals. There are also minor changes to the procedures and requirements for preparing proposals. Proposers familiar with earlier PME solicitations should carefully review the new text to assure proposal compliance.

The PME program now allows proposals that request funds to acquire components and develop new nonflight instruments.

1.2 Scope of Program

This Program Element allows proposals for the purchase or development of new or upgraded nonflight analytical, computational, telescopic, and other instrumentation required by investigations in the following eligible Planetary Science research programs:

- Emerging Worlds (C.2)
- Exobiology (C.5)
- Habitable Worlds (E.3)
- Laboratory Analysis of Returned Samples (C.18)
- Planetary Protection Research (C.15)
- Planetary Science and Technology from Analog Research (C.14)
- Solar System Observations (C.6)
- Solar System Workings (C.3)

1.3 Types of PME proposals

A Planetary Major Equipment (PME) proposal may be submitted in one of two ways: as a special section that is Appended to a research proposal in one of the eligible programs listed in Section 1.2; or as a Stand-Alone equipment proposal submitted to one of the eligible programs. In this solicitation, the term "Target Program" refers to the eligible program to which a particular PME proposal is submitted.

1.3.1 *Appended PME proposals*.

Appended PME requests must be part of a normal, full research proposal submitted to the eligible "Target Program." Appended PME requests may either be integral to the research proposal (i.e., required to perform the research) or they may be presented as enhancement options to the research proposal (see Section 4.3 for more information on this topic).

1.3.2 *Stand-Alone PME proposals*

Stand-Alone PME requests are self-contained proposals submitted to one of the eligible programs to improve research already being done in that program. In order to submit a Stand-Alone PME proposal, the following requirements must be met:

- The Principal Investigator (PI) of the Stand-Alone PME proposal must also be the PI of an existing, funded "parent" award in the target program. The parent award may also have been funded under a discontinued program that allowed PME proposals in ROSES-2013. Proposers in the latter situation should obtain guidance on where to submit their Stand-Alone PME proposal from the PME Point of Contact prior to the earliest Step-1 proposal deadline of the current eligible programs to which the original proposal might be relevant.
- The parent award of the Stand-Alone PME proposal must not have entered its last funded task year at the time of the Step-2 proposal deadline in the target program.

A Stand-Alone PME proposal that does not meet these criteria is nonresponsive to this Program Element and will be rejected without review.

1.4 Allowable PME requests

Instrumentation purchases or upgrades that may be requested through the PME program are to be of a substantial nature, with hardware costs over $40,000. A PME 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 $40,000, these are not considered to be major equipment purchases under this Program Element, even if the combined cost exceeds $40,000.

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.

2. Instrument Management and User Access

All PME requests must specify how the instrument is to be used in terms of one of the three categories defined below:

- 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.
- An Investigator Facility Instrument is acquired or developed to support the PI’s research, where an identified portion of its time is to be reserved for use by the PI, but where an additional specified portion of its time will be made available to other knowledgeable NASA-supported planetary program investigators and where all details or access, method of use, charging, and data rights are determined by the PI in negotiation with potential users.

- A Regional Facility Instrument is one of considerable cost or one that is limited to a particular location by virtue of its use on a specific facility, but which has been acquired or developed by a PI to support the PI's research. An identified portion of a regional facility instrument's time will be reserved for use by the PI, but a significant, specified portion of its time must also be available to other NASA-supported planetary program investigators. Unlike an Investigator Facility Instrument, however, 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.

Collective use by other members of the scientific community is encouraged. Proposals for both types of facility instruments must include:

(a) A description of the potential user-community.
(b) A management plan for the instrument that includes:
    i. A statement of the percentage of the instrument's time that would be available to other users.
    ii. A general 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, and
        - how users would apply to gain access (e.g., by personal communication, formal proposal, or other method).

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 §200.313. However, in cases where the equipment upgrade is for 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.

3. Costs

The Planetary Major Equipment program 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). Only nonflight instruments may be purchased or developed. 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 solicitations. 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 his/her agency's interest.

Proposals selected for PME support will be funded through augmentation to the science research program proposal. Final reports should be sent to the cognizant science research program officer, with a copy sent to the PME Program Officer listed in the table below.

4. Programmatic Information

Letters of affirmation from the relevant community are permitted for proposals to this program, but only for Investigator Facility Instruments and Regional Facility Instruments (hereinafter simply "Facility Instruments").

4.1 Submission of PME proposals

All proposals must include a convincing case for instrument funding, and should address, as applicable:

- Why the instrument is necessary for the investigator's research or how it would enhance that research, citing specific examples;
- For Facility Instruments, why the enhanced capability is important to planetary science in general;
- For Facility Instruments, how the enhanced capability would benefit the larger planetary science community;
- How the requested instrument relates to existing capabilities, both in the investigator's own laboratory and elsewhere.

4.1.1 *Appended PME proposals*

No separate data management plan (DMP) is required for an Appended PME proposal. Archiving and release of data produced by the requested instrument should be covered in the DMP associated with the main research proposal.

When filling out the NSPIRES cover page budget for an Appended PME proposal, all costs associated with an Appended PME request should be included as a single rolled up number per year preferably on one of the configurable lines (Section F. Other Direct Costs, lines 8-10 and label as "Cost of Appended PME"). In most cases, it is expected that the PME costs will be contained within a single budget year.

The research proposal must contain an appendix entitled, "Planetary Major Equipment Request," which should be the last item in the proposal (subsequent to all of the required sections in the main proposal). This appendix should include:

(a) A single cover page specifying:

   i. The title of the PME request
   ii. The name and institution of the PI
   iii. The category of instrument being requested (Investigator, Investigator Facility, Regional Facility)
   iv. A brief summary/abstract of the PME request (which will not be evaluated, and therefore should contain only information covered in the body of the PME request)

(b) A maximum of five (5) pages of description of the instrument request, including an explanation of how this purchase will contribute to the research described in the main body of the research proposal to which the PME request is appended, any cost-sharing arrangements, and, for Investigator and facility instruments, a management plan as described above in Section 2. If the proposal contains instrument-development efforts, a detailed work plan and schedule for this should also be part of this section; in such cases the work plan, supported by items listed in the Facilities and Equipment section of the proposal, should demonstrate that sufficient capabilities exist to implement the development effort.

(c) A page of instrument specifications;

(d) At least one quote for the instrument or major components;

(e) A budget summary of all costs associated with the PME request alone. This section is independent of the budget section that is part of the full proposal. Reminder: the full proposal budget must encompass all budget items associated with the PME request; the PME budget summary represents a subset of the full budget.

The PME appendix does not count toward the page limits of any section of the host proposal.

4.1.2 *Stand-Alone PME proposals*

Stand-Alone PME requests, made in conjunction with an existing (previously funded) "parent" award in the Target Program, should be complete proposals prepared in full compliance with all applicable instructions and deadlines associated with the research program to which the PME proposal will be submitted, except as noted in this section. The proposer should select the PME checkbox on the Cover Page of this submission. The proposal should include:

(a) The Scientific/Technical/Management section may contain a maximum of seven (7) pages; this supersedes the normal 15-page limit for ROSES-2016. The text should specify the name of the program (in Section 1.2) that made the award, the title of the parent award, the grant number (or, if the PI is at a NASA center, the original proposal number), PI name, and start/end dates. It should contain a description of the instrument request, including the category of instrument being requested (Investigator, Investigator Facility, Regional Facility), how this purchase will contribute to the research described in the PI’s ongoing program of research funded under the parent award, any cost-sharing arrangements, and, for Facility instruments, a management plan as described above in Section 2. The Scientific/Technical/Management section should contain sufficient background information on the parent research award so the PME proposal can be reviewed without any knowledge of the contents of the original parent proposal. If the proposal contains instrument-development efforts, a detailed work plan and schedule for this should also be part of this section; in such cases the work plan, supported by items listed in the Facilities and Equipment section of the proposal, should demonstrate that sufficient capabilities exist to implement the development effort.

(b) A page of instrument specifications should be included in the proposal outside the Scientific/Technical/Management section;

(c) The budget section should include at least one quote for the instrument or major components;

(d) Investigator and Regional Facility PME proposals may contain a section of letters-of-affirmation from members of the potential user community;

(e) The **stand-alone** proposal should follow the Target Program's instructions for preparation of a relevance section, and if one is required, may simply state, "This is a Stand-Alone PME proposal based on a parent award that has already been deemed relevant to this program."

(f) The **stand-alone** proposal should follow the Target Program's instructions for **location** ~~preparation~~ of a Data Management Plan (DMP). **However,** the DMP **for a stand-alone PME** proposal may **simply** state, "This is a Stand-Alone PME proposal which, by definition, does not **require** a Data Management Plan." **[Clarified and corrected May 19, 2016].**

4.2 <u>Evaluation Criteria and Review of PME Proposals</u>

PME proposals will be reviewed as part of the science research-program peer reviews. Appended PME proposals will be reviewed in the context of the full research proposal to which they are appended. Stand-Alone PME proposals will be reviewed only on the basis of information in the PME proposal itself; the previous proposal resulting in funding of the parent award will not be available to the review panel. Evaluation factors will be those listed in each science research Program Element, with the following additions:

- All proposals will be evaluated for the value that the equipment will add to the PI's proposed (for appended PME proposals) or funded (for Stand-Alone PME proposals) research. All proposals may be evaluated for the value that the new or enhanced capability would add to the planetary science community; however this will be a critical factor in the evaluation of facility instrument proposals.
- For facility instruments, reviewers may also consider the value to science beyond that offered specifically to the planetary science community.
- For facility instruments, review of the proposed facility-management plan may affect either or both the technical merit and cost elements of the evaluation.
- The relevance of an appended PME proposal is determined by the relevance of the research proposal to which it is appended, using evaluation criteria specific to the Target Program. Stand-Alone PME proposals are automatically deemed to be relevant because they are based on parent awards in the Target Program that have already been selected for funding.

4.3 Relationship of an appended PME proposal to the main science proposal.

Appended PME proposals will only be funded if the main science proposal itself is selected for funding, regardless of the intrinsic merit of the PME request.

In constructing a full research proposal with an appended PME request, the PI should consider whether and how the main part of the proposal could be executed if the PME request were not funded. Proposers are strongly encouraged to present a contingency plan (if one is possible) for the nonselection of the PME request. Such a plan should be part of the Scientific/Technical/Management section of the Main Proposal (not in the PME 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 was not available.

In general, the main science proposal will be evaluated under the assumption that the equipment proposed in the PME request will be selected for funding. The proposal may also receive a separate score for intrinsic merit, taking into account any contingency plan that was presented, that would apply if the PME request were to be declined.

4.4 Funding for PME awards.

In general, funding for PME awards is drawn from a separate PME-program budget, as noted in Section 5. PME proposals to all PME-eligible Target Programs may compete for these funds. Some Target Programs may also contribute to PME awards from their own program budgets, thereby augmenting the amount of PME funds available in a given year. However, if a PME proposal's budget contains any items other than equipment (e.g., funding for labor to conduct development activities), those funds are expected to be supplied by the Target Program, and the PME proposal will be in competition for these funds with regular research proposals submitted to that program.

5. Summary of Key Information

Expected annual program budget for new awards	~ $1.4M, 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 the maximum number of years permitted, refer to the guidelines of the Program Element to which the PME proposal is submitted.

Due date for proposals	For Stand-Alone PME proposals, Step-1 and Step-2 proposals should be submitted to the relevant science research program according to the schedule in Tables 2 and 3 in the *ROSES Summary of Solicitation*. For PME proposals appended to new research proposals, no separate Step-1 proposal is required; PME 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.
Page limit for the central Science/Technical/Management section of proposal	7 pp (see § 4.1.2 a) for stand-Alone proposals affiliated with an existing parent research award; 5 pp (See §4.1.1 b) for PME requests Appended to new proposals to programs (listed in §1.2); 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 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 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	Please refer to the specific science research Program Element. It will be of the form NNH16ZDA001N-AAA where AAA is the abbreviation for that program.
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 on April 8, 2016. This amendment delays the Step-1 due date for this program. Step-1 proposals are now May 2, 2016, and Step-2 proposals are still due by June 24, 2016.

This Program Element continues to use a two-step proposal submission process described in Section 2 of Appendix 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, Appendix C.2) or Solar System Workings (SSW, Appendix 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.

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 (Appendix C.12 PICASSO, and Appendix 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://www.isas.jaxa.jp/e/enterp/missions/hayabusa/index.shtml 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 is scheduled to launch 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 have low priority for LARS funding.

- Mars sample-return missions
- New Frontiers comet sample-return missions
- New Frontiers lunar sample-return missions
- Future Discovery missions (Discovery >13)
- 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 (PME). See Appendix C.17 for information on how to append a PME request to a regular LARS research proposal or submit a stand-alone PME proposal to supplement an existing LARS award.

Appended PME 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 PME 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 PME requests to LARS are the same as for other Program Elements.

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

Proposers to this Program Element may apply for Early Career Fellowships (ECFs). See Program Element C.16 for a description of the application and evaluation process.

3.4. Mission data, facilities, and resources

Please refer to ROSES-2016 Appendix C.1, §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 Appendix C.1, §3.3.

3.6 Statement of Relevance

Proposals to this Program Element do not require a separate or explicit statement of relevance. As stated in Appendix C.1, §3.4, all proposals, including those submitted to this Program Element, will be evaluated for relevance to the solicitation. 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)

Appendix C.1, §3.5, 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

Appendix C.1, §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 Appendix C.1 and in Chapter 2 of the *NASA Guidebook for Proposers*. Note that these requirements have been updated in 2016. 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	~$2.5M
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 in the *ROSES Summary of Solicitation*.
Due date for Step-2 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
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 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 required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
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	NNH16ZDA001N-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. Mandatory Step-1 proposals are due February 8, 2017, and Step-2 proposals are due May 3, 2017.

This is a new program element offered in ROSES-2016. 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 E-mail the program point of contact with any questions sufficiently ahead of the Step-1 proposal deadline. In addition, the NSPIRES page has a Frequently Asked Questions document 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 nonmission 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 data from any spacecraft not supported by a separate Planetary Science Division Data Analysis Program.

Investigations using the New Horizons 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 New Horizons 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) 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 mission data. These tasks may incorporate theory, modeling, laboratory studies, correlative analyses, and/or other research. Proposals that include tasks that are not data analysis 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 4.3 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 fifteen-page limit. This requirement supersedes Section 2.3.5 of 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 fifteen-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 Appendix C.1, The Planetary Science Division Research Program Overview, Section 3.3.

- Mission information can be accessed via the NASA website(s).
  - https://www.nasa.gov/mission_pages/newhorizons/main/index.html
- Mission data information can be accessed via the PDS webpage(s).
  - 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 Appendix 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 Section 2.3 of 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 Appendix C.1, Section 3.5). 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 Appendix 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 Appendix C.1, Sections 3.5-3.6, 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 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 Appendix C.1 and in Chapter 2 of the *NASA Guidebook for Proposers*. Note that these requirements have been updated in 2016. Violation of these rules is sufficient ground for a proposal to be rejected.

5. Planetary Science Division Early Career Fellowship Program

Proposals to this program element may include an application for an Early Career Fellowship (ECF). See Program Element C.16 for a description of the application and evaluation process.

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 in the *ROSES Summary of Solicitation*.
Due date for Step-2 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
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 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 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 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	NNH16ZDA001N-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 CONCEPTS FOR OCEAN WORLDS LIFE DETECTION TECHNOLOGY

NOTICE: September 16, 2016. The point of contact for this program element was changed to Meagan Thompson, see the Summary Table of Key information.

May 10, 2016. This amendment presents final text for Concepts for Ocean worlds Life Detection Technology (COLDTech). This text replaces in its entirety the placeholder notice that was released previously. Mandatory Step-1 proposals are due by June 17, 2016, and Step-2 proposals are due by August 12, 2016.

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 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 Concepts for Ocean worlds Life Detection Technology (COLDTech) Program supports the development of spacecraft-based instruments and technology for surface and subsurface exploration of ocean worlds such as Europa, Enceladus, and Titan. The goal of the program is to develop and reduce the technical risk of instruments and technology for potential future missions so that they may eventually be proposed in response to future Announcements of Opportunity (AOs) for flight missions. Note that the COLDTech Program itself does not solicit instruments or technology for a flight opportunity.

Specifically, COLDTech seeks to a) develop and advance the maturity of science instruments, especially those focused on the detection of evidence of life, especially extant life, in the ocean worlds of the outer Solar System (e.g., Enceladus, Europa, and Titan); b) sample acquisition, delivery and analysis systems for such missions, and c) spacecraft technologies required to access the oceans. Such spacecraft technologies may include, but are not limited to, technologies required to safely land on a poorly characterized or unknown surface, low power/mass/volume tools to melt or drill through an icy surface, high-radiation environment electronics, and low temperature power systems. Sample distribution systems capable of parsing and delivering samples to multiple instruments (and to one instrument multiple times) are of interest in order to reproduce results with the same, as well as different, instruments. Efforts that focus on advancing the technology readiness level (TRL) of a system composed of multiple existing technologies at various TRLs are allowed under this opportunity. While instruments focused on the detection of evidence of life, especially extant life, in the ocean worlds of the outer Solar System are especially of interest, COLDTech will not be limited to such instruments. NASA is currently studying a potential Europa lander mission, and instruments and technologies relevant to such a mission are also especially of interest.

The goal of the COLDTech program is to develop and reduce the technical risk of instruments and technologies so they can be proposed for future missions. Specific TRLs or missions are not prescribed for the COLDTech program since a broad range of technology maturity is solicited.

The scientific potential of ocean worlds is receiving increasing recognition, and COLDTech solicits instrument and technology developments that would be beneficial for both near and far term missions to ocean worlds. NASA is currently studying a potential Europa lander mission which, in time, may be the first “Ocean Worlds” landed mission. Many similarities exist between this Europa lander concept (including its technology and instrument needs) and other landers and in situ explorers for other worlds. As a result, the Europa lander mission concept, and especially its science objectives and challenging resource constraints, are broadly relevant to many planetary missions, especially those to ocean worlds. The instruments and technologies that address such a mission are also applicable to this same broad swatch of planetary missions. Information on the lander mission concept is presented below for reference to benefit COLDTech proposers. Proposers are encouraged to utilize the commonality between this mission concept and other possible planetary missions when crafting their proposals.

The current Europa lander mission concept envisions a "soft" landing system that would deliver the lander with a total mass of approximately 300 kg to the surface. The mission concept is anticipated to have a surface lifetime of less than 30 days using a power system consisting of solar panels and/or batteries. The lander would provide the ability to deliver multiple surface and/or subsurface samples to instruments. The anticipated prioritized goals of this mission are:

1. Search for evidence of biomarkers and/or life, especially extant life.
2. Assess the habitability (particularly through quantitative compositional measurements) of Europa via in situ techniques uniquely available to a landed mission.
3. Characterize surface properties at the scale of the lander to support future exploration, including the local geologic context.

The payload for this mission is not yet specified, but the payload and its resource allocation are expected to be quite limited due to the challenges posed by landing on Europa. While still under study, the current best estimates (CBE) for resource allocations for the entire payload are:

- 35 kg (26.6 kg CBE with 32% margin)
- 24,900 cm^3 (maximum expected value)
- 2,500 W-hrs (CBE for entire surface mission)
- 2,700 Mbits (CBE for entire surface mission)

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 role of the proposed development in an ocean worlds mission concept. For example, the science objectives and measurements of a proposed instrument development, the capabilities of the sample acquisition and delivery system, or the role of the proposed technology and the extent to which it is enhancing or enabling.

- Technology developments to mitigate risk. The proposal must describe a) the current maturity level of the proposed technology (including the TRL), b) the development plan to increase that maturity (including specific developments, testing, etc. to be pursued) and how these activities will reduce risk and mature the technology, and c) the expected maturity level (including the TRL) at the end of the COLDTech-funded development period. Note that standard NASA practice is for technologies to be at TRL 6 by the Preliminary Design Review for the flight mission. Thus, it is not expected that all technologies proposed to the COLDTech Program will reach TRL 6 by the end of the COLDTech effort.
- Mission Infusion. Since the purpose of technology development is to ultimately include the technology in a flight mission, proposals should include a short plan describing the proposers' strategies for maximizing the likelihood of mission infusion.
- One to two year awards. Awards may not exceed two years in duration.

Proposers are strongly encouraged to address the likely challenges presented by planetary protection, including requirements for sterilization, when exploring ocean worlds.

2.2 Additional Selection Considerations

In addition to standard evaluation definitions given in the ROSES *Summary of Solicitation* Section VI (a) and Section C.2 of the *NASA Guidebook for Proposers*:

The following will also be evaluated as part of merit:

- The likelihood that the proposed effort will successfully mature the proposed technology, as described in the proposal;
- The eventual ability of the technology to be accommodated within the anticipated resource constraints of a typical lander or in situ explorer to an ocean world.

The following will be evaluated as part of relevance:

- The relevance of the proposed development to the surface and/or subsurface exploration of the ocean worlds (e.g., Europa, Enceladus, and Titan), especially as it relates to searching for signs of life, especially extant life.

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.

- Interim and final briefings to program managers at NASA Headquarters. Both briefings should be conducted via teleconference. Budget should not be allocated for travel to NASA Headquarters in Washington, DC, for the final briefing.
- Final report to NASA Headquarters not to exceed 10 pages.

2.4 Participation in Other Programs

This program does not participate in the Early Career Fellowship program or the NASA

Postdoctoral Program

3. The Two-Step Submission Process

To facilitate the early recruitment of a conflict-free review panel, and to ensure proposals are submitted to the appropriate program, this program will use a two-step proposal submission process (see Section IV. (b) vii of the ROSES *Summary of Solicitation*.)

A Step-1 proposal is required and must be submitted electronically by the Authorized Organizational Representative (AOR). No budget is required. Only proposers who submit a Step-1 proposal are eligible to submit a Step-2 proposal. Full (Step-2) proposals must broadly contain the same scientific goals proposed in the Step-1 proposal. The PI cannot be adjusted and proposers that want to add funded investigators between the Step-1 and Step-2 proposals must inform the point(s) of contact below and cc sara@nasa.gov at least two weeks in advance of the Step-2 due date. Submission of the Step-1 proposal does not obligate the proposer to submit a Step-2 (full) proposal later.

3.1 Step-1 Proposal

Proposers should refer to the "Instructions for Submitting a Step-1 Proposal" under "Other Documents" on the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) webpage for this program. The Scientific/Technical/Management section of the Step-1 proposal is restricted to the 4000 character Proposal Summary text box on the NSPIRES web interface cover pages and no PDF upload is required or permitted. The Step-1 proposal should include a brief description of the goals and objectives of the proposal, a brief description of the methodology to be used to address them, and the relevance of the proposed research to this call. The Step-1 proposal may be used to determine whether the proposal was submitted to the appropriate program element. No evaluation of intrinsic merit will be performed on Step-1 proposals.

NSPIRES will notify proposers whether their Step-2 proposal is encouraged or not, at which point they will be able to submit Step-2 proposals.

3.2 Step-2 Proposal

This is a reminder that all proposals submitted to ROSES must strictly conform to the formatting rules in Section IV of the *Summary of Solicitation* and Chapter 2 of 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	~ $20M/Year
Number of new awards pending adequate proposals of merit	~ 15 awards
Maximum duration of awards	2 Years
Due date for Step-1 proposals	June 17, 2016
Due date for Step-2 proposals	August 12, 2016
Planning date for start of investigation	December 1, 2016
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 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. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
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	NNH16ZDA001N-CLDTCH

NASA point of contact concerning this program	**Meagan Thompson** NASA Program Officer Planetary Science Division Science Mission Directorate National Aeronautics and Space Administration Washington DC 20526-0001 Telephone: 202-358-**1733** E-mail: **meagan.thompson@nasa.gov** **[Changed September 16, 2016]**

C.21 SMALL INNOVATIVE MISSIONS FOR PLANETARY EXPLORATION

NOTICE: The Planetary Science Division no longer plans to offer the Small Innovative Missions for Planetary Exploration (SIMPLEx) Program as program element C.21 of ROSES-2016. Instead, NASA anticipates that this program element will be included in ROSES-2017.

1. Program Description

This solicitation supports the formulation and development of science investigations that require a spaceflight mission that can be accomplished using small spacecraft. All proposed investigations must be responsive to the goals of the Planetary Science Division, as described in the *2014 NASA Science Plan* available at http://science1.nasa.gov/about-us/science-strategy/. In order to advance the objectives outlined in the Science Plan, proposed investigations may target any body in the Solar System except for the Earth and Sun. Investigations of extra-solar planets are not solicited in this program element.

CubeSats are small satellites built from a set of standardized subunits that each measure 10x10x10 cm and weight 1.33 kg (designated '1U'). Common configurations include 1U, 2U, 3U, and 6U (2Ux3U) satellites, deployers for all of which are commercially available. Due to their standardized form and low-cost disposable nature, these satellites are suitable platforms on which to train students and early career researchers. Proposers may also refer to Section V(b)(v) "Use of Short Duration Orbital Platforms, including CubeSats" of the ROSES Summary of Solicitation.

Proposals to this program element may propose to use 1U, 2U, 3U, and 6U form factors. Larger satellites and hosted payloads are not solicited at this time. This program element encourages, but does not require, the submission of CubeSat investigations that operate in interplanetary space and would, therefore, meet more demanding engineering and environmental requirements than has been experienced by previous CubeSats. While it is expected that proposed investigations would involve some advanced engineering development of instruments and/or spacecraft systems technology, all proposals must include a science investigation that will return and publicly archive usable scientific data and result in the publication of results in refereed scientific journals.

Activities such as extended missions, guest investigator programs, general observer programs, participating scientist programs, and/or interdisciplinary scientist programs, where appropriate, have the potential to broaden the scientific impact of investigations. Such optional activities may be proposed as Science Enhancement Options (SEOs). Flight hardware may not be proposed as SEOs. NASA considers any proposed SEO activities as optional. Inclusion of such optional activities in a proposal does not imply a commitment from NASA to fund them, even if the baseline investigation is selected. NASA reserves the right to accept or decline proposed SEO activities at any time during the mission; in particular, the decision may not be made at the time the baseline investigation is selected for flight. The process for deciding on SEO activities may involve further reviews (e.g., a "Senior Review" for extended missions). NASA reserves the right to solicit and select all participants (e.g., guest investigators and participating scientists) in such programs.

All SIMPLEx investigations are cost-capped missions; however, optional risk reduction activities will be considered. In the development of any cost-capped mission, trades are performed between different activities. Some of these trades may serve to reduce the implementation risk of the mission (e.g., tests of various types, fabrication of high fidelity simulators). This solicitation encourages proposers to include a description of activities which might reduce the implementation risk of their investigation, but which cannot be accommodated under the cost cap — Risk Reduction Activities. NASA will consider these activities as optional. Inclusion of such optional activities in a proposal does not imply a commitment from NASA to fund them, even if the baseline investigation is selected. NASA reserves the right to accept or decline proposed risk reduction activities at any time during the mission; in particular, the decision may not be made at the time the baseline investigation is selected for flight.

2. Programmatic Information

For further information about the SIMPLEx Program contact:
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C.22 DYNAMIC POWER CONVERTORS FOR RADIOISOTOPE POWER SYSTEMS

This program element has some rules and requirements that differ from those set forth in other documents, such as the Planetary Science program overview, C.1, and the ROSES *Summary of Solicitation*. Where conflicts exist between this program element and those documents, the rules in this program element take precedence, see Section I(h) of the ROSES *Summary of Solicitation*.

1. Background

The NASA Radioisotope Power Systems Program Office (RPSPO) seeks to investigate dynamic power conversion technologies for Radioisotope Power Systems (RPS). The current RPS, the Multi-Mission Radioisotope Thermoelectric Generator (MMRTG), produces ~110 W_e at a conversion efficiency of 6 %. NASA desires higher conversion efficiency RPS options that are reliable and robust with long design life. Dynamic conversion methods offer the potential for higher conversion efficiencies, but have yet to be demonstrated in a flight application. Examples of dynamic conversion technologies include Brayton, Stirling, and Rankine cycle machines.

The goal of this effort is to investigate dynamic conversion technology options suitable for use in a power system that utilizes General Purpose Heat Source (GPHS) Step 2 modules. The intent is to gather data on candidate dynamic conversion technologies to fill knowledge gaps, support assessments of dynamic conversion technologies, and elicit generator requirements. The focus of this effort is on the conversion technology itself, the technology required to operate the convertor (i.e., controllers), and the thermal management necessary to operate the convertors. NASA will lead this convertor technology investigation while collaborating with the US Department of Energy (DOE). Once flight development risks for conversion technologies are understood and generator development is deemed practical, NASA and DOE will determine the path forward for DOE's development of a dynamic RPS for flight. As such, the flight requirements for the dynamic RPS are not finalized and this work will be integrated into the final set of system requirements.

2. Contract Framework

This solicitation may result in multiple contracts awarded for the design and fabrication of prototype dynamic convertors. Proposals that are selected for funding will be awarded contracts in phases. Award of subsequent phases is contingent upon reviews of deliverables at the end of each phase. At the conclusion of each phase, each contractor's deliverables and plans will be evaluated, and one or more contracts may be awarded to continue onto the next phase. Contractors will be notified whether or not they are selected to move to the next phase.

The work will comprise up to three phases, each summarized below:

2.1 Phase 1 (up to 6 months)

- The Government anticipates a firm fixed-price contract.
- Produce a convertor design and supporting analysis. Each contractor's design will undergo a design review at the end of Phase 1. One or more designs may be chosen to continue to Phase-2.

------------------- Inter-Phase requirements and deliverables negotiation-------------------

2.2 Phase 2 (up to 18 months)

- The Government anticipates a cost-reimbursement contract.
- Finalize the design, fabricate at least one prototype convertor, and demonstrate performance via experiment that includes at a minimum a set of Government-specified tests, then deliver the prototype convertor(s) to the Government. One or more of the Phase 2 participants may continue into Phase 3.

2.3 Phase 3 (up to 12 months)

- The Government anticipates a cost-reimbursement contract.
- Contractor provides support and consultation during the Government's independent evaluation on the prototypes at the NASA Glenn Research Center (GRC).

Between Phase 1 and Phase 2, a discussion and potential renegotiation of the requirements and deliverables will take place based on the outcome of the Phase 1 design review. Phase 2 will be awarded only after successful completion of Phase 1 and any subsequent negotiation of requirements/deliverables. Note that a proposal in response to this solicitation must address all three phases.

The Government will perform independent testing on the prototype convertors during Phase 3. These tests may include but are not limited to: performance mapping over a range of temperatures and input power levels, exposure to random vibration representative of launch, exposure to static acceleration, durability testing, DC and AC electromagnetic interference (EMI) characterization, and characterization of residual dynamic forces. The Government will not perform any life testing or thermal vacuum testing on the prototype convertors. However, thermal vacuum operation and life testing is anticipated for final flight convertors.

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 this solicitation or in the *NASA Guidebook for Proposers*.

Cost sharing is permitted, but will only be used as an evaluation factor by the selection official to differentiate proposals that are otherwise equal in rating.

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.

No proposals that have the NASA Glenn Research Center civil servants or contractors as prime or partner(s) will be accepted.

This solicitation assumes no equipment will be furnished by the Government.

The contractor shall use the SI unit system for all proposals and deliverables.

3. Dynamic Convertor Performance Goals

Requirements for a flight convertor are not complete at this time, however many performance goals have been formulated. As this dynamic conversion technology development effort progresses between now and 2020, flight convertor requirements will be adjusted as necessary. The purpose of this solicitation is to produce prototype dynamic convertors that will be useful for technology evaluation. The Government intends to evaluate the prototype convertors to understand each design's technical maturity, forward development risk, interfaces to a generator, effects on generator requirements, and the potential to mature each design for a robust, reliable, high-efficiency RPS. It is desired that the prototype convertors meet as many of the performance goals as possible, which are summarized in Table I. The contractor shall identify (in the proposal) which of these goals will be targeted and elevated to requirements for prototype convertor designs. It is also desired that prototype convertors be designed such that as many of these performance goals as possible can be demonstrated via test. It will not be expected of the contractor to verify every performance goal via test. The minimum set of performance verification tests required of the contractor is defined in the deliverables section of this solicitation.

Table I. Dynamic convertor performance goals

<table>
<tr><th>Category</th><th>Goal</th></tr>
<tr><td>Design life</td><td>20 years of continuous operation at full power</td></tr>
<tr><td>Start-stop cycles</td><td>Tolerant of 150 start-stop cycles without any permanent effect on performance</td></tr>
<tr><td>Launch vibration</td><td>No permanent loss of power or long-term effect after exposure to launch acceptance vibration testing, defined as:

Duration of 1 min in each axis
Convertor operating at full power at onset of random vibration
Random vibration of magnitude 10.35 g_{rms} in all axes with following spectral distribution:

<table>
<tr><th>Frequency (Hz)</th><th>Acceleration Spectral Density (g^2/Hz)</th></tr>
<tr><td>20</td><td>0.015</td></tr>
<tr><td>50</td><td>0.100</td></tr>
<tr><td>250</td><td>0.100</td></tr>
<tr><td>300</td><td>0.080</td></tr>
<tr><td>800</td><td>0.080</td></tr>
<tr><td>2000</td><td>0.015</td></tr>
</table>
</td></tr>
</table>

Static and quasi-static acceleration	Tolerant of exposure to static and quasi-static acceleration, defined as: • 5 g for 5 days in all axes while operating at full power at onset • 20 g for 1 minute in all axes while operating at full power at onset
Performance degradation	Output power decreases by less than 0.5 % per year for constant heat input (Does not include generator-level sources of degradation, such as Pu-238 fuel decay, or insulation degradation)
Thermal-to-electric conversion efficiency	> 25% (Defined as electrical power out from the convertor over heat input to the convertor)
Partial power operation	Maintains > 20 % thermal-to-electric conversion efficiency when input thermal power is 50% of designed maximum
Hot-end operating temperature	< 1000 °C
Cold-end operating temperature	Requires no less than 100 °C to meet efficiency goal Capable of operation between 20 and 175 °C
Thermal energy input	Must accept heat from an integer number of GPHS-Step 2 modules
Atmospheric environment	Capable of operation in: • Earth : 1 atm of air • 2 atm of argon • Deep space : vacuum • Mars : 5 torr CO_2 • Titan : 1.5 atm 94-99% N_2, 1-6% CH_4, and 0.2% H_2
Radiation	No loss of performance after exposure to 300 krad
EMI	DC magnetic field : less than 100 nT at 1 m while operating at maximum power AC magnetic field : No upper limit defined, but less is better, and ability to characterize is desirable
Autonomy	Convertor does not require external commands or setpoint adjustments in response to varying environments, for example: • No adjustments needed during launch • No adjustments needed during static acceleration • Simple startup procedure during fueling
Tolerance of loss of electrical load	Capable of loss of electrical load for 10 seconds while operating at full power without any permanent loss of performance
Transmitted forces	Low force transmission to structure is desirable
Specific power (W/kg)	> 20 W/kg
Manufacturability	Known manufacturable design is desirable Manufacturing or materials development is undesirable

Required instrumentation	Designs that do not require sensors for feedback or adjustment are desirable

These performance goals were determined via examination of anticipated RPS missions and generator environments. No flight-ready dynamic RPS design currently exists, but some general characteristics of an anticipated generator are known, and are described here to provide insight for convertor technology work. Based on mission studies from the *Vision and Voyages for Planetary Science in the Decade 2013-2022*, NASA desires a generator with a power output between 200 to 500 W_e. The arrangement of convertors within the generator is not specified, and the design space is flexible. Thus, the convertor power output (defined as the electrical power output at its terminals) is not currently restricted. The anticipated generator operating environments and missions are known at this time. The generator must be capable of operating on the ground, inside a spacecraft fairing, during transport in the approved shipping container with active fluid loop cooling, in low-Earth orbit, throughout a Venus flyby, during planetary entry/descent/landing, on certain planetary surfaces, and in deep space. The overall size of the generator is limited by the approved shipping container. A generator must fit within a cylindrical volume 0.6 m in diameter and 0.9 m in length. Based on these generator expectations, the rationale for each convertor performance goal (Table I) is as follows:

Long design life, with high reliability and robustness is most important. Life is critical because the dynamic convertor will have to provide power continuously for the duration of a mission; which could be as long as 17 years. Robustness is important because no project can perfectly predict all events that a power system will experience. A robust design will increase the confidence that a convertor technology will survive unforeseen events or off-nominal environments. Attention must be paid during the prototype convertor stage of development, so that robustness will be integral to the convertor design well before the generator flight development begins. Robustness is summarized as follows:

Robustness is a system characteristic enabled by design margins that result in controlling variability such that it is tolerant to factors encountered during manufacturing, transport, user operation or time. Robustness in manufacturing results in a system that is tolerant to process variations. Robustness in transport results in a system that is tolerant to handling variations. Robustness in user operation results in a system that is tolerant to environmental and control variations. Robustness in time results in a system that is tolerant to wear variations.

Specific examples of robustness include:

- Manufacturing repeatability does not require complex workmanship
- Convertor is not sensitive to transport loads, nor orientation during transport
- Convertor is tolerant of some amount of operational user error
- Wear characteristics are not dependent on complex workmanship

The start-stop, launch vibration, and static acceleration items were derived from knowledge of RPS processing and relevant missions. Prior projects have provided an estimate for the number of start/stop cycles the convertors will experience during flight generator production, for which 150 provides margin. Launch vibration environments are known for many vehicles. The flight acceptance level is set by NASA-STD-7001A. The spectral profile amounting to 10.35 g_{rms}

encompasses all planned launch vehicles for RPS missions. Previous RPS-equipped missions have utilized spin stabilization at various points during launch or cruise. The anticipated spacecraft size and RPS mounting distance were used to arrive at the 5g estimate. The duration of this 5g exposure was estimated by examining previous missions. The 20g static acceleration represents g-forces due to landing profiles, and was also derived from examination of candidate missions and knowledge of planetary landing methods. The Government plans to test the prototype convertors' performance while exposed to static acceleration. This type of test is performed with a centrifuge, which typically have limited control of spin-up and spin-down times. Because of this, any static acceleration test will have a time-dependent profile of g-load application. The planned centrifuge facility requires on the order of eight minutes to spin up to a g-load of 20 g, and the same amount of time to spin down to a stopped position. This profile of g-loading will be taken into account during any static acceleration tests performed by the Government.

The degradation goal was formulated by examining heritage RPS performance and the missions' scheduled power needs. The end-of-mission power output is most important, and could be as long as 20 years after fueling. The degradation value of less than 0.5 % per year will accommodate all foreseeable missions. It is expected that prototype dynamic conversion devices can be fabricated with long or infinite life components. A degradation rate of 0.5 % is allowed for known degradation mechanisms as well as uncertainty and unknowns related to conversion device degradation. This does not include generator-level sources of degradation, such as decay of the Pu-238 fuel, which alone causes a reduction in the available thermal input power by 0.8 % per year.

Conversion efficiency is important to enable an alternative to thermoelectric technology used in current RPS. A conversion efficiency that offers at least a 3x improvement over current thermoelectric technology is desired; hence the goal of 25% at the convertor level.

Operation at partial power is needed to enable generator designs with redundant convertors, and to account for Pu-238 fuel decay. This aspect is also referred to as "turn-down ratio" or "operation at part load." Generator concepts with redundancy consist of convertors that share heat sources and operate at half their maximum input power. This arrangement permits failure of a subset of convertors and a rerouting of thermal input power to the surviving convertors to compensate, with a corresponding increase in those convertor's output powers to maintain full generator power output. Operation at partial power is also necessary to account for Pu-238 fuel decay, even in the case of a nonredundant arrangement of convertors. For a 17-year mission, the end-of-mission available thermal input power could be as low as 80% of the initial thermal power.

The hot-end operating temperature ceiling of 1000 °C was derived from knowledge of GPHS temperature limits along with known heat source to convertor interface options. The outer surface of the GPHS module can operate no higher than 1100 °C.

The cold-end operating temperature limits were derived from known radiation heat transfer principles and known space radiator capabilities. Cold-end temperatures below 100 °C will substantially increase the radiator size and mass. The convertor must be capable of operating at a cold-end temperature of 175 °C to accommodate expected radiation sink temperatures; notably during planetary protection treatment, a Venus flyby, or a lunar environment with a dusty radiator.

Convertors must accept thermal energy input from one or multiple Step 2 General Purpose Heat Sources (GPHS). Each Step 2 GPHS is 5.3 cm x 9.32 cm x 9.72 cm rectangular cuboid. Each GPHS will produce between 244 and 256 watts of thermal power upon fueling, and uses Pu-238 with a half-life of 88 years. The GPHS module can operate at up to 1100 °C at its outside surface. During launch and Earth flybys, the outer surface of the GPHS must be maintained above 700 °C. More information on the GPHS module and its use in RPS can be found in Reference1 and 2.

Candidate future missions that would utilize RPS span a wide range of planetary atmospheric environments, but currently the goal is for compatibility with Earth, Mars, and Titan atmospheres only. Some generator designs may isolate the convertors from these atmospheres, but at this time it is desired that the convertors be capable of exposure to each atmosphere listed in the table.

The radiation dose was estimated by examining previous and candidate missions. Sources of radiation include that from the Pu-238 fuel, as well as external environments during travel through the solar system. Radiation can be in the form of electrons, protons, or alpha particles, but ground tests of radiation exposure are typically performed with gamma sources. The largest expected total ionizing dose (TID) is 150 krad, so to provide margin the goal for radiation TID tolerance is set at 300 krad.

The EMI goal was estimated by examination of candidate mission instrumentation, avionics requirements, and communications requirements. The DC magnetic field limit of 100 nT at 1 meter is necessary to enable magnetometer-equipped missions. This is a potential generator-level requirement, but it is assumed that less DC magnetic field from the convertor will ease the achievement of this requirement. This DC magnetic field limit assumes a spacecraft bus voltage of 28 V_{DC}. There is no goal currently for AC magnetic field emissions, but lower emissions are preferred. The Government may elect to perform AC magnetic field measurement and characterization on the prototype convertors. Characterizations of AC magnetic field may include: AC magnetic field intensity and frequency, frequency variability/phase noise, and harmonic content.

Convertor designs with autonomy that require minimal external intervention during the various operation modes of a mission are most desirable. Convertors that enable generator concepts, which operate autonomously in response to fuel decay, environmental changes, and other effects, are preferred over designs that require frequent monitoring and adjustment. The most advantageous generator is one that is capable of unattended operation with little or no risk. An example of this category is the need for adjustments during launch or static acceleration. A convertor that does not need adjustment commands during these mission stages is most desirable. Similarly, during generator fueling, a convertor that requires little user intervention to start is most desirable.

Designs that tolerate temporary loss of electrical load without effect on long-term performance would offer a desirable element of robustness. This ability would also provide a reaction period for other systems to take corrective actions, if necessary.

Low transmitted force (vibration or torque) from the generator to the spacecraft is necessary for many missions. Convertor designs that are inherently self-balanced, or have some feature that reliably reduces residual imbalance are desirable. While a generator could be augmented to reduce any residual dynamic force from the convertors, it is assumed that low convertor residual dynamic forces will result in low residual forces to be dealt with at the generator level. The residual dynamic force should be considered under all realistic scenarios, including failure modes and the transition to failure modes.

Specific power of the generator is a function of the conversion technology's specific power. A convertor with a specific power of 20 W/kg will yield a generator with a specific power that is comparable with existing RPSs.

Manufacturability of the convertor is important because of the timeline towards a flight mission. A design that is known to be easily manufactured using existing standard manufacturing processes is desirable.

Designs that do not require instrumentation for stable operation (such as hot-end temperature and moving component position) are preferable over designs that would require long-life sensors.

4. Phase 1 (up to six months) Deliverables

The following table summarizes the deliverables and their due dates. The details are discussed below.

Table II. Phase 1 Deliverable summary

Deliverable	Anticipated Due Date
Technical reports	Monthly
Kickoff presentation	Phase 1 start + 1 week
FMECA	50% through Phase 1
TIM #1 presentation	50% through Phase 1
Design description document	Phase 1 end
CAD solid model	Phase 1 end
Physics-based models	Phase 1 end
Performance verification plan	Phase 1 end
Phase 2 proposal update	Phase 1 end
Phase 1 final technical report	Phase 1 end
Phase 1 summary presentation	Phase 1 end
Phase 1 design review materials	Phase 1 end

During Phase 1, the contractor shall design a prototype convertor and perform supporting analysis. The contractor shall provide monthly technical reports each in the form of an electronic document, and support monthly status update telecons. The contractor shall support a Technical Interchange Meeting (TIM) near the middle of Phase 1. The contractor shall support a design review at the end of Phase 1. The contractor shall support a technical discussion with the RPS community at the end of Phase 1. The contractor shall provide the following specific deliverables during Phase 1 in accord with the due dates shown in Table II:

- Kickoff presentation - A presentation to introduce and summarize the upcoming work, in support of the kickoff meeting.
- FMECA - A spreadsheet that summarizes failure mode effects and criticality analysis at the convertor level. The FMECA draft template has been provided as an attachment to his solicitation. This template illustrates the extent of information sought by the Government. The contractor may provide equivalent information in other formats.
- TIM #1 presentation – A presentation to support the first TIM, which will cover design details, design status, and the FMECA.
- Design description document – A document that describes the convertor design, its features, and analysis of its performance. The contractor shall organize this document into the following sections:

  Prototype design description – a section that covers the following:
  - A discussion of which performance goals were targeted and used as requirements for prototype design
  - What design trades were considered during the design process
  - Description of heat source interface (temperature, area, heat flux)
  - Description of heat rejection interface (temperature, area, heat flux)
  - Nominal output voltage and current
  - A discussion of how flight convertors could be integrated in a 200 to 500 We generator, including interfaces to the GPHS module(s) and generator
  - Estimates of mass and volume for the prototype and flight convertor
  - Manufacturability of the prototype convertor
  - Discussion of convertor control requirements, i.e. what is necessary to maintain steady state operation of the convertor, what user adjustments or commands are needed to maintain safe operation of the convertor, what is necessary to regain control after a loss-of-control event, and what is necessary for startup and shutdown of the convertor.

  Prototype performance predictions – a section that covers the following:
  - Discussion of which performance goals are achieved by the prototype design, and those which are not achieved
  - Analysis or data supporting life prediction and reliability for a flight design
  - Methods for performance prediction (i.e. Sage / Simulink modeling, experimental data from similar devices, or other analyses)
  - Power output, efficiency (electrical power output / thermal power input), and specific power (W/kg).
  - Power output range
  - Scalability of design upwards and downwards in power output
  - Performance over the hot-end and cold-end temperature operating range

- Efficiency when throttled to accept a fraction of nominal thermal input power
- Calculation of residual dynamic forces, and possible mitigation methods (i.e. active or passive balancers, reaction wheel, etc.)
- Effect of start/stop cycles
- Maximum safe time rate of change ($\Delta T/\Delta t$) of convertor temperatures
- Convertor performance while undergoing launch vibration
- Convertor performance while undergoing static acceleration
- Convertor response to sudden component failure, such as seizure of a moving part, or sudden loss of working gas
- Description of potential degradation and aging mechanisms within the convertor, analysis of these mechanisms to determine their rates
- List of finite-life components
- Discussion of differences between the prototype design and a flight design, and the expected effects of these differences with regard to meeting the performance goals listed in Table I

Test support equipment (TSE) proposed – a section that discusses what TSE will be required to operate the convertor and demonstrate its performance both at the contractor's site and at the Government's site. This section shall also include a discussion of the control method necessary for laboratory operation of the prototype convertor.

Risk assessment – a section that discusses the risks associated with the concept if it were to be developed for flight, the severity of these risks, and how they could be mitigated:

- Risks associated with meeting the remaining convertor performance goals
- Design risks
- Flight manufacturing risks

Robustness assessment – a section that discusses the design's tolerance to off-nominal conditions such as the following:

- Temporary over-temperature on hot or cold ends
- Loss of electrical load while at design temperatures
- Higher-than-expected mechanical loads
- Tolerance of a component failure
- Manufacturing variance

Flight design maturation approach – a section that discusses forward work necessary to advance the design to meet the remaining flight convertor performance goals. This shall include the number of hardware build iterations required, and an estimate for flight convertor per-unit cost and fabrication time.

- CAD solid model - A set of 3D CAD files, including the individual components and top level assembly. Preferred format is Solidworks. Other formats are acceptable so long as they can be read by Solidworks, or are not proprietary.
- Physics-based models – Any top level models used to predict convertor steady-state performance, such as Sage or Simulink
- Performance verification plan – A document that discusses which of the requirements and performance goals will be demonstrated, and the method of demonstration. At a minimum

the contractor shall perform tests that demonstrate steady-state performance, operational capability over the required range of cold-end temperatures, capability of operation at partial input power, and capability for at least ten start/stop cycles. The performance demonstration shall accommodate optional on-site witnesses from the Government.

- Phase 2 proposal update – The contractor will refine the Phase 2 plan based on work performed during Phase 1. The contractor shall provide a document that updates the original proposal material for Phase 2, covering how the design will be fabricated, tested, and its performance validated. The updated Phase 2 proposal shall contain at a minimum the following information:
    - Cost estimate – an updated cost estimate cost for achieving the Phase 2 deliverables, including prototype performance verification testing
    - Schedule – an updated timeline for achieving the Phase 2 deliverables, including prototype performance verification testing
    - Manufacturing plan – a discussion of how fabrication will be managed, including how fabrication risks will be mitigated, identification of long-lead items, and discussion of critical operations.
- Phase 1 final technical report – A document that summarizes the accomplishments and deliverables of Phase 1
- Phase 1 summary presentation – The contractor shall provide a Phase 1 summary presentation that is suitable for sharing outside the Government. The Government may elicit input on the convertor designs from the RPS mission community.
- Phase 1 design review materials – The contractor shall provide data necessary to support a documentation and design review of the convertor design and plan as described in Table III.

Table III. Phase 1 Design Review Criteria

Needed for Review (Entrance Criteria)	Successful Review Criteria (Exit Criteria)
1 A design that can be shown to meet requirements and key technical performance measures. 2 Information on the mass and power including assumptions, uncertainties, Current Best Estimate (CBE), Not to Exceed Estimates, contingencies and margins. 3 Technical work products for prototype convertor hardware to be delivered in Phase II, if funded, have been made available to the cognizant participants 1 week prior to the review: a Product build-to specifications along with supporting trade-off analyses including producibility/manufacturability and data that are ready for Phase II after review comments are incorporated. b Fabrication, drawings, assembly, integration, and test plans and procedures are being developed and are ready for Phase II after review comments are incorporated.	1 The flow down of verifiable requirements is complete and proper or, if not, an adequate plan exists for timely resolution of open items. 2 The detailed design is expected to meet the requirements with adequate margins. Design considers the assessment of any single point failures or convertor limiting faults and potential mitigations. Provide evidence that calculations/analyses are performed under a specific quality standard and that data used in analyses are appropriate and traceable. 3 Documents are sufficiently mature to proceed with fabrication, assembly, integration, and test, and plans are in place to manage any open items. 4 Cost and schedule estimates are credible 5 Phase II plan is credible 6 The verification plan is complete. 7 The testing approach is comprehensive, and the planning for system assembly, integration and test is sufficient. All Test Support Equipment (TSE) has been identified, designed if necessary, costed and included in the cost and schedule. 8 Adequate technical and programmatic margins (e.g.,

c Technical data package (e.g., integrated schematics, spares provisioning list, interface control documents, engineering analyses, Test Support Equipment (TSE), parts and materials list, identification of facilities required (especially any needing modification or requiring specialty services and/or out of house services and specifications). d Control methodology (e.g., interfaces, instrumentation, telemetry, and data I/O) e Convertor to Generator interfaces (e.g., Assumptions (including environments), requirements and constraints between the conversion hardware and generator hardware) f Operating procedures including limits, constraints, startup and shutdown. g Verification plan including a verification matrix. h Technology readiness assessment. i Technology Development Plan. j Risk assessment and mitigation. k FMECA Table 4 Updated Costs and schedule 5 Updated Phase II Plan	mass, power) and resources exist to complete Phase II within budget, schedule, and known risks. 9 Risks for success are understood and credibly assessed, and plans and resources exist to effectively manage them. 10 Safety and mission assurance risks, FMECA, maintainability, manufacturing processes and test procedures have been adequately addressed in the system and operational designs, and are at the appropriate maturity level to begin Phase II manufacturing and test, and indicate that the safety/reliability/quality residual risks are at an acceptable level. 11 Any new or custom material properties tests are completed along with analyses of loads, stress, fracture control, contamination generation, etc. or industry standard materials are used. 12 COTS parts have been selected, and planned testing and delivery will support build schedules. If Custom parts have been selected the analyses supporting the selection and material properties are known, complete and documented. If sub-component knowledge is unavailable there is an achievable plan to develop the data. 13 The operational concept has matured, is at a sufficient level of detail, and has been considered in test planning. 14 Manufacturability has been adequately included in design. 15 The control methodology and appropriate hardware and software implementation are sufficient. 16 The Convertor to Generator interfaces are considered and understood and are achievable.

5. Phase 2 (up to 18 months) Deliverables

The following table summarizes the deliverables and their due dates. The details are discussed below.

Table IV. Phase 2 Deliverable Summary

Deliverable	Anticipated Due Date
Technical reports	Monthly
Cost reports – 533M and Q	Monthly
Updated CAD solid model	Phase 2 award date +1 month
Manufacturing drawings	No later than Phase 2 start +2 months
Operating procedures	No later than Phase 2 start +6 months

TIM #2 presentation	20% through Phase 2
TIM #3 presentation	40 % through Phase 2
Prototype performance test data	Phase 2 end
Convertor prototype(s)	Phase 2 end
Test support equipment (TSE)	Phase 2 end
Controller	Phase 2 end
Flight maturation plan	Phase 2 end
Phase 2 final technical report	Phase 2 end
Phase 2 final presentation	Phase 2 end

During Phase 2, the contractor shall fabricate at least one convertor prototype, demonstrate its performance, and deliver the prototype(s) to the Government for independent testing. At a minimum the contractor shall perform tests that demonstrate steady-state performance, operational capability over the required range of cold-end temperatures, capability of operation at partial input power, and capability for at least 10 start/stop cycles. During Phase 2, the Government will travel to the contractor's location to witness performance demonstration(s), and to receive a training briefing on the operation of the prototype. The contractor shall provide monthly technical reports each in the form of an electronic document, as well as support monthly technical status update teleconferences. Refer to NPD 9501 and the following link for the 533 cost report forms: http://www.nasa.gov/pdf/104405main_NASA_Forms_533.pdf. The contractor shall support two TIMs during Phase 2. The contractor shall provide the following during Phase 2 in accord with the due dates shown in Table II:

- Updated CAD solid model – An update of the 3D CAD files provided in Phase 1. Preferred format is Solidworks. Other formats are acceptable so long as they are not proprietary, and can be read by Solidworks.
- Manufacturing drawings – Detailed manufacturing drawings. Manufacturing drawings shall be provided in electronic format, either Solidworks drawing files or PDF.
- Operating procedures – Operating procedures to guide Government testing. i.e. startup, shutdown, and operating point changes.
- TIM #2 presentation - A presentation to support the TIM for reliability analysis planning
- TIM #3 presentation - A presentation to support the TIM for reliability analysis planning
- Prototype performance test data – An electronic report document containing data and test result discussion from performance verification tests performed on the prototype(s)
- Convertor prototype(s) – One or more convertors delivered to NASA for independent evaluation
- TSE (Test support equipment) - Any test support equipment deemed necessary for delivery to the Government via the interphase negotiation
- Controller – A laboratory controller necessary for operation of the prototype convertor. The controller can be integral to the TSE.
- Flight maturation plan – A document describing the convertor design and hardware technology maturation plan. The plan must address any of the convertor performance goals that were not achieved at the prototype level, and what development would be necessary to

mature the design for flight. The plan must also provide an estimate of development cost to achieve a flight convertor design, as well as a per-unit cost and fabrication time estimate for flight convertors.

- Phase 2 final technical report – A document summarizing the accomplishments and deliverables of Phase 2
- Phase 2 final presentation – A presentation in support of the Phase 2 final review meeting

6. Phase 3 Deliverables and Technical Support (up to 12 months)

Table V. Phase 3 Deliverable Summary

Deliverable	Anticipated Due Date
Technical reports	Monthly
Cost reports – 533M and Q	Monthly
Replacement parts, repairs	As needed

There are no predetermined hardware deliverables for Phase 3, but the contractor may be required to provide support to the Government's independent performance testing, in the following regards:

- Consultation during setup of prototype in Government lab
- Consultation of operating procedures
- Troubleshooting
- Repairs or adjustments to the prototype
- Spare part manufacturing

To aid planning of Phase 3, the contractor shall provide hourly rates to support these activities, and estimated part pricing, in the proposals and phase plans.

The Government will perform independent verification testing on the prototype convertors during Phase 3. These tests will include, but are not limited to: performance mapping over a range of temperatures, exposure to launch vibration, exposure to static acceleration exposure, durability testing, DC and AC electromagnetic interference (EMI) characterization, and characterization of residual dynamic forces. The Government will not perform any life testing or thermal vacuum environmental testing on the prototype convertors.

7. Reporting

The contractor shall provide monthly technical progress during all phases, as well as participate in monthly status discussions via telecon. During cost reimbursement contracts, the contractor shall provide monthly cost reports. The contractor shall also provide a final report at the conclusion of each phase. This final report shall be prepared in a format suitable for publication as a NASA Contract Report (CR). The actual publication of the CR may follow the completion of the work. Guidelines for preparing NASA CRs will be provided to winning contractors.

8. Travel

The contractor shall plan for and accommodate the following travel:

Phase 1

- Kickoff meeting – key personnel travel to GRC for 1 day at onset of Phase 1 to present proposal material and plans for Phase 1
- TIM #1 – key personnel participate in a Technical Interchange Meeting (TIM) for 2 days near the middle of Phase 1. Information will be exchanged in support of risk analysis.
- Phase 1 design review – key personnel travel to GRC for 1 day to present an out brief of the Phase 1 accomplishments and deliverables
- Phase 1 presentation to RPS community – key personnel travel to meeting location to share Phase 1 results with non-Government participants, such as system integration contactors or mission investigators

Phase 2

- TIM #2 – key personnel participate in a TIM for up to one week near middle of Phase 2. Information will be exchanged in support of risk analysis.
- TIM #3 – If deemed necessary by the Government, a third TIM will be held. Key personnel participate in a TIM 2-3 days. Information will be exchanged in support of risk analysis.
- Phase 2 final review – key personnel travel to GRC for 1 day to present an out brief of the Phase 2 accomplishments and deliverables

Phase 3

- Test support – key personnel travel to GRC twice for a duration of up to 5 days each trip, to support prototype testing

9. Two-Step Proposal 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 Appendix C.1 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 an Authorized Organizational Representative (AOR). Every organization that intends to submit a proposal to NASA in response to this NRA must be registered in NSPIRES. Organization registration must be performed by an organization's electronic business point-of-contact (EBPOC) in the System for Award Management (http://www.sam.gov). Completing the registration process may take some time; proposers are urged to begin this process early. Additionally, each individual named as a participant on the proposal cover page must be registered in NSPIRES and must confirm his or her participation via the system. See the ROSES *Summary of Solicitation* for additional details.

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 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.

9.1 Step-1 Proposal

Submission of a notice of the mandatory Step-1 proposal is required to aid Government review planning. The Scientific/Technical/Management section of a Step-1 proposal shall be submitted via NSPIRES and is restricted to the 4000 character text box on the NSPIRES web interface cover pages. The Step-1 proposal must include: an identifiable title of the forthcoming proposal, proposing company and point-of-contact (POC), names and affiliations of team members, personnel roles and responsibility, and an abstract summarizing the upcoming proposal.

Following the submission of a Step-1 proposal, the proposer will be notified through NSPIRES whether the Step-2 proposal is "encouraged" or "discouraged," at which point the proposer will be able to submit a Step-2 proposal. No evaluation of intrinsic merit will be performed on Step-1 proposals. The perceived relevance of the proposed work to the particular Program Element will be the main factor in deciding whether submission of a Step-2 proposal will be encouraged. Please note that the Step-2 proposal evaluation is independent of the Step-1 evaluation.

9.2 Step-2 Proposal

The NSPIRES web interface cover page budget is not needed for proposals submitted to this program element. Other than that budgets follow the standard ROSES-2016 rules. That is, no dollar values for salary, fringe or overhead should appear in the main proposal PDF file. However, all budget details, including salary, fringe or overhead for the proposing organization and all sub awards should appear in the separately uploaded "total" budget file. The main proposal PDF file should include a summary table of work effort and a justification of the cost of procurement items other than salary, fringe or overhead.

The offeror shall provide a proposal introducing a dynamic convertor concept that has the potential to meet the aforementioned needs of the Government. Refer to the Technical Deliverables section of this document for details on what work will be performed during each phase. Note that proposals need not consume the maximum allotted time for each phase. For example, if the contractor has a relevant design or hardware at the ready, an abbreviated Phase 1 or Phase 2 period is permitted and encouraged. The proposal may not exceed 30 pages of technical discussion text. Figures or illustrations may occupy up to 10 additional pages beyond the 30 allotted for technical discussion text. Technical discussion contained on figures or illustrations will not be evaluated as part of the proposal. Step-2 Proposals must strictly adhere to the standard formatting requirements (fonts, spacing margins, etc.) described in Section 2.2 of Planetary Science Research Program Overview. The uploaded proposal PDF file must not exceed the ROSES limit of 20 MB in size. Proposals that violate the rules may be rejected without review or declined following review on this basis alone.

The offeror shall provide a proposal containing at a minimum the following information organized in the following manner:

Concept Description

- Concept description with a top-level assembly illustration and cross sectional view
- Overall convertor estimated dimensions
- Underlying assumptions and rationale
- Design trades that will be evaluated in Phase 1

Concept performance characteristics

- Identification of which convertor performance goals (Table I) will be pursued, and which will be promoted to requirements for the prototype convertor(s)
- Concept performance (power output, efficiency), and operating limits (hot-end and cold-end temperature ranges, nominal output voltage and current)
- Estimated convertor mass and specific power
- An estimate of partial power operational capability (ability to operate at a fraction of design input power)
- Method of performance estimation
- How the concept achieves long operating life with high reliability and robustness
- A discussion of mechanisms of degradation during long-term operation
- Basis for power output size selection, and cursory discussion of how it could be arranged in a 200-500 We generator
- Software that will be used for modeling, design, and analysis
- A discussion of what is necessary to accept heat from GPHS modules.
- A discussion of what is necessary to reject heat from the rejection zone of the cycle
- Identification of any issues meeting the requirements for operation in planetary atmospheres
- Identification of any weaknesses that would not meet the radiation tolerance requirement
- A discussion of residual dynamic force emitted by the convertor, and possible mitigation methods. This should cover nominal, as well as off-nominal and failed component scenarios
- Expected behavior while undergoing launch vibration in the cases of operating and non-operating
- Expected behavior while undergoing static acceleration in the cases of operating and non-operating
- A discussion of expected convertor EMI and possible mitigation methods. This need not include EMI from controller hardware
- An estimate of convertor life, method of estimation, identification of life-limiting components, and reasons why those components are life limiting
- A discussion of what's required for convertor control during all stages of a mission, and viable methodologies. Include discussion of what is required for startup and shutdown, and any sensors necessary for convertor control.

Work plan

- Plan for Phase 1, including cost and schedule estimate
- Plan for Phase 2, including cost estimate, schedule, fabrication plan, and performance verification plan
- Plan for Phase 3 support, including cost estimate

9.3 Step-2 Proposal Evaluation Criteria

The three basic evaluation criteria are given in the *ROSES Summary of Solicitation* Section VI (a) and Section C.2 of the *NASA Guidebook for Proposers* and they are Relevance, Merit, and Cost. Clarifications and additions specific and to this program element are listed below. The following items specific to this dynamic RPS convertor development effort will also be considered when evaluating the relevance, merit, and cost reasonableness of the proposals:

- Amount of supporting evidence for claims of convertor potential performance
- Number of performance goals that the concept is predicted to achieve
- Advantage over previous dynamic convertor development efforts
- Feasibility of proposed concept
- Ease of convertor concept integration into a subsequent generator development effort
- Disclosure of risks for prototype and flight convertor development
- Clarity of declaration of intellectual property that will retain limited data rights

10. Data Rights and Export Control

The Government parties involved with the selected convertor development contracts shall have access to all data products that emerge throughout the three phases. Any intellectual property possessed by the proposing entity prior to contract activities, developed with private funds, must be declared as such in the proposal, and may be subject to negotiation prior to contract award. Items deemed preexisting intellectual property may be identified with limited data rights. All other data throughout the three phases of the effort will be identified with unlimited data rights. See Federal Acquisition Regulation (FAR) clause 52.227-14, Rights in Data-General, for more information.

The NASA Glenn Research Center Export Administrator has made the determination that the work performed under these contracts will not be subject to the export control laws and regulations of the United States.

11. Summary of Key Information

Expected annual program budget for new awards	$1M per year for up to 3 years
Number of new awards pending adequate proposals of merit	~1-6 awards.
Maximum duration of awards	3 years
Due date for Step-1 proposals	See C.22 in Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for Step-2 proposals	See C.22 in Tables 2 and 3 in the *ROSES Summary of Solicitation*.

Planning date for start of investigation	~7 months after proposal due date
Page limit for the central Science-Technical-Management section of proposal	Maximum 30 pages of text for the "Science-Technical-Management" section of the proposal, and up to 10 pages for figures; see also Chapter 2 of the *NRA Proposers Guidebook* at: http://www.hq.nasa.gov/office/procurement/nraguidebook/
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 *Summary of Solicitation* of this NRA.
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 proposals	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Procurement point of contact	Melissa Merrill, melissa.a.merrill@nasa.gov
Technical point of contact	Salvatore Oriti, salvatore.m.oriti@nasa.gov

12. References

[1] C. Vining, G. Bennett, Power for Science and Exploration: Upgrading the General-Purpose Heat Source Radioisotope Thermoelectric Generator, 46th Joint Propulsion Conference & Exhibit. July 2010, attached to this solicitation

[2] D. Pantano, D. Hill, Thermal Analysis of Step 2 GPHS for Next Generation Radioisotope Power Source Missions, American Institute of Physics Conference Proceedings February 2005.

13. Acronyms and Definitions

DOE	Department of Energy
EMI	Electromagnetic interference
GPHS	General Purpose Heat Source
GRC	Glenn Research Center
MMRTG	Multi-Mission Radioisotope Thermoelectric Generator
NASA	National Aeronautics and Space Administration
NOI	Notice of Intent
RPS	Radioisotope Power System
RPSPO	Radioisotope Power Systems Program Office

TIM	Technical Interchange Meeting
TSE	Test Support Equipment
atm	Unit of atmospheric pressure
grms	Unit of acceleration magnitude
krad	Unit of radiation dosage
N	Unit of force, Newton
nT	Unit of DC magnetic field, nano-Tesla
torr	Unit of atmospheric pressure
W/kg	Units of specific power, watts per kilogram

C.23 PLANETARY SCIENCE DEEP SPACE SMALLSAT STUDIES

NOTICE: This program element does not use the two-step proposal submission process. Notices of intent to propose are requested by September 30, 2016, and proposals are due by November 18, 2016. No data management plans are required with submissions to this program element.

1. Scope of Program

This program element supports the study of spaceflight mission concepts that can be accomplished using small spacecraft, including CubeSats. All proposed investigations must be responsive to the goals of the Planetary Science Division, as described in the *2014 NASA Science Plan*. Additionally, proposals may address the operational requirements of the Planetary Defense Coordination Office in conducting surveys for potential Near Earth Objects (NEO's) and characterization of known NEO's as documented in the National Research Council study, "Defending Planet Earth: Near-Earth Object Surveys and Hazard Mitigation Strategies Final Report," released in 2010.

NASA's Planetary Science Program is considering including small secondary payloads on every future planetary science launch. As such, studies performed under this program element will provide valuable information to assist future Announcement of Opportunity planning and NASA's development of small spacecraft technologies relevant to deep space science investigations.

In order to advance the objectives outlined in the Science Plan, proposed investigations may target any body in the Solar System, including near Earth objects (NEO's), except for the Earth and Sun. Investigations of extra-solar planets are not included in this program element.

The Planetary Science Deep Space SmallSat Studies (PSDS3) program is intended to capitalize on the creativity in the planetary science community to envision science enabled by smaller and significantly lower cost deep space missions. NASA expects to make awards for mission concept studies that will explore the breadth of missions possible that are enabled by CubeSat/SmallSat technologies. Mission design assistance, if required, for these mission concepts will be offered by NASA during the six-month studies. NASA Headquarters will also use the results of these studies when considering expanding the provisions and capabilities of future Announcements of Opportunity for technology development.

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. 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'). Common configurations include 1U, 2U, 3U, and 6U (2Ux3U) spacecraft. 12U and 24U configurations are also being developed, although they are not yet fully documented as standard formats. NASA has previously developed several 3U CubeSat missions that have flown in low-Earth orbit (e.g., GeneSat, PharmaSat, O/OREOS).

Proposals to this program element may propose to use CubeSat form factors from 1U up to 12U and 24U or larger Evolved Expendable Launch Vehicle Secondary Payload Adapter (ESPA) mounted satellites up to 180kg. Hosted payloads are not solicited at this time. This program element requires the submission of investigations that would operate in interplanetary space and, therefore, must meet more demanding engineering and environmental requirements than have been experienced by missions in low Earth orbit.

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 study awards across a range of mission concepts requiring new technologies that will enable smaller missions in deep space. Mission cost ranges (Phases A through F) to be explored are \$10M to \$100M and mass ranges from 1U (~1.3kg) to ESPA class (180kg) over a variety of form factors.

For information on NASA's small satellite platform technologies, visit the NASA Small Satellite Technology Program.

3. Requirements

As in all NASA Planetary competed missions, the studies are to be led by a designated Principal Investigator (PI) with a small science team. 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 with experience in 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, if needed, NASA field centers will provide study teams access to mission design assistance. 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.

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

Glenn Research Center - COMPASS Lab
https://re.grc.nasa.gov/compass/
Steve Oleson steven.r.oleson@nasa.gov 216-977-7426

Goddard Space Flight Center - Integrated Design Center
https://idc.nasa.gov/mdl/index.php
Jennifer Bracken jennifer.m.bracken@nasa.gov 301-286-5127

Jet Propulsion Laboratory - TeamX-C
http://www.jpl.nasa.gov/cubesat/
John Baker john.d.baker@jpl.nasa.gov 818-354-5004

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

Kennedy Space Center - Launch Services Program
http://www.nasa.gov/mission_pages/smallsats/elana/
Robbie Ashley robert.l.ashley@nasa.gov 321-867-6037

Marshall Space Center - Advanced Concepts Office
http://www.nasa.gov/centers/marshall/capabilities/adv_capabilities.html
Jack Mulqueen jack.mulqueen@nasa.gov 256-544-0534

Successful proposers will be expected to produce a publicly releasable mission concept study summary/fact sheet and present a summary of their study at a special session of a domestic Planetary Science Conference, to be arranged by NASA after awards are made. Additionally, a full written report to NASA is required (see Section 6.3).

Short proposals (up to ten pages) are solicited that clearly summarize the mission concept, science target(s) and objectives, relevance to NASA Planetary Science objectives, and the nature of the science advancement expected from the mission.

This program element solicits only concept studies for planetary science missions; it does not solicit technology development, flight instrumentation, or any hardware development. Proposals for mission concepts not appropriate for the Planetary 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 should adhere to the following parameters:

- Any Solar System body, including NEO's but excluding the Sun and the Earth, is permitted. Multiple targets are permitted. Mission concepts dealing with extrasolar planets are not permitted under this program.
- Mission concepts may not include the use of radioisotope power systems or heater units.
- Mission concept architectures requiring multiple spacecraft are permitted.
- For mission concepts requiring or providing auxiliary communications relay capability, study teams may assume that NASA will supply the recently developed Iris Communication Cube as Government Furnished Equipment (GFE).
- Mass/Volume of up to 24U CubeSat format or 180kg ESPA ring mounted secondary payload. Studies will examine if new dispenser/deployment designs will be required to accommodate the mission design.
- The mission concepts should target costs of less than $100M, excluding launch and integration into carrier (if required).

Note: While the above establish limits for mass, volume, and cost, NASA desires to significantly reduce the resources required for innovative new missions, and, therefore, intends to award a range of studies across the spectrum of mass, volume, and cost.

5. Programmatic Information

Answers to questions will be posted on the NSPIRES web page for this program element under "Other Documents".

5.1 Compliance Requirements

Proposers should be aware of the following compliance requirements 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.
- Mission concept studies must be completed within six months of award.
- NASA expects to fund a number of studies at a level of $200,000-$500,000 per study that span the range of CubeSat/SmallSat capability and mission cost. Proposals are required to provide a commitment letter from each participating institution (industry, Government, research, or academic) indicating a commitment to conduct the proposed study. Proposals that request funds significantly beyond this amount or that do not provide an institutional commitment are subject to return without review.
- The augmentation of the proposed study by using institutional discretionary funds or partnering with another institution is permitted.
- Proposals must strictly conform to the formatting rules in Section 2.2 of Program Element C.1 The Planetary Science Research Program Overview and Chapter 2 of the *NASA Guidebook for Proposers*. Proposals that violate the rules may be rejected without review.

5.2 Evaluation Criteria

The three basic evaluation criteria for the PSDS3 program are listed in the ROSES Summary of Solicitation Section VI (a) and Section C.2 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:

- Realism and feasibility of the proposed study plan, and
- Impact and importance of the science advancement expected from the mission, including a description of how and to what extent the proposed research will advance our current state of knowledge.

For this program relevance will be evaluated according to:

- Relevance of the proposed mission concept to PSD objectives as demonstrated by linkages between the mission concept objectives and the *2014 NASA Science Plan*, or

- Relevance of the proposed mission concept to the National Research Council study, "Defending Planet Earth: Near-Earth Object Surveys and Hazard Mitigation Strategies Final Report" as demonstrated by linkages between the mission concept science objectives and the themes defined in the report.

5.3 Proposal Guidelines

Proposals must be submitted by an institution hosting a scientist serving as the Principal Investigator (PI) for the study. Proposals should contain all elements described in Section 2.3 of the *NASA Guidebook for Proposers*. However, the Scientific/Technical/Management section of the proposals is limited to 10 pages rather than 15 pages. This section should be sure to discuss 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 technologies to be assessed. (seven pages)

Proposals should include a mission study fact sheet (one page) that is not counted against the page limit. This fact sheet should include the science objectives, relevance, and importance to PSD science and/or Planetary Defense objectives, mission overview (including mission objectives and major mission characteristics), anticipated payload, mission management (if known), and mission schedule.

5.4 Final Report

It is expected that mission design work during the study will force 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 target(s) and rationale
- Level 1 science requirements, traceability to Section 4.3 of the Science Plan or the NRC Near Earth Object final report, and the proposed instrument complement with supporting rationale
- Core science team expertise and traceability to mission objectives
- Mission design/architecture (trajectories, multiple spacecraft, etc.)
- Preliminary instrument complement
- Spacecraft concept, mass budget, power budget, telemetry rates
- Technology needs, quantified gaps, and development required
- Concept of Operations
- Launch vehicle interface and deployment method
- Estimated Mission Costs and explanation of the cost estimation method
- 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.

Proposers must allocate sufficient travel funds to be able to present their concept and study results at a special session of a domestic Planetary Science Conference, to be arranged by NASA after awards are made.

6. Summary of Key Information

Expected annual program budget for new awards	~ $3.0M
Number of new awards pending adequate proposals of merit	~ 6-15
Maximum duration of awards	6 months
Due date for Notice of Intent to propose (NOI)	See C.22 in Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See C.22 in Tables 2 and 3 in the *ROSES Summary of Solicitation*.
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	See the *NASA Guidebook for Proposers Responding to a NASA Research Announcement – 2016.*
Page limit for the central Science-Technical-Management section of proposal	10 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Submission medium	Electronic proposal submission is required; no hard copy is required. 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	NNH16ZDA001N-PSDS3
NASA point of contact concerning this program	Carolyn Mercer Planetary Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-1014 E-mail: cmercer@nasa.gov

C.24 HOT OPERATING TEMPERATURE TECHNOLOGY PROGRAM

NOTICE: This program element does not use the two-step proposal submission process. Notices of Intent are requested by September 28, 2016, and the due date for proposals is November 23, 2016. No data management plans are required with submissions to this program element.

1. Scope

The Hot Operating Temperature Technology (HOTTech) program supports the advanced development of technologies for the robotic exploration of high-temperature environments such as the Venus surface, Mercury, or the deep atmosphere of Gas Giants. The goal of the program is to develop and mature technologies that will enable, significantly enhance, or reduce technical risk for *in situ* missions to high-temperature environments with temperatures approaching 500 degrees Celsius or higher. It is a priority for NASA to invest in technology developments that mitigate the risks of mission concepts proposed in response to upcoming Announcements of Opportunity (AO) and expand the range of science that might be achieved with future missions. Note that this HOTTech program element is not soliciting hardware for a flight opportunity.

HOTTech is limited to high temperature electrical and electronic systems that could be needed for potentially extended *in situ* missions to such environments. NASA seeks to maximize the benefits of its technology investments and consequently technologies that offer terrestrial benefits in addition to meeting needs of planetary science. While specific technology readiness levels (TRLs) are not prescribed for the HOTTech program, proposers are reminded that the goal of the program is to mature technologies so they can be proposed as part of a selectable mission concept or technology demonstration to a flight AO with reduced risk. It is the responsibility of the proposer to describe how their proposed technology development effort addresses the goals of enabling or enhancing future mission capability or reducing risk and how the technology will be matured for a flight opportunity as part of an integrated system. Efforts that focus on advancing the TRL of a system composed of multiple existing technologies at various TRLs are allowed under this opportunity.

Proposed technologies are expected to have applicability to either a) mission concepts recommended by the Decadal Survey or b) helping answer decadal science questions. Prospective proposers are encouraged to review The Decadal Survey (*Vision and Voyages for Planetary Science in the Decade 2013-2022*) for additional information on the recommended science objectives for these mission concepts, but strict adherence to those recommended science objectives is not required.

The use of NASA facilities and the related costs can be included in proposals to this call, per agreement with relevant Points of Contact (POCs). Examples of potential facilities include the Glenn Extreme Environment Rig (GEER) at NASA GRC (POC: lori.arnett@nasa.gov), Venus In-situ Chamber Investigations (VICI) at NASA GSFC (POC: natasha.m.johnson@nasa.gov), the NASA Glenn Microsystems Fabrication Clean Room (POC: glenn.m.beheim@nasa.gov) and other facilities found on the VEXAG website or other sources. Inquiries can be directed to Adriana Ocampo at aco@nasa.gov and Quang-Viet Nguyen at quang-viet.nguyen@nasa.gov for further information.

2. Programmatic Considerations

Proposers to this call are not required to provide a data management plan.

2.1 Special Considerations and Requirements for Proposals

All proposals submitted to this program must specify:

- The role the proposed technology would have in helping achieve decadal science questions.
- Any potential for spin-off into terrestrial applications
- Technology development that would occur should the proposal be selected. The proposal must describe:
  a) the current maturity level of the proposed technology,
  b) the development plan to increase that maturity (including specific developments, testing, etc. to be pursued) and how these activities will reduce risk and mature the technology, and
  c) the expected maturity level at the end of the HOTTech-funded development period.
- Awards may not exceed three years in duration, but standard rules for no cost extensions will be followed.
- Awards to external organizations may be made as grants, cooperative agreements, or contracts, depending on the nature of the work proposed, and inter- or intra-Agency transfers, depending on the proposing organization. The Science Mission Directorate (SMD) will send funds directly to the Co-Investigators (Co-Is) at NASA Centers and other Government laboratories, including the Jet Propulsion Laboratory (JPL).

2.2 Additional Selection Considerations

The three basic evaluation criteria are given in the *ROSES Summary of Solicitation* Section VI(a) and Section C.2 of the *NASA Guidebook for Proposers* and they are Relevance, Merit, and Cost. Clarifications and additions specific to this program element are listed below. The following will also be evaluated as part of merit:

- The likelihood that the proposed effort will successfully mature the proposed technology;
- The potential that the proposed effort may lead to adoption or use by a commercial entity as a product in order to leverage the resources applied by NASA; and
- The likelihood that the proposed work will help reduce the risk of a mission concept proposed to a near-term New Frontiers or Discovery AO including technology demonstrations.

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 Principal Investigator (PI). The proposed budget must provide for these reporting requirements:

- Interim Year 1 and final briefings to program managers. The briefings may be conducted via teleconference.
- Year one report not to exceed eight pages and brief quarterly summaries not to exceed one page.
- Final report not to exceed twenty pages.

2.4 Data Rights

Any intellectual property possessed by the proposing entity prior to initiating these activities, developed with private funds, must be declared as such in the proposal and may be subject to negotiation prior to award. Items deemed preexisting intellectual property will be identified with limited data rights. All other data developed via these awards will be identified with unlimited data rights. See Federal Acquisition Regulation (FAR) clause 52.227-14 Rights in Data-General for more information.

3. Proposal Formatting

Proposals submitted to HOTTech must strictly conform to the formatting rules in Section IV of the *Summary of Solicitation* and Chapter 2 of 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: 8 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 on average. 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 total program budget	$3M
Number of new awards pending adequate proposals of merit	Up to 5 awards
Maximum duration of awards	3 Years
Due date for electronic submission of Notice of Intent to propose	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after due date
Page limit for the central Science-Technical-Management section of proposal	8 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 required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
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	NNH16ZDA001N-HOTTCH
NASA points of contact concerning this program both of whom share the following mailing address: Planetary Science Division Science Mission Directorate National Aeronautics and Space Administration Washington DC 20526-0001	Adriana Ocampo Telephone: (202) 358-2152 E-email: aco@nasa.gov Quang-Viet Nguyen Telephone: (202) 358-0218 E-email: quang-viet.nguyen@nasa.gov

C.25 ROSETTA DATA ANALYSIS

NOTICE: The Planetary Science Division intends to solicit proposals for the Rosetta Data Analysis program as part of ROSES-2017. This amendment to ROSES-2016 is being issued to provide information to the community. When this program element is incorporated into ROSES-2017, a full description will be issued, either in the initial ROSES-2017 release or as an amendment released at least 90 days prior to the due date for Step-2 proposals.

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.

Programmatic Information

The Planetary Science Division expects to schedule the Step-1 and Step-2 proposal due dates of RDAP to coincide with those of the Discovery Data Analysis Program (DDAP; program element C.11), and expects that RDAP proposals will be co-reviewed at the same time as DDAP proposals. However, RDAP awards will be funded from a source other than the Discovery Program. NASA expects to make approximately ten RDAP awards.

Point of Contact

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C.26 INSTRUMENTS FOR GONDOLA FOR HIGH-ALTITUDE PLANETARY SCIENCE

NOTICE: October 7, 2016. The Planetary Science Division plans to solicit proposals for Instruments for Gondola For High-Altitude Planetary Science as program element C.26 of ROSES-2016. This amendment to ROSES-2016 is being issued to provide information to the community. When this Program Element is incorporated into ROSES-2016, a full description will be issued as an amendment released at least 90 days prior to the due date for Step-2 proposals.

Scope of Program

NASA's Planetary Science Division has begun development of the stratospheric balloon platform Gondola for High-Altitude Planetary Science (GHAPS) intended for use by the broad science community. NASA intends to release a new program element for GHAPS science instruments through ROSES in early November 2016. The report of the science instrument definition team (SIDT), convened to define the scope of potential science investigations and derive the science requirements and potential instrument concepts for such a platform that could address Planetary Science Decadal Survey questions, is available on the NSPIRES web page for this program element. A summary of that report will also appear in Poster #123.31 at the joint 48th meeting of the Division for Planetary Sciences and 11th European Planetary Science Congress in Pasadena, California, October 16-21, 2016. The issuance of this community announcement does not obligate NASA to release a program element.

NASA points of contact concerning this program:

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APPENDIX D. ASTROPHYSICS RESEARCH PROGRAM

D.1 ASTROPHYSICS RESEARCH PROGRAM OVERVIEW

1. Introduction

The objectives of research solicited in program elements described in Appendices D.2 through D.10 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://nasascience.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* (Section 2) and the *ROSES-2016 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-2016 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.

The program elements 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; Appendix D.2) supports research whose primary emphasis is 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 also supports the analysis of data from 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; Appendix 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 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; Appendix 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; Appendix D.3). Theoretical work pertaining to atomic and molecular astrophysics and other topics directly related to Laboratory Astrophysics should also be proposed to APRA.

5. Astrophysics Guest Investigators

Five program elements support science investigations that require and/or support new data obtained with currently operating NASA astrophysics space missions. Guest investigator programs are included for the Swift gamma-ray burst explorer (Appendix D.5), the Fermi Gamma-ray Space Telescope (Appendix D.6), the K2 mission with the Kepler spacecraft (Appendix D.7), and the nuclear spectroscopic telescope NuSTAR (Appendix D.10). The JAXA-NASA ASTRO-H mission is planned to launch in early 2016, and, based upon the currently planned launch and commissioning schedule, NASA expects to issue the initial call for Guest Observer (GO) Proposals (Cycle 1) by an Amendment to ROSES-2016 in April 2016. Guest investigator programs for the Hubble Space Telescope (http://www.stsci.edu/), the Chandra X-ray Observatory (http://cxc.harvard.edu/), Stratospheric Observatory for Infrared Astronomy (SOFIA) (http://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 two-step proposal submission process. Please carefully read Section 7 of the K2 Program Element.

6. Strategic Astrophysics Technology

The Strategic Astrophysics Technology program (SAT; Appendix 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 Fellowships in Space Astrophysics

The Nancy Grace Roman Technology Fellowship in Space Astrophysics (RTF; Appendix D.9) gives early career researchers the opportunity to develop the skills necessary to lead astrophysics flight instruments or projects, and future space astrophysics missions. Fellows must be recent Ph.D. recipients; in general, graduating in a calendar year no earlier than seven years before the issuance date of this ROSES NRA. They must hold a nontenured early career position, such as a postdoctoral, tenure-track, term civil service, or equivalent position. The program aims to foster new talent by putting early-career instrument builders on a trajectory towards long-term positions at a U.S. institution; therefore, fellows are required to be U.S. citizens or to have lawful status of permanent residency. NASA does not require a data management plan for proposals to RTF. Proposals for the Nancy Grace Roman Technology Fellowship (RTF) program are not solicited in ROSES-2016. It is anticipated that henceforth the program will solicit proposals on alternate years; thus RTF proposals will again be solicited in ROSES-2017.

8. Exoplanet Research Program

The cross-division program on exoplanets is described in Appendix 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 Appendix 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.

D.2 ASTROPHYSICS DATA ANALYSIS

NOTICE: Corrected April 28, 2016. References to salary and overhead in Sections 1.1 and 1.3.1 have been removed to make this program element consistent with the new budget guidelines in Section IV(b)(iii) of the ROSES Summary of Solicitation and the FAQ about budgets in ROSES-2016 that instruct proposers to hide costs of salary, fringe and overhead. New text is in bold, deleted text is struck through.

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 2016 Proposers

- The budget justification of any proposal that involves the collection and analysis of new ground-based observations must include **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 a** separate budget breakout detailing the work effort and **procurement** costs (e.g., ~~salary~~, travel, ~~overhead~~, **equipment,** consumables, etc.) associated with executing the ground-based observing component of the investigation. 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. **[Corrected, April 28, 2016].**
- 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 the making 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.

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 solicitation. Proposals found to be noncompliant will be declined and may be returned without review or adjectival rating.

Table 1. A Representative List of Projects/Missions that had a Significant NASA Contribution and may Represent the Primary Data Source for an ADAP 2016 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)	Nuclear Spectroscopic Telescope Array (NuSTAR)
Extreme Ultraviolet Explorer (EUVE)	Planck
Far Ultraviolet Spectroscopic Explorer (FUSE)	Roentgen Satellite (ROSAT)
Fermi Gamma Ray Space Telescope**	Rossi X-ray Timing Explorer (RXTE)
Galaxy Evolution Explorer (GALEX)	Spitzer Space Telescope*
Herschel Space Observatory	Stratospheric Observatory for Infrared Astronomy (SOFIA)
High Energy Astronomy Observatories (HEAO-1, 2, 3)	Submillimeter Wave Astronomical Satellite (SWAS)
High Energy Transient Explorer 2 (HETE-2)	Suzaku (Astro E2)
Hubble Space Telescope**	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.

Most NASA space astrophysics data may be found in one or more of the following NASA astrophysics data centers:

- High Energy Astrophysics Science and Analysis Data Center (HEASARC) (http://heasarc.gsfc.nasa.gov/);

- Infrared Science Archive (IRSA) (http://irsa.ipac.caltech.edu/);
- Mikulski Archive for Space Telescopes (MAST) (http://archive.stsci.edu/);
- NASA Exoplanet Science Institute (NExScI) (http://nexsci.caltech.edu/);
- NASA/IPAC Extragalactic Database (NED) (http://nedwww.ipac.caltech.edu/); and
- Virtual Astronomical Observatory (VAO; http://www.usvao.org/)

Analyses of data from non-Astrophysics NASA missions are eligible for ADAP support, provided the primary scientific goals of the investigation address NASA's strategic objective and science goals for Astrophysics described in the agency's 2014 Strategic Plan (Strategic Objective 1.6, p. 21-22) and 2014 Science Plan (Section 4.4, p. 74-85). 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 Limitations of the Program

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 ~~work effort (including salary, travel, etc.)~~ **total cost** funded **by NASA** under the proposal. The budget justification for any such proposals must include a separate breakout of the **resources, including** work effort and **procurement** costs (e.g. ~~salary~~, travel, ~~overhead~~, **equipment,** consumables, etc.) associated with 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. **[Corrected, April 28, 2016].**

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 such parameters are not eligible for support under the ADAP.

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 accepts proposals for the development of publicly-accessible databases of observational data from NASA-sponsored balloon-borne and sounding rocket astrophysics suborbital experiments. However, only suborbital experiments funded under the auspices of the Astrophysics Division's Astrophysics Research and Analysis program (APRA; Appendix D.3) 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 category 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*

The Spitzer Space Telescope Guest Observer (GO) program has been significantly descoped and now only provides support for U.S. investigators with programs involving ≥ 200 hours of observing time. Therefore, scientists with approved Priority 1 GO observations involving < 200 hours of Spitzer time are eligible to propose for data analysis support under ADAP 2016, even if those observations have yet to be executed or the data are still within their proprietary period at the time of the proposal deadline. Moreover, scientists with approved Priority 2 GO observations involving < 200 hours of Spitzer time are eligible to propose for data analysis support under ADAP 2016, providing that the awarded observations have at least been initiated at the time of the ADAP proposal submission deadline. These eligibility requirements are summarized in Table 2 below. Proposers are reminded that proposals found to incorporate any ineligible GO data whatsoever are subject to being declared noncompliant and declined without review.

Table 2. Eligibility of Approved Spitzer GO programs for support under ADAP 2016

Class of GO Proposal	Execution Status at ADAP 2016 proposal deadline	Eligibility for ADAP 2016 Support
Priority 1, < 200 hrs	Any	ELIGIBLE
Priority 2, < 200 hrs	Partially executed or completed	ELIGIBLE
	Yet to be executed	INELIGIBLE*
Priority 1 or 2, ≥ 200 hrs	Any	INELIGIBLE*
Priority 3, any duration	Any	INELIGIBLE*

* As with the data from any other NASA space astrophysics mission, these data are eligible for support under the ADAP once they are available in the public domain.

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-2016 NRA and the ADAP solicitation. It is generally not sufficient to simply submit the approved GO proposal.

1.3.5 *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; Appendix D.4);
- Investigations involving new measurements or calculations of fundamental atomic, molecular, or nuclear parameters. Such research is supported under the Laboratory Astrophysics element of NASA's Astrophysics Research and Analysis program (APRA; Appendix D.3);
- Investigations whose primary focus is 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 are (1) necessary to the achievement of the scientific goal(s) of the proposed investigation and, (2) not the object of that investigation.
- Investigations whose primary focus is 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.

In addition, proposals 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. Any proposal that invokes the use of data that are not public at the time of the ADAP 2016 proposal submission deadline (other than that explicitly allowed under Section 1.3.4) will be ruled noncompliant and will not be rated or considered for funding.

1.3.6 *Proposal formatting*

In addition to the scientific scope of the ADAP described in the following sections, both the *NASA Guidebook for Proposers* (Section 2) and Section IV (b) ii of the *ROSES-2016 Summary of Solicitation* provide clear and specific requirements for the format of proposals submitted in response to this 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 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 (including star-forming clouds, protostars, protoplanetary and debris disks, and formation of exoplanets and exoplanetary systems);
2. Stellar Astrophysics and Exoplanets (including the structure and evolution of main sequence stars, brown dwarfs, and exoplanet detection and characterization);
3. Post-Main Sequence Stars (including 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 (e.g., neutron stars, X-ray binaries, black-hole binaries);
5. Supernovae and Gamma Ray Bursts (includes studies of the progenitor and the physics of stellar explosions, but not studies of supernova remnants and their interaction with the ISM);
6. Interstellar Medium (including dense clouds, the diffuse ISM, supernova remnants, interstellar dust, HII regions, and diffuse galactic emission);
7. Normal Galaxies and Galactic Structure (including studies of the structure of the Milky Way and other galaxies);
8. Active Galaxies and Quasars (including interacting galaxies, starburst galaxies, U/LIRGs, Seyfert galaxies, radio galaxies, active galactic nuclei, and quasars);
9. Large Scale Cosmic Structures (including clusters of galaxies, galaxy environment and evolution, intracluster medium, diffuse x-ray background, and cosmology); and
10. Astrophysical Databases (including 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 2015 Submission statistics

In 2015, a total of 252 proposals were submitted in response to the ADAP solicitation, an 18% decrease in the number of proposals compared to the ADAP 2014 solicitation. The distribution of those proposals over the various Research Areas covered by ADAP 2015 is shown in Figure 1 below. Also shown in the figure is the distribution of requested durations (one-, two-, three-, or four-years) of the proposals in each Research Area. 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.

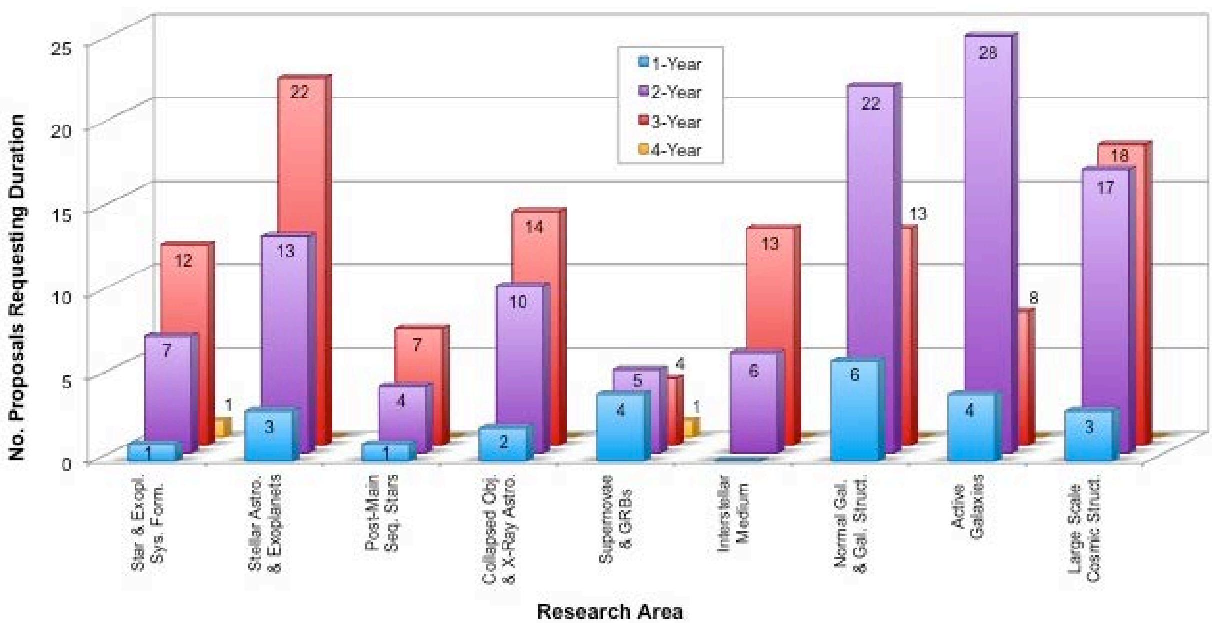

Figure 1. The distribution of 2015 ADAP proposal submissions, broken down by requested funding duration, across the Research Areas covered by the program. Proposals in the Astrophysical Databases Research Areas were grouped into one of the Research Areas shown based on their subject matter.

2.2 Distribution of annual funding levels for ADAP tasks

With an annual budget of around $17M, the ADAP typically supports around 130 investigations in any given year (includes new starts, plus continuing investigations). Although the average annual ADAP award is approximately $124,000, actual award amounts span the range from less than $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 2016.

2.3 Evaluation Criteria

In addition to what is described in the guidebook for proposers and the *ROSES Summary of Solicitation*, for this program element the merit criterion includes an evaluation of the suitability and perceived impact of the proposed products of the investigation (e.g., data products and data analysis tools) and how and when they will be made available.

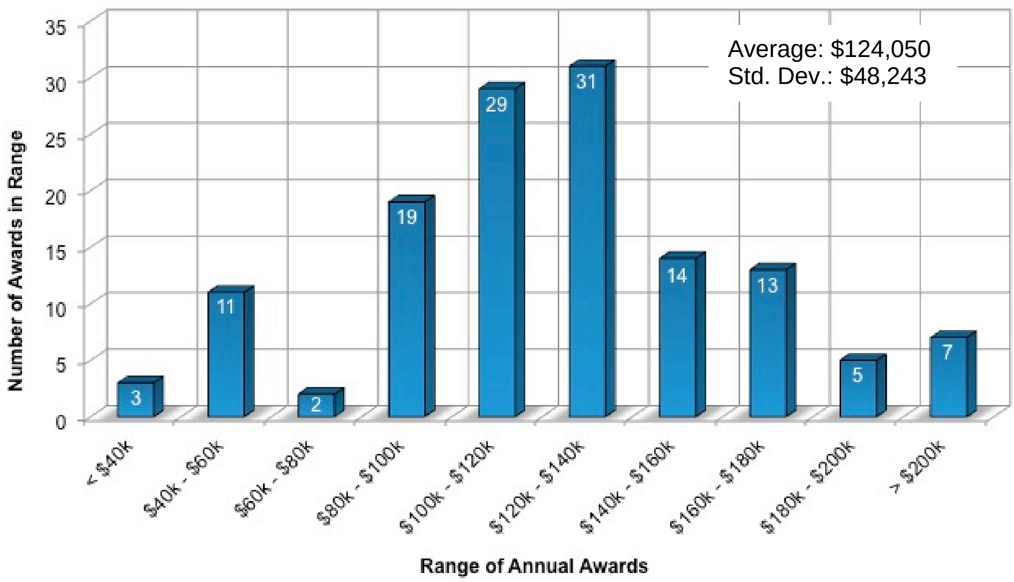

Figure 2. The distribution of annual awards for funded ADAP tasks in FY 2016. Data include both ADAP 2015 new starts and ongoing tasks from previous solicitations.

3. Summary of Key Information

Expected program budget for first year of new awards	~$4.9M
Number of new awards pending adequate proposals of merit	~40
Maximum duration of awards	4 years; shorter-term proposals are welcome; four-year proposals must be especially well justified. Proposals solely for the purposes of database development have a maximum duration of 3 years.
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	January 1, 2017

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 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/
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	NNH16ZDA001N-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 E-mail: Douglas.M.Hudgins@nasa.gov

D.3 ASTROPHYSICS RESEARCH AND ANALYSIS PROGRAM

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 Level1 (TRL1) through TRL9. The emphasis of this solicitation 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 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 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 Appendix D.4 of this NRA.
- 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 Appendix 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 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).
- In the Fundamental Physics discipline area, this program element solicits 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 program element should be space-related (suborbital, orbital, etc.). This program is not intended to support applied physics or laboratory experiments. Investigations predominantly theoretical in nature should be directed to the Astrophysics Theory Program or to other Federal agencies, as appropriate.
- Projects directed mainly toward the analysis of archival data are solicited under the Astrophysics Data Analysis Program described in Appendix D.2 of this NRA.
- If a proposal is offered as a direct successor to a previous NASA award, it should include a description of the predecessor effort, including any significant findings, and describe how the proposed work extends the previous accomplishments. See Section 1.5 of 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 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.

1.2.1 *Suborbital/Suborbital-class Investigations*

This APRA category supports science investigations and/or technology development utilizing payloads flown on sounding rockets, balloons, commercial reusable suborbital rockets, or similar-class payloads flown as flights of opportunity. Suborbital payloads may be recovered, refurbished, and reflown 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 Office of the Chief Technologist (OCT). 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.

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 complete investigations, including payload development and construction, instrument calibration, launch, and data analysis. 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, the degree to which it advances the technology readiness level of a detector or supporting technology, and the degree to which it advances the readiness of early-career researchers or graduate students to assume leadership roles on future NASA space flight missions.

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.

The Sounding Rocket Program is currently planning to provide launches from Woomera, Australia, in September of 2018 and again in April-June of 2020, subject to the availability of funds. Investigators responding to this APRA solicitation may propose sounding rocket flights launched from this southern hemisphere site for either opportunity. Normal payload recovery is anticipated for flights using either the Black Brant IX or Black Brant XI launch vehicles.

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 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 *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. As described in Section 2.3.10.c (ii), 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 serves as the "Institutional PI" for the award to his/her organization (see Section 1.4.2 in 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 program 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 program.

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 program 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.

1.2.4 *Laboratory Astrophysics*

The Laboratory Astrophysics category of the APRA program 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 program supports both 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 exo-planetary 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 JWST or ASTRO-H 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 program 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 APRA categories in five recent cycles; note that proposals for APRA-10 (denoted A-10) were due in 2011 and funded in FY 2012 etc. If the budget allows, we expect (but cannot guarantee) that 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-10	A-11	A-12	A-13	A-14	A-10	A-11	A-12	A-13	A-14
Suborbital Investigations	8.9	5.0	6.1	5.7	9.1	12	8	15	17	17
Detector Development	1.3	2.7	3.1	1.6	4.2	4	10	7	5	11
Supporting Technology	2.8	3.1	1.9	2.3	2.8	12	13	6	9	9
Laboratory Astrophysics	1.8	0.9	0.6	1.1	1.0	8	8	5	8	8
Ground-Based Observations	0.06	0	0	0	0	1	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.

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 Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
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 Chapter 2 of 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 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	NNH16ZDA001N-APRA
NASA point of contact concerning this program	Michael R. Garcia Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1053 E-mail: Michael.R.Garcia@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	E-MAIL
Kartik J. Sheth	Infrared, Submillimeter, and Radio Astrophysics	(202) 358-4805	Kartik.Sheth@nasa.gov
Michael R. Garcia	Ultraviolet and Visible Astrophysics	(202) 358-1053	Michael.R.Garcia@nasa.gov
Louis J. Kaluzienski	X-ray Astrophysics	(202) 358-0365	Louis.J.Kaluzienski@nasa.gov
Stefan M. Immler	Gamma-ray Astrophysics	(202) 358-0615	Stefan.M.Immler@nasa.gov
W. Vernon Jones	Particle Astrophysics and Fundamental Physics	(202) 358-0885	W.Vernon.Jones@nasa.gov
Douglas M. Hudgins	Laboratory Astrophysics	(202) 358-0988	Douglas.M.Hudgins@nasa.gov

D.4 ASTROPHYSICS THEORY

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.

Proposals to the ATP program may not:

- Consist primarily of data reduction or data analysis (such proposals should be directed to the mission-specific programs or the Astrophysics Data Analysis Program (ADAP) described in Appendix D.2 in this solicitation);
- Propose theoretical work pertaining to atomic and molecular astrophysics and other topics directly related to Laboratory Astrophysics (these should be proposed to the Astrophysics Research and Analysis (APRA) program element described in Appendix D.3);
- Develop experimental payloads to test theories of gravitation and fundamental physics (such proposals should be submitted to the APRA program element described in Appendix D.3);
- Address theoretical topics that are predominantly unrelated to the needs of NASA's space astrophysics programs (such proposals should be directed to other appropriate Federal agencies);
- Deal strictly or predominantly with Solar System objects or solar-terrestrial interaction studies, including solar energetic particles (see Appendices B and C for appropriate programs);
- Propose to develop technologies or experimental concepts for future NASA missions (these proposals should be submitted to the APRA program element described in Appendix D.3 or the Strategic Astrophysics Technology program element described in Appendix D.8);

- Propose to develop new data analysis methods for future space missions (these proposals should be submitted to the APRA program element described in Appendix D.3)
- Primarily aim at studying new mission concepts;
- Request support for organizing and/or hosting scientific meetings; or
- Request support for substantial computing facilities or resources beyond nominal workstation or network requests.

2. <u>Proposal Category and Research Areas</u>

ATP proposals will only be accepted from individual Principal Investigators (PIs) whose proposed work has a clear, single focus. Group proposals, i.e., those in which several researchers submit an omnibus proposal of related, but separate, theoretical research investigations under a designated PI, are not solicited for the ATP and will be considered unresponsive to this solicitation. However, individual theory PIs may include as many Co-Investigators and Collaborators as they wish on their proposals.

Investigators may submit more than one proposal to the ATP if the research program of each proposal is significantly distinct. If a proposal is submitted as a successor to work supported by an earlier proposal, the new proposal must identify the related work and clearly summarize all significant results from it.

For the purposes of conducting the peer review, every proposal for this ATP must identify one (or more, if appropriate) of the Topic Categories from the list below in both its Notice of Intent to propose and in the proposal submission itself. The primary use of these Topic Categories is to facilitate the assignment of the proposal to an appropriate review panel. NASA reserves the right to assign a proposal to a different category. Depending on the mix of proposals received, review panels may not correspond exactly to these categories.

1. Star and Exoplanet Formation (e.g., star forming clouds, protostars, protoplanetary and debris disks, planet formation, astrochemistry);
2. Stellar Astrophysics and Exoplanets (e.g., asteroseismology, convection, stellar evolution, brown dwarfs and exoplanets, mass loss, circumstellar disks);
3. Collapsed Objects and X-ray Astrophysics (e.g., white dwarfs, neutron stars, cataclysmic variables, X-ray binaries, black-hole binaries);
4. Supernovae and Gamma Ray Bursts;
5. Interstellar Medium, Cosmic Rays, and Galactic Structure (e.g., supernova remnants, dark clouds, interstellar dust, H II regions, diffuse galactic emission, planetary nebulae, stellar clusters);
6. Normal Galaxies (e.g., quiescent galaxies, interacting galaxies, starburst galaxies);
7. Active Galaxies and AGNs (e.g., population studies, accretion discs, jets);
8. Large Scale Cosmic Structures and Dark Matter (e.g., clusters of galaxies, galaxy environment and evolution, intracluster medium, diffuse photon backgrounds);
9. Dark Energy and the Cosmic Microwave Background (e.g., theoretical studies of cosmological observation techniques, theoretical cosmology, dark energy models);
10. Gravitational Astronomy (e.g., gravitational wave sources, computation of gravitational radiation waveforms, data analysis methods for future missions to investigate gravitational radiation); and

11. Other Astrophysics Theory (NASA Headquarters will assign the proposal to what it deems is the most appropriate review panel).

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 successful proposers to the Astrophysics Theory 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.

4. Summary of Key Information

Expected program budget for first year of new awards	~ $4M
Number of new awards pending adequate proposals of merit	~ 30
Maximum duration of awards	4 years; shorter term proposals are encouraged; four-year proposals must be well justified
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	No earlier than 6 months after the proposal due date, but no later than July 1, 2017.
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 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/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See 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	NNH16ZDA001N-ATP
NASA point of contact concerning this program	Keith B. MacGregor Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-2463 E-mail: HQ-ATP@mail.nasa.gov

D.5 SWIFT GUEST INVESTIGATOR – CYCLE 13

NOTICE: The execution of the Swift Guest Investigator – Cycle 13 is contingent upon the outcome of the 2016 Senior Review.

The Cycle 12 limitation that no more than 500 time-constrained observations could be performed has been removed. There is no limit to the number of time-constrained observations that will be accepted in Cycle 13

1. Scope of Program

1.1 Overview

The 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 13 observations and funding will commence on or around April 1, 2017, and last approximately 12 months. Further details on the Cycle 13 program will be posted on the Swift web pages (http://swift.gsfc.nasa.gov/proposals) in August 2016. As was the case in Swift GI Cycles 4 through 12, 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 (http://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 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 (http://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 http://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 project*

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) and the X-ray Multi-Mirror Mission (XMM-Newton)). 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: http://swift.gsfc.nasa.gov/proposals/nrao.html

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 13 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 13 to Cycle 14. For regular proposals, there will be no time carried over from Cycle 13 to Cycle 14, except when observing for an awarded program has commenced during Cycle 13. GIs whose observing programs have not begun in Cycle 13 will be required to repropose if they wish to acquire observing time. Targets whose observations have commenced in Cycle 13 will be awarded carryover time in Cycle 14 until the proposed observations are substantially complete. Similarly, Cycle-12-accepted proposals that have not been initiated by the start of Cycle 13 will not be carried over. Cycle 12 GIs concerned that their programs may not be started before the end of the cycle should re-propose for Cycle 13.

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 13; 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 13 ToO proposals may be triggered until March 31, 2018. GIs whose ToO programs do not trigger in Cycle 13 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 13 to Cycle 14, and may be triggered until March 31, 2019.

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 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 require 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 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 solicitation 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.

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, http://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 http://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.*

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/). 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 Appendix.

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 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 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 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).

NASA program personnel will evaluate the Phase-2 cost proposals against the third evaluation criterion, cost realism, and reasonableness. Comparison of the proposed cost to available funds will be performed as specified in Section C.2 of the *NASA Guidebook for Proposers.*

2.3 Supplemental Information

Further details concerning the proposal submission requirements and process can be found at the Swift Science Center website http://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 in the *ROSES Summary of Solicitation*.
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, 2017 (6 months after start of Cycle 13 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 http://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	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/

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	https://heasarc.gsfc.nasa.gov/ark/swiftrps/ (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 E-mail: 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 10

NOTICE: Amended on October 19, 2016. In addition to a number of changes in wording, this amendment eliminates the previously supported two-year duration awards from the "Regular" Proposal category (Section 1.4) and revises the funding expected to be available for Cycle 10 (Sections. 2.1 and 3). Phase-1 proposals are due at 4:30 pm Eastern Time on February 24, 2017, via the Remote Proposal System (RPS) website. See Section 2.2.1.

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.

During this and all future cycles of the GI program, all Fermi gamma-ray data will be nonproprietary and will be publicly released immediately after ground processing. Release of summary data from the Large Area Telescope (LAT) shall be the same as in previous cycles.

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, which 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 nonuniformity 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. The extended mission phase encompasses August 2013 and beyond.

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 Types of Proposals

The Cycle 10 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 10. Pointed observations will follow the same open data policy as sky survey data, i.e., they will become public immediately;
3. Analysis of correlative multiwavelength observations with other instruments and observatories (but excluding operation of such facilities) that are directly relevant to Fermi science objectives (see FUG recommendation at http://fermi.gsfc.nasa.gov/ssc/resources/multi/); and
4. Theoretical investigations that will advance the science return of the Fermi mission.

1.3.1 *Analysis of all LAT gamma-ray and GBM event data*

The LAT team's science goals are: (1) development of event-reconstruction and background-rejection techniques; (2) production of a comprehensive full-sky catalog of gamma-ray sources; and (3) a description of the diffuse gamma-ray emission. Proposed Fermi investigations should avoid duplication of the first two of these goals. The extent to which the proposed research will enhance the science return from Fermi will be considered in the proposal evaluation process (see Section 2.2 below).

The LAT's primary science data product is a list of events detected within the LAT's field-of-view. These events can be used to detect sources and study their temporal and spectral properties. Fermi observes the sky in a survey mode that provides nearly uniform sky exposure 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 and should be made publicly available for the benefit of the Fermi community.

1.3.2 *Requests for LAT pointed observations*

GIs may also request pointed observations 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 (http://fermi.gsfc.nasa.gov/ssc/help/).

1.3.3 *Multiwavelength observations*

Because correlative observations will substantially augment the science return from Fermi, such proposals are encouraged. Examples of correlative observations that will add significantly to the Fermi science include monitoring of blazars, follow-up observations of gamma-ray bursts, and determination of pulsar ephemerides. To foster correlative observations, the Fermi project has established joint observation programs with other ground- and space-based facilities. The Fermi GI program can award optical, radio, X-ray or high-energy gamma-ray observations through Fermi's joint programs with NRAO, NOAO, 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. 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 Memoranda of Understanding (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.

1.3.4 *Theoretical investigations*

Theoretical studies related to the observations conducted with Fermi hold the potential to significantly enhance the scientific impact of the mission. GI proposals for such theoretical investigations are also solicited and must specifically address how the anticipated results will advance Fermi science objectives.

1.4 Classes of Proposals

There are two proposal classes: (1) Regular proposals with research plans that can be completed in one year, and (2) Large proposals whose research plans are more expansive and may take up to three years to complete. Large programs will remain prioritized for projects that are inherently resource intensive and large in scope. The number of Large projects funded in any given year will be very limited.

The burden of justifying the need for Large projects is on the proposers. The peer-review committees will not be permitted to descope Large projects and must be recommended for selection (or not) as proposed. Proposing a project in duplication as a single year plus as a Large program is strongly 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.

The continuation into year two of Regular Projects that were approved for two years duration will not require a second scientific peer evaluation. The PIs of such projects will, however, be solicited by the NASA Shared Services Center (NSSC) for a progress report that will be reviewed by NASA prior to the release of year-two funds.

1.5 Proposal Length and Format

The page limit for the Science/Technical/Management section of Phase 1 proposals is four pages for Regular proposals and six pages for Large proposals. These page limits include figures and references. An additional page is required to describe the technical justification for the observation time, as well as the telescope and instrumentation configurations being requested through the joint programs with NOAO, NRAO, Arecibo, INTEGRAL, and VERITAS.

Proposals must be single-spaced, typewritten, English-language text on standard U.S. letter paper, using one column, and using an easily read font size 12-point or larger and having, on average, no more than 15 characters per horizontal inch. No smaller font is permitted in the subsections of the proposal, including references. However, text in figures and their captions may be in fonts as small as 10-point. In addition, the proposal shall have no more than 5.5 lines per inch of text. Pages should have at least one-inch (2.5 cm) margins on all sides. Proposals not conforming to this format will be declared noncompliant and may be rejected without further review.

2. Programmatic Information

2.1 General Information

Awards for Regular (one 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 U.S.-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.

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. This is particularly important for multiyear proposals (two-year Regular and Large proposals). 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 year's proposed. Every line item in the NSPIRES budget needs to be explained in the accompanying text. All proposal materials must 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 program gamma-ray, X-ray, radio, or optical observations.
- The standard ROSES requirement for a table of contents in the body of the proposal is waived.
- The Scientific/Technical/Management section must 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.

The evaluation of relevance of a proposal shall include:

- For data analysis development and theoretical investigations, 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 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 specified in Section C.2 of the *NASA Guidebook for Proposers*.

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

Expected total program budget for new awards.	Funding for the GI program is expected to be \$2.0-2.5M (this might permit, for example, the selection of ~30-40 Regular proposals with average awards of \$55K and generally less than \$60K per year, and 2 or 3 Large proposals with average awards of \$125K per year and generally less than \$150K per year). Deviations from these targeted figures are possible.
Maximum duration of awards	1 year for Regular proposals and up to 3 years for Large proposals (see Section 1.3)
Due date for Notice of Intent to propose (NOI)	Option not available
Due date for phase-1 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation.*
Planning date for start of investigation	5-10 months after proposal due date.
Page limit for the central Science-Technical-Management section of Phase 1 proposal	4 pp for regular proposals, 6 pp for large proposals; 1 additional page is required to describe joint program observations (see Section 1.5). Page limits include figures and references. This instruction supersedes the limits given in the *NASA Guidebook for Proposers.*
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	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
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 E-mail: 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 5

NOTICE: Amended on September 12, 2016. This amendment changes the Field for Campaign 16 (see Section 2) and delays the due dates for this program element. Step-1 proposals are now due November 3, 2016, and full Step-2 proposals are due December 15, 2016. New text is in bold and deleted text is struck through.

Proposals to this program will be accepted by a two-step process in which the Notice of Intent is replaced by a brief mandatory Step-1 proposal submitted by an Authorized Organizational Representative. No PDF upload is possible for the Step-1 proposal. Step-1 proposers must merely fill in the Proposal Summary text box on the NSPIRES cover pages. Only proposers who submit a Step-1 proposal will be eligible to submit a Step-2 (full) proposal. Potential proposers are strongly encouraged to carefully read the information about the two-step proposal process provided in Section IV(b)(vii) of the ROSES-2016 *Summary of Solicitation* and in Section 7 of this Program Element.

1. Scope of Program

This program element solicits proposals for the acquisition and analysis of new scientific data from the K2 mission (http://keplerscience.arc.nasa.gov). K2 repurposes the space-borne hardware and ground-based operations of the Kepler mission (http://keplerscience.arc.nasa.gov) for a pointed survey of predetermined locations along the ecliptic plane. The single, visible-wavelength instrument on board K2 provides high-precision photometry capability, with short cadence and long cadence modes (1 minute and 30 minute exposures, respectively), and provides a powerful tool for broadband variability analyses of planetary, stellar, extragalactic, and solar system sources.

1.1 Background

The loss of a second of the four reaction wheels on board the Kepler spacecraft in May 2013 brought an end to its four plus year primary science mission to continuously monitor more than 150,000 stars in the 116 square degree Kepler field for transiting exoplanet candidates. Developed over the months following this failure, the K2 mission represents a new concept for spacecraft operations that enables continued scientific observations with the Kepler space telescope. The K2 mission entails a series of sequential observing "Campaigns" of fields distributed around the ecliptic plane and offers a photometric precision approaching that of the original Kepler mission to within a factor of approximately two (http://keplerscience.arc.nasa.gov/k2-observing.html - fine-point-photometric-precision). Operating in the ecliptic plane minimizes the torque exerted on the spacecraft by solar wind pressure, reducing pointing drift to the point where spacecraft attitude can effectively be controlled through a combination of thrusters and the two remaining reaction wheels. Each ecliptic Campaign is limited by Sun angle constraints to a duration of approximately 80 days. Therefore, four to five K2 Campaigns can be performed during each future 372-day orbit of the spacecraft. A description of the Campaign field distribution across the sky and the full mission concept is provided at http://keplerscience.arc.nasa.gov/k2-fields.html and http://keplerscience.arc.nasa.gov/k2-observing.html.

2. Scope of this Solicitation

This solicitation is specifically for science utilizing data collected within K2 Campaigns 14, 15, and 16 observing fields, which are currently planned for execution around the periods (earliest start and latest possible end dates for each campaign); May 30 to August 28, 2017 (Campaign 14), August 21 to November 18, 2017 (Campaign 15), and November 20, 2017 to February 9, 2018 (Campaign 16). Campaign 14 will cover a low-density region towards Leo and somewhat near the North Galactic Cap. Campaign 15 is a denser field, somewhat close to the Galactic Plane/near the Galactic Center. **The focus of Campaign 16 will now be supernova science and the pointing will be in the direction of M67 and Praesepe star clusters. This new pointing position is described at: http://keplerscience.arc.nasa.gov/k2-fields.html#c16. Campaign 16 will be forward facing, which facilitates simultaneous Earth/K2 observing. Proposals for Campaign 16 targets will not be restricted by science topic, but it is anticipated that a fraction of the available observing resources will be dedicated to supernova science.** ~~Campaign 16 will be closer to the South Galactic Cap, covering a relatively low-density field.~~ **[Amended September 12, 2016]** Supporting technical and scientific material is available at the Kepler Science Center website for the K2 mission (http://keplerscience.arc.nasa.gov). A separate solicitation will be released in approximately nine months for future Campaigns. There is also expected to be a small, unfunded Director's Discretionary Targets (DDT) program run by the K2 GO office to allow exceptional targets to be observed. DDT proposals will be handled through the Guest Observer (GO) Office (http://keplerscience.arc.nasa.gov/k2-ddt.html), outside of ROSES.

3. Changes Since K2 Guest Observer (GO) Cycle 4 in ROSES-2015

This solicitation is for different K2 observing fields, namely Campaigns 14, 15 and 16, described in Sections 2 and 5. Investigations that have broadly similar goals and team members to selected Cycle 1 or Cycle 2 proposals may use up to an additional 0.5 pages to describe progress they have made to delivering value-added community resources.

4. The K2 Mission

4.1 K2 Mission Science

Unlike the Kepler mission, there are no primary science objectives for the K2 mission in most Campaigns (with the exception of Campaign 9). While K2 continues to further the science goals of the Kepler mission – identifying exoplanet candidates and providing data for the calculation of planet occurrence rates – the spacecraft is now primarily a general-user facility (http://keplerscience.arc.nasa.gov).

4.2 Instrumentation and Technical Capabilities

The Kepler spacecraft is in a heliocentric orbit, which insures a thermally stable environment and provides the ability to remain on a single pointing for the duration of each Campaign. Pointing is maintained by a combination of two reaction wheels and thrusters, reacting to motion data provided by fine guidance sensors (fine-point observing) or star trackers (coarse-point observing). With only two remaining reaction wheels, these operations are only possible while pointing within the orbital plane of the spacecraft, which approximates to the ecliptic. Only this specific family of pointings yields operational configurations where solar pressure is largely mitigated by spacecraft geometry, thereby making viable precision pointing and photometry approaching the quality for the Kepler mission. K2 has demonstrated a benchmark photometric precision on an m_v = 12 G2V star of ~170 parts-per-million (ppm) in 30 minutes of integration, i.e., one long cadence exposure. This corresponds to ~50 ppm over a 6.5-hour transit of an Earth-sized body around that star.

While stars brighter than m_v = 11.5 will saturate some pixels, K2 performs well on stars as bright as m_v = 4, provided the scientific benefit justifies the large number of pixels needed to capture saturated flux bleeding along CCD columns. Targets brighter than m_v = 3 will not be observed because they bleed off the CCD. K2 also has many faint-target scientific applications where m_v = 20 objects yield a photometric precision of a few percent over 30 minutes.

The broad photometric bandpass has a half-maximum transmission range of 430 to 840 nm. The instrument does not have changeable filters, dispersing elements, or a shutter. The detector has a pixel scale of 3.98 arcseconds. Image quality varies with position in the focal plane, with the 95% encircled energy diameter ranging from 3.1 to 7.5 pixels, with a median of 4.2 pixels. The percentage of point-source flux concentrated in the center pixel is between 20% and 62%, with a median value of 45%.

4.3 Observing Modes and Data Products

Constraints imposed by onboard storage and communications dictate that at most 6% of the data from the full focal plane are saved and downloaded. Instead, data for specific, predetermined targets are saved and transmitted as subimages with a typical area of 160 pixels, depending on source brightness. The brighter a target, the more pixels are required to capture it. Image size can be tailored further to accommodate extended or very bright, saturated objects. The current solicitation requests target proposals for Campaigns 14, 15, and 16. The Kepler Science Center will derive pixel masks for those targets successfully justified by proposers and upload these targets to the spacecraft before each Campaign.

All observations are taken at one of two temporal resolution settings: long (30-minute) or short (1-minute) cadence. It is expected that on the order of 10,000 to 20,000 long cadence targets will be available per Campaign, and approximately 50-100 short cadence targets. Extended or bright objects requiring larger aperture sizes decrease the total number of targets available to the GO program and must be well justified.

Data distribution and archival services will be performed by the Space Telescope Science Institute's Mikulski Archive for Space Telescopes (MAST) archive (https://archive.stsci.edu). Final data products available to observers will include original and calibrated pixel values and long cadence light curves for each individual target. The calibration will correct for bias level, smear, galactic cosmic rays, flat fielding, dark current, background, and instrument noise. Simple aperture photometry will be used to generate the light curves.

Data will be delivered to the observer in Flexible Image Transport System (FITS) format. A thorough understanding of the noise sources and systematic errors of K2 will be needed by observers in order to generate their own light curves from the original (uncalibrated or calibrated) pixel data or interpret structure found in archived light curves. There is no exclusive use period associated with any K2 GO data.

5 Guest Observer Science

5.1 Permitted GO Science Areas

There are no guaranteed, or predetermined, targets for K2 Campaigns 14, 15, and 16. All K2 targets are proposed by the community through the GO program or the DDT program.

For Campaign 14, 15, and 16 targets, the K2 GO Program welcomes proposals addressing compelling scientific questions in any area of astrophysics and planetary science providing the required observations are amenable to the operational characteristics and constraints of the mission. These may include, but are not limited to, exoplanet detection, stellar astrophysics, galactic and extragalatic astrophysics, and Solar System science. A single proposal can be used to request targets in more than one campaign. All science proposals must be compelling and well-justified scientifically and technically. Proposers should particularly note that short cadence resources and bright targets are expensive in pixels and onboard storage and have historically been in high demand. Short cadence proposals must justify scientifically and technically the need for higher cadence monitoring relative to long cadence observations.

Proposers must take into account the difference between science that can be achieved exclusively using archived K2 and Kepler data and science that requires new observations by K2. The K2 GO program is specific to the case of science requiring new observations. Funding for archival science is provided through the Astrophysics Data Analysis Program (ADAP; Appendix D.2 of ROSES-2016). This includes all Kepler data and K2 Campaigns 0-13. All proposals to this call must justify the need for new observational data within their program. However, NASA welcomes proposals that build upon data already collected and programs requiring more data to enhance or complete investigations.

5.2 On-source Monitoring Times

Each K2 Campaign has a duration of approximately 80 days and remains fixed upon a single boresight position. The target list remains fixed throughout the full duration of a Campaign; targets cannot be swapped during a Campaign. The fixed locations and observing windows of Campaigns 14, 15, and 16 are provided at http://keplerscience.arc.nasa.gov/k2-fields.html.

5.3 Target Selection Tools

Pointed observations away from the single stare position of any given field cannot be accommodated by K2; Campaign targets are limited to the objects available in the fixed field of view. Small gaps between the 42 detector CCDs result in additional loss of available objects that would otherwise be within the Kepler field of view. A documented target search tool, http://archive.stsci.edu/k2/epic/search.php, determines if an object of a particular coordinate lies close to the observable field of view. The target search tool accesses the Ecliptic Plane Input

Catalog (EPIC), which provides physical data, coordinates, magnitudes, and colors, for sources close to K2 silicon. The EPIC is complete to only $m_v \sim 17$; specifications of the catalog are documented at http://archive.stsci.edu/k2/epic.pdf. It is the proposer's responsibility to identify targets that are faint or missing from the EPIC. K2 collection of valid data relies on the delivery of accurate celestial positions, proper motions (if needed), and magnitudes of each target. Proposals must state the origin for this information, especially if it does not come from the EPIC. Determining whether or not desired targets fall on active regions of the focal plane is also the responsibility of the proposer. The Kepler Science Center at http://keplerscience.arc.nasa.gov/software.html#k2fov provides a tool to identify which targets fall upon active silicon. Only those targets within the active fields of view should be proposed.

5.4 Target Table

All proposals for targets are required to include a target table with the format shown in Table 1 to specify desired observing modes and other needed parameters. A definition of each column and a template for insertion into the proposal may be downloaded from the Kepler Science Center website at http://keplerscience.arc.nasa.gov/k2-proposing-targets.html - target-table. In addition to appearing as text within the proposal, this table must also be submitted electronically to the Kepler Science Center. Table 1 below includes example entries.

Table 1: Required Format of Target Table.
See http://keplerscience.arc.nasa.gov/k2-proposing-targets.html - target-table for instructions on completing the table.

Object	Right Ascension (deg) J2000	Declination (deg) J2000	Kp (mag)	Cadence (min)	Proper motion ("/yr)		extent (arcsec)	Comments
					δRA	δDec		
204436324			12.6	30				
203457483			13.9	1				
J113853.2+010514.6	174.72172	1.08747	18.3	30				Not in EPIC; Kp estimated from SDSS
201744789			11.4	30			11	Extended object with radius 11.0 arcsec
207942582	172.57983	-2.96567	14.5	30	0.13	0.35		High propose motion star

6. Programmatic Information

6.1 Proposal Submission and Evaluation

There are two categories of K2 guest observer proposals in Cycle 5. They are:

- Small proposals—proposals requesting fewer than 1000 targets, with a budget capped at $50,000.
- Large proposals—proposals requesting 1000 or more targets, with a budget capped at $150,000. Large proposals must also include the development and dissemination of a value-added community resource product.

The above cost caps are for the total cost of the award, including NASA Civil Servant Salary and overhead. Proposers should not include detailed budget information with either Step-1 or Step-2 proposals. NASA will seek detailed budgets from selected proposals after peer review.

Proposals submitted to NASA in response to this solicitation will be evaluated with respect to the criteria specified in Section C.2 of the *NASA Guidebook for Proposers*, which are intrinsic merit, relevance to the K2 Cycle 5 GO solicitation, and the realism/reasonableness of the proposed work effort and resources. In addition to the factors for intrinsic merit given in the *NASA Guidebook for Proposers*, intrinsic merit includes the following factors:

- The suitability of using the K2 observatory and data products for the proposed investigation;
- The legacy value of the data collected;
- The degree to which the investigation uses K2's unique capabilities;
- The feasibility of accomplishing the objectives of the proposed investigation with the requested observations, including the degree to which the proposal satisfies K2's observational constraints; and
- The feasibility and suitability of the proposed analysis techniques.

6.2 Budget Justification, Period of Performance, and Availability of Funds

For Campaigns 14, 15, and 16, funding amounts will be determined formulaically based on target allocation. For GO Cycle 3, which covered two standard campaigns, 19 awards were made, which included seven awards at $100K and 12 awards at $30K or less. An additional six awards totaling $476K were made to support the microlensing science team in GO Cycle 3. For Campaigns 14, 15, and 16, award sizes will range from $30K for a few targets to up to $50K for 999 targets. Proposals of over 1000 targets may receive up to the maximum award amount of $150K.

K2 Cycle 5 Guest Observer (GO) programs will exploit data collected in K2 Campaign 14, Campaign 15, and/or Campaign 16 fields and will begin on or about May 30, 2017. Funding for selected programs in Campaigns 14, 15, and 16 will start once data is made available through the public archive at the Mikulski Archive for Space Telescopes (MAST), anticipated to begin around November 15, 2017. There is no exclusive use period associated with any K2 GO data. The duration of awards will be one year, not including no-cost extensions.

6.3 Eligibility

Except as described in the following paragraph, application to the K2 GO program is open to all investigators, including those from outside the U.S. under NASA's no-exchange-of-funds policy. Investigators who are not affiliated with a U.S. institution are not eligible for funding through this program. Co-Investigators (Co-Is) affiliated with a U.S. institution are eligible to receive funding under a proposal led by a foreign Principal Investigator (PI). In this scenario, only a single Co-Investigator per proposal will be considered as a lead PI for funding purposes, and proposals should identify a lead Co-Investigator within the U.S.

However, in accordance with Public Law 113-76, Division B, Title V, Section 532, NASA cannot support 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. See Section III(c) of the ROSES-2016 NRA and the ROSES FAQ on this subject for more information on these restrictions.

7. Submission of Proposals to the K2 Cycle 5 GO Program

7.1 The Two-Step Proposal Submission Process

To facilitate the early recruitment of conflict-free reviewers, and to ensure that proposal concepts are responsive to and compliant with the solicitation, the K2 GO 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). Step-1 proposals will not be submitted to a formal, binding peer-review. 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 unless concerns regarding the responsiveness/compliance of their proposal concept are identified. However, a generic communication will go out to all who submitted a Step-1 proposal to indicate that Step-2 proposals can be submitted when the Step-2 "response structure" is opened on the NSPIRES web page. Only proposers who submit a Step-1 proposal are eligible to submit a Step-2 proposal. Full (Step-2) proposals must address the same scientific goals proposed in the Step-1 proposal. The Step-1 proposal title and PI cannot be adjusted. The Step-1 proposal summary (i.e., abstract) is not binding and can be revised in Step-2. Only the Step-2 proposal summary will be considered in the peer-review process. To add funded investigators between the Step-1 and Step-2 proposals, proposers must notify the NASA point of contact listed in Section 8 in writing (E-mail with cc to sara@nasa.gov) at least two weeks in advance of the Step-2 proposal due date. Submission of the Step-1 proposal does not obligate the proposer to submit a Step-2 (full) proposal later. No budget is required for either the Step-1 or Step-2 proposals. The funding level for awards is cost capped, see Section 6.1.

7.1.1 *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. The Step-1 proposal should identify the PI and all funded Co-Is on the proposal. The Scientific/Technical/Management section of the Step-1 proposal is restricted to the information submitted in NSPIRES and should include a description of the science goals and objectives of the proposal, an estimate of the number of targets to be observed (a target table is not required), a brief description of the methodology to be used, and a description of the relevance of the proposed research to this solicitation. The relevance section will be used to confirm that the proposal is responsive to the requirements of this call.

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 E-mail when they are able to submit their Step-2 proposals. If NASA determines that the proposed investigation is likely to be either nonresponsive or noncompliant with the solicitation, proposers will be notified in advance of the submission of their Step-2 proposal. In such cases, proposers are not precluded from submitting their Step-2 proposal, but should be aware that, without addressing the issues identified in the notification, there is a risk that their proposal may be declined without review.

7.1.2 *Step-2 Proposals*

Proposers should refer to the PDF 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) proposal is essentially identical to that associated with any other ROSES proposal, subject to the following program-specific constraints:

a) Large proposals must include a section of no more than one page in length describing a value-added community resource product that the Large proposal PI will provide at the end of the period of performance of the grant and how that product will be made available to and benefit the community. This product should be greater than simply a published paper. Example products might be delivery of a uniform set of well-produced open cluster star light curves, follow-up ground-based observations of exoplanet host stars, or a catalogue of sources with additional astrophysical information. This information will be used in Large proposal evaluation. Investigations that have broadly similar goals and team members to selected Cycle 1 and Cycle 2 proposals may use up to an additional 0.5 pages to describe progress they have made to delivering value-added community resources.
The target list of any Large proposal may be reduced if the need for a large number of targets is not adequately justified in the proposal.
If the products are to be ingested and curated at an existing astrophysics archive (e.g., the MAST archive at the Space Telescope Science Institute (STScI) or the NASA Exoplanet Database), the proposal should include a letter of acknowledgement from the relevant archive.

b) The Scientific/Technical/Management section of the Step-2 proposal, which consists of text, tables (excluding the target table), and figures must not exceed four pages for proposals in the Small category, or six pages for proposals in the Large category. Large programs can use up to an additional 0.5 pages to describe progress they have made to delivering value-added community resources. References do not count against the page limit.

c) A complete table of proposed targets (see Section 5.4) must also be included at the end of the Scientific/Technical/Management section of the proposal, but does not count against the page limit of that section. However, the target table should be truncated in instances where its incorporation will cause the Scientific/Technical/Management section to exceed a length of fifteen-pages.

d) For the purpose of submitting proposals through NSPIRES, proposers from non-U.S. institutions must affiliate in NSPIRES with the Kepler Guest Observer Office, which will submit the proposal on their behalf. For details, see http://keplerscience.arc.nasa.gov/k2-proposing-targets.html.

e) Complete and submit electronically the proposal through NSPIRES (http://nspires.nasaprs.com). Hard-copy submissions are not permitted.

f) A separate electronic version of the target table must be submitted to the Kepler Science Center by the proposal deadline. An Excel template for the target table, which is suitable for direct insertion into the proposal, instructions about the required file format for submission to the Kepler Science Center, and information regarding the file-naming convention for the target table file are available at http://keplerscience.arc.nasa.gov/k2-proposing-targets.html.

g) All electronic proposal materials (proposal and separate electronic target file submitted to NSPIRES and the Kepler Science Center, respectively) must arrive at the designated destinations by 11:59 p.m. Eastern time on the due date given in Section 8 in order to be included in the proposal review for this cycle of the K2 GO Program.

7.2 Proposal Formatting

This is a reminder that all proposals submitted to ROSES must strictly conform to the formatting rules in Section IV of the ROSES *Summary of Solicitation* and Chapter 2 of the *NASA Guidebook for Proposers*. Any proposal found to violate these formatting 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:

- Margins: 1 inch on all sides, with a standard page size of 8.5 × 11 inches.
- Font: The *NASA Guidebook for Proposers* requires easily read fonts having, on average, no more than 15 characters per inch (e.g., 12-point 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. Proposers may not adjust line-spacing settings for a 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%. Proposers may not place expository text in tables or figures in order to gain space.

7.3 Sources of Additional Information

The Kepler Science Center (http://keplerscience.arc.nasa.gov), located at the NASA Ames Research Center, provides support to Guest Observers and to proposers of this solicitation, such as technical information about the K2 mission and instrument, and other information supporting proposal preparation, including a Frequently Asked Questions link and template files for proposal preparation. Contact information may be found in Section 8.

8. Summary of Key Information

Expected program budget for Campaigns 14, 15, & 16 awards	~$1.5M. The funding level for awards are cost capped, see Section 6.1
Estimated number of funded investigations selected for observations	~7 Large investigations containing >1,000 observed targets over Campaigns 14, 15, and 16 combined, and ~12 Small investigations containing <1,000 observed targets over Campaigns 14, 15, and 16 combined.
Maximum duration of awards	1 year
Due Date for electronic submission of MANDATORY Step-1 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due Date for electronic submission of Step-2 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.

Planning date for start of investigation	Funds will be awarded when the data are made publicly available. Proposers should use November 15, 2017 as the probable date for receiving data from Campaign 14 (for reference, this observing cycle should start around May 30, 2017).
Page limit for the Step-2 central Science-Technical-Management section	Small proposals: No more than four pages for the Scientific/Technical/ Management section, including text, tables, and figures. Large proposals: No more than six pages for the Scientific/Technical/ Management section, including text, tables, and figures. Up to an additional 0.5 pages is allowed to describe progress toward delivery of value-added community resource products by PIs with selected K2 GO Cycle 1 or Cycle 2 proposals. References and the required target table do not count against these page limits, but the target table should be truncated in cases where it would cause this section to exceed 15 pages.
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 *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 and number of copies	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 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	NNH16ZDA001N-K2GO5
Mandatory submission of electronic version of target table	http://keplerscience.arc.nasa.gov/k2-proposing-targets.html#target-table
Kepler Science Center	Webpage: http://keplerscience.arc.nasa.gov Email: keplergo@mail.arc.nasa.gov

Technical questions concerning this program element may be directed to the Kepler Science Center	Thomas Barclay Kepler Guest Observer Office NASA Ames Research Center, MS 244-30 Moffett Field, CA 94035-1000 Telephone: (650) 604-3560 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

1. Scope of Program

1.1 Overview

Over the next decade and beyond, NASA's Astrophysics Division 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 search and characterize the planets and planetary systems orbiting other stars. To enable implementation of these missions, the NASA Science Mission Directorate's Astrophysics Division has established the Strategic Astrophysics Technology (SAT) program to support the maturation of key technologies to the point at which they are feasible for implementation in space flight strategic missions.

The 2010 Decadal Survey of Astronomy and Astrophysics (hereafter, Astro2010), strongly endorsed the SAT program (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 the Astro2010 recommendations (see the Astrophysics Implementation Plan at http://science.nasa.gov/media/medialibrary/2012/12/20/Rev1-StrategicIImplementationPlan-20Dec2012.pdf).

The focus of the SAT program is described 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, TRL levels one to three are generally considered to be basic research on new technologies, while TRL levels seven to nine correspond to the development of flight hardware.

The SAT program is designed to support the maturation of technologies whose 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 provides the definitions for the midrange TRLs supported by the SAT program.

The Astrophysics Division has three main science programs: Exoplanets 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 areas of scientific interest are represented within the SAT program through its three elements:

- Technology Development for Exoplanet Missions (TDEM)
- Technology Development for Physics of the Cosmos (TPCOS)
- Technology Development for the Cosmic Origins (TCOR)

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.

TRL	Definition	Hardware Description	Software Description	Exit Criteria
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 common to TDEM, TPCOS, and TCOR. Proposers are also urged to read Sections 2, 3, and 4 for further details on the requirements specific to each science area.

Proposers shall:

- Identify the SAT element(s) most closely related to the proposed technology (e.g., TDEM, TPCOS, TCOR; see Section 3). 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 and funding;
- Identify a strategic mission or mission concept to which the proposed technology is anchored (competed missions, such as Explorers, are not considered *strategic* missions);
- Describe the proposed path to achieving the goals of the proposed technology. In particular:
  (a) Provide proof that the technology being proposed is already at TRL=3;
  (b) Specify the expected end TRL at the conclusion of the proposed program. However, 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;
  (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, both the *NASA Guidebook for Proposers* (Section 2) and Section IV (b) ii of the *ROSES-2016 Summary of Solicitation* provide clear and 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 Annual Program Office Presentations

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 (See Sections 2, 3, and 4). NASA reserves the right to terminate a grant if it deems that achievement of the proposed goals according to the proposed schedule is unlikely to occur.

2. Technology Development for the Exoplanet Exploration Program

NASA's Exoplanet Exploration Program (ExEP) supports the development of those technologies that will allow us to search and characterize extrasolar planets and planetary systems. As compelling as these future ExEP missions are, implementing them presents many daunting technological challenges. The Technology Development for Exoplanet Missions (TDEM) element of the SAT Program is designed to support the maturation of key technologies that will overcome these challenges and pave the way to ever more ambitious exoplanet exploration missions.

2.1 TDEM Areas of Emphasis

The long term goal for NASA's exoplanet exploration program (ExEP) envisioned by Astro2010 is a "*New Worlds Mission*" that would conduct imaging and spectroscopy of rocky planets in the habitable zones of stars in the Solar neighborhood. To meet the challenge of Astro2010, the TDEM element of the SAT program solicits investigations that will advance the technology readiness of key technologies that will enable a future strategic *New Worlds Mission*, with the near term goal of bringing both coronagraphic- and starshade-based systems to TRL 5 by the end of the current decade. Detailed discussion of the current technology needs in the relevant areas can be found in the ExEP Technology Plan, which can be downloaded at http://exep.jpl.nasa.gov/reportsAndDocuments. Prospective SAT/TDEM proposers are strongly encouraged to review this document before preparing their proposal, as it reflects the programmatic considerations that will be taken into account in the review and selection of TDEM submissions. Proposers are also encouraged to review the list of current and past SAT/TDEM investigations (https://exep.jpl.nasa.gov/technology/) as these may also influence the programmatic prioritization of potential new investigations.

Technology activities of particular interest to the ExEP and the TDEM Program are those that undertake milestones in the following areas:

(1) *Starlight Suppression Demonstrations*
Demonstration of technologies that will enable a space observatory to reject scattered starlight to the degree that the light of an exoplanet can be separated from that of its parent star (10^7 contrast ratio at infrared wavelengths; 10^{10} contrast ratio at visible wavelengths). For coronagraph technologies, this includes interest in demonstrations with obscured and unobscured, segmented apertures suitable for operation with 10-m-class telescopes.

For starshade technologies, there is interest in (a) performance demonstrations leading to the validation of high-fidelity models, (b) petal unfurling/unwrapping mechanisms and latches, and (c) designs suitable for operation with 10-m-class telescopes.

(2) *Wavefront Sensing and Control of Scattered Starlight*
In order to achieve the requisite degree of starlight rejection, the light paths within coronagraphic systems must be controlled to picometer precision consistent with 10^{-11} contrast stability. Advances in control algorithms, wavefront-sensing technology, and deformable mirror technology beyond WFIRST-AFTA are, therefore, central to implementing such instruments on a space-based platform.

(3) *System Performance Assessment*
Testing new subsystems, instruments, and observatory designs on the ground for performance verification may not be feasible, even if they are small enough to fit in existing vacuum chambers. Thus, future exoplanet missions will have to rely on high-fidelity, very high high-density validated models that capture the physics properly and seamlessly integrate thermal, mechanical, and optical models, to infer expected on-orbit performance. Ultimately, the expected science performance relies on the integration of models that also include incoherent sources of scatter related to background objects, baffling, optical shielding, and multiple reflections. The ability to extract planet and disk images from the data requires calibration models based on realistic observing scenarios.

Relevant technology development activities involving ground-based astronomical facilities are eligible for funding under the TDEM element, providing there is clear and explicit traceability to a future exoplanet mission. Unfortunately, due to budgetary constraints, proposals for suborbital programs are not solicited at this time.

Over the years, the ExEP has developed a number of advanced testing and modeling tools to support the development of exoplanet exploration technologies. These tools are available to the community and proposers are encouraged to take advantage of them, as appropriate. An informational workshop will be held in advance of the proposal deadline to provide information for proposers wishing to take advantage of one or more of the available ExEP test facilities and/or tools and to provide guidance for developing quantitative, practical technology milestones for their proposed task. Information about the scheduling of the workshop and instructions for participation will be posted at http://exep.jpl.nasa.gov/news. The ExEP's two large High

Contrast Imaging Testbeds (HCIT) will be available to support new TDEM investigations in Fiscal Year (FY) 2017.

2.2 TDEM-specific Exclusions.

Proposals in the following areas are specifically not solicited under the TDEM element of SAT 2016:

- Investigations that advance technologies for future missions with goals other than the direct detection of extrasolar planets (e.g., astrometry, high-precision photometry, transit spectroscopy);
- Investigations that advance technologies for ancillary measurements that (although they may enhance the scientific capabilities of a future mission) do not directly enhance the ability of the system to isolate and analyze the light emitted or reflected from an exoplanet;
- Investigations that advance technologies leading to the development of infrared interferometry as the basis for a future strategic exoplanet direct detection mission;
- Proposals for the development of technologies for potential competed (e.g., Explorer) exoplanet direct detection missions;
- Investigations that address general technology maturation activities without specific application to the requirements of a future strategic exoplanet direct detection mission;
- Proposals for development and maintenance of testing facilities and/or tools that substantively reproduce the capabilities of existing ExEP infrastructure;
- Proposals for the advancement of technologies in the following specific areas: (1) detector technology; (2) mirror technology (with the exception of adaptive systems associated with wavefront sensing and control in coronagraphs); (3) telescope assembly technology; (4) spacecraft sunshields and thermal control; (5) propulsion systems; (6) vibration isolation systems; and (7) spacecraft pointing control (with the exception of telescope-starshade alignment control in external occulter systems).
- Investigations that advance starshade technologies in the areas of (1) deployment activities (other than those described in Section 2.1 (1) above), (2) shielding (aka blanketing) concepts and demonstrations, such as opacity testing and resistance to micrometeroids, (3) stray light investigation and analyses, including petal surfaces and edges, and (4) sensors and algorithms that enable the system to move from star to star and that enable the system to meet and maintain positional stability during science observations.

Finally, the potential use of one of the 2.4-m space telescopes NASA obtained from another Federal agency (termed the Astrophysics Focused Telescope Assets, or AFTA) as the basis for implementing the Wide Field InfraRed Survey Telescope (WFIRST) envisioned in the Astro2010 Decadal Survey has unexpectedly created a new, near-term opportunity in exoplanet exploration. Studies commissioned by the Astrophysics Division have established that an AFTA-based WFIRST mission (WFIRST-AFTA), augmented by the addition of a coronagraphic instrument, could be capable of conducting direct detection observations of planets as small as Neptune in the Solar neighborhood. In view of this promise, a coronagraph is now included as a component of the baseline WFIRST-AFTA mission concept, and advancement of relevant coronagraph technologies has been incorporated into the directed technology development program that NASA has established to bring WFIRST-AFTA to a suitable level of technology readiness on a timescale consistent with its expected implementation (i.e., after the launch of JWST). Consequently, coronagraph technologies that will be advanced under the WFIRST-AFTA technology development are not eligible for funding under the auspices of the SAT Program. Technologies that are not eligible include: (1) masks/apodizers for Shaped-pupil, hybrid Lyot, and Phase-Induced Amplitude Apodization Complex Mask (PIAA-CMC) coronagraphs; (2) low-order wavefront sensing and control; (3) data postprocessing; (4) system-level performance demonstration and modeling of obscured, nonsegmented aperture systems.

2.3 The TDEM Technology Development Model.

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 proposed under the auspices of the TDEM element may involve one or all of these elements. In addition, milestones for all SAT/TDEM investigations that make use of ExEP high-contrast testbeds shall incorporate both predictive and posttest 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.

3. Technology Development for Physics of the Cosmos (TPCOS) Missions

The primary science objectives of the Physics of the Cosmos (PCOS) Program are to understand the origin and destiny of the Universe, the physics of phenomena near black holes and other compact objects, and the nature of gravity, addressing the question "How does the Universe work?" (See http://science.nasa.gov/about-us/smd-programs/physics-of-the-cosmos/). Missions that are directed at advancing the fields of cosmology, high-energy astrophysics, and fundamental physics are nominally within the scope of this program. Detailed discussion of the current PCOS technology needs in the relevant areas can be found in the most recent version of the PCOS Program Annual Technology Report, which is available from the PCOS Program web site at http://pcos.gsfc.nasa.gov/. Prospective SAT/TPCOS proposers are urged to review this document before preparing their proposals.

The following technological areas are identified as of particular interest for the TPCOS Program:

- *Technologies for X-ray Astrophysics*, including, but not limited to, high-resolution microcalorimeter arrays, lightweight replicated optics and precision structures, high-resolution gratings (both transmission and reflection).
- *Technologies for Gravitational Wave Astrophysics*, including, but not limited to: dimensionally stable, optical telescopes; frequency-stabilized metrology lasers; high-resolution phasemeters; low-noise microthrusters; ultra-quiet inertial references; and long-distance, laser metrology techniques.
- *Technologies for CMB Polarization Measurements*, including, but not limited to, high-throughput cold mm-wave telescopes and large low-background multiplexed arrays of detectors.

Due to the limited budget available, proposals requiring a dedicated suborbital flight (balloon or rocket) for technology tests or risk reduction are not solicited in this call, but may be included in future solicitations. However, proposals that require suborbital balloon or rocket flights may be considered if they piggyback with a payload of an already approved suborbital mission or a payload on a Suborbital Reusable Launch Vehicle. Questions concerning piggyback payloads may be addressed to the individuals listed in the table below.

Piggyback Balloon Payload	Piggyback Sounding Rocket Payload
Debora Fairbrother Balloon Program Office Code 820 Wallops Flight Facility NASA Wallops Island, VA 23337 Telephone: (757) 824-1453 Email: Debora.A.Fairbrother@nasa.gov	Philip Eberspeaker Sounding Rocket Program Office Code 810 Wallops Flight Facility NASA Wallops Island, VA 23337 Telephone: (757) 824-2202 Email: Philip.J.Eberspeaker@nasa.gov

Piggyback Suborbital Reusable Launch Vehicles (sRLV)
LK Kubendran Flight Opportunities Space Technology Program NASA Headquarters Washington, DC 20546 Telephone: (202) 358-2528 Email: lk@nasa.gov

The proposal must address the question of how a potential future strategic mission (see Section 1.2) that primarily addresses PCOS science goals will be enabled or enhanced by the proposed suborbital work.

Annual reports for a selected TPCOS investigation must be submitted to the Program Scientist 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.

In addition, PIs of selected investigations shall submit a short status update on a bimonthly basis and make an annual progress presentation to the PCOS Program Office. By the end of the full term of the investigation, the Program Office convenes a technology management board to evaluate the technology readiness level realized during the course of the project.

4. Technology Development for the Cosmic Origins Program (TCOR)

The Cosmic Origins Program (COR) seeks to investigate how planets, stars, galaxies, and cosmic structure come into being and when and how the elements of life in the Universe arose. In general, areas of astronomy and astrophysics not explicitly called out in the previous program definitions fall within the Cosmic Origins Program. Further information on the scope, activities, and the Program Annual Technology Report (PATR) of the Cosmic Origins theme can be found in the website at: http://cor.gsfc.nasa.gov. First and second priorities for areas of long-lead and mission enabling technology development that are of particular interest to the Cosmic Origins Program include:

1. *Next Generation Detectors*
   Highly sensitive detectors and large arrays of detectors are fundamental to the capabilities of COR missions. In particular, high- Quantum Efficiency (QE), large-format, photon counting and ultra-low-noise detectors from the extreme ultraviolet to the far-infrared portion of the spectrum and their associated technologies (e.g., manufacturability, read-out electronics, packaging) will be critical to achieving the goals of future Cosmic Origins investigations.

2. *Optical Coatings, Gratings, and Filters*
   Improved coatings for optics, for reflective purposes as mirrors, for antireflective (AR) uses on optical elements such as gratings and detectors, and for wavelength-selective applications as filters, dichroics, or blockers, could yield more sensitive instruments and permit more instrument design freedom. The known UV reflective materials and protective coatings used on Al, such as MgF_2, LiF, CaF_2, LaF_3, etc., may have reached performance limitations, and we are seeking new and superior solutions that could be incorporated into flight hardware. For reflective coatings, most crucially in the Lyman ultraviolet (900-1300 Å), increasing system throughput is a very cost-effective way to achieve more science. Studies of improved deposition processes for known Lyman UV-reflective coatings (e.g., SiC) and investigations of new coating materials with promising Lyman UV performance, with reflectivities in excess of 50%, and reflectivities close to unity at longer UV wavelengths are areas where progress would be valuable. Because

SAT proposals assume a TRL entry gate of at least 3, proposals that address the needs outlined here, but do not meet this TRL threshold, should be submitted as APRA proposals.

3. *Precision Large Optics*
   COR flight missions rely heavily on their ability to collect sufficient light with appropriate angular resolution to address important relevant questions. Therefore, a premium is placed on the ability to develop scalable manufacturing techniques, including the testing and control optics of suitable and affordable mirror sizes. Keys to advancements in this arena are new techniques and technologies for reducing areal density of optics, production times, and cost; manufacturing ultra-precise, low-mass structures to reduce launch volume for large-aperture space telescopes and interferometers; operation at short and long wavelengths (900 – 2000 Å, 30 – 300 μm); and mechanisms and methods for improving thermal and dynamic stability, and wavefront sensing and control.

Proposals that are building on previously funded COR technology development must be justified with new, distinct, objectives for the new investigation. Such proposals should also include a clear description of prior advances, milestones, and TRL achieved. The proper justification and demonstration of the TRL level 3 or higher of the proposed technologies is an explicit requirement for compliance with this SAT call for proposals. The annual report for selected efforts should contain documentation of the progress towards the milestones identified in the proposal.

Due to the limited budget available, proposals requiring a dedicated suborbital flight (balloon or rocket) for technology tests or risk reduction are not solicited in this call, but may be included in future solicitations. However, proposals that require suborbital balloon or rocket flights may be considered if they piggyback with a payload of an already approved suborbital mission. Questions concerning piggyback payloads may be addressed to the individuals listed in the table above in Section 3.

The proposal must address the question of how a potential future mission that primarily addresses COR science goals will be enabled or enhanced by the proposed suborbital work.

4.1 Reporting Requirements for TCOR

An Annual Report for each selected investigation must be submitted, containing detailed documentation of the progress towards the milestones identified in the proposal and a description of the plan forward and its expected outcomes. This Report will be included in the Program Annual Technology Report.

In addition, PIs of selected investigations submit a short status update on a bimonthly basis, and make an annual progress presentation to the Program Office. By the end of the full term of the investigation, the Program Office convenes a technology management board to evaluate the technology readiness level realized during the course of the project.

5. Programmatic Information

5.1 General Information

The period of performance for proposals submitted in response to this solicitation may not exceed two or three years depending on the program element (see Section 6). The following table provides the approximate amount of funding available for new awards, distributed over Fiscal Years 2017 and 2018. It also gives the number of new investigations that may be selected for the three SAT categories pending the availability of funds and an adequate number of proposals of sufficient merit.

SAT Category	Approximate Funds for New Selections [$M]	Approximate Number of New Selections
TDEM	$2.0 per year	~2-5
TPCOS	$2.0 per year	~2-5
TCOR	$2.0 per year	~2-5

5.2 Student Participation

When appropriate, participation of graduate students is encouraged, especially if the project can be concluded within the nominal tenure of graduate training. In such cases, a brief summary of the educational and training goals of the student participants should be included in the proposal.

5.3. Request for reviewer names

Proposers are strongly encouraged to provide names and contact information of up to five nonconflicted experts qualified to review their proposal. These experts must not be from the institutions of the PI or Co-Is. This information should be included in the proposal summary in the Notice of Intent.

6. Summary of Key Information

Expected program budget for first year of new awards	See Section 5.1
Number of new awards pending adequate proposals of merit	See Section 5.1
Maximum duration of awards	3 years for TDEM and TCOR elements, 2 years for TPCOS; proposals with a term shorter than 2 years will be accepted, but are not encouraged.
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	January 1 of the year following the proposal due date (except proposers from 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; see also Chapter 2 of 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 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	NNH16ZDA001N-SAT
NASA point of contact concerning this program	The relevant Program Officers listed below with their areas of expertise, all share the same mailing address: Astrophysics Division Science Mission Directorate NASA Headquarters 300 E Street SW Washington, DC 20546-0001

Name	Program Element	Telephone	E-mail
Douglas Hudgins	TDEM	(202) 358-0988	Douglas.M.Hudgins@nasa.gov
Rita M. Sambruna	TPCOS	(202) 358-2166	Rita.M.Sambruna@nasa.gov
Mario R. Perez	TCOR	(202) 358-1535	Mario.Perez@nasa.gov

D.9 NANCY GRACE ROMAN TECHNOLOGY FELLOWSHIPS IN SPACE ASTROPHYSICS FOR EARLY CAREER RESEARCHERS

NOTICE: Proposals for the Nancy Grace Roman Technology Fellowship (RTF) program are not solicited in ROSES-2016. It is anticipated that henceforth the program will solicit proposals on alternate years, thus RTF proposals will again be solicited in ROSES-2017. Information from the ROSES-2015 RTF solicitation is provided below for reference and planning purposes.

1. Overview

The goals of the Nancy Grace Roman Technology Fellowship (RTF) program in Astrophysics are to give early career researchers the opportunity to develop the skills necessary to lead astrophysics flight instruments/projects and 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.

Institutions and organizations are encouraged to submit proposals to the RTF program on behalf of their outstanding early career researchers, including postdoctoral researchers, nontenured faculty members, term civil servants, and employees who intend to develop careers involving innovation and technology development for space astrophysics, with the individual as the PI of the proposal.

The RTF awards will be issued as grants, except in the case of Government employees, who will be directly funded.

The RTF is structured into three components with specific gates for entering the next phase. The first component is a one-year Concept Study Phase to generate the detailed plans and commitments for developing the proposed space astrophysics technology (Section 3.2). The final report from the Concept Study, due nine months after the start of the award, will be peer reviewed. A subset of the Technology Fellows will be selected to continue the fellowship and implement the plans conceived during the Concept Study. This Development Phase (Section 3.3), the second component of the RTF structure, is for an additional four-year duration. Finally, the third component is an opportunity for Fellows in the four-year Development Phase to apply for start-up funds (Section 3.4) when they obtain a tenure-track, permanent civil service, or equivalent position.

2. Eligibility

To be eligible for an RTF award, proposal PIs must meet the following requirements at the time of submission:

- Be a recent Ph.D. recipient, defined as having graduated on or after January 1 of a year that is no more than seven years before the issuance date of this ROSES NRA.

Individuals who have interrupted their careers for substantive reasons, such as family leave or serious health problems, and are more than seven years beyond the receipt of their Ph.D. degrees, may also be eligible. These applicants should make a written request for prior concurrence from NASA before the due date for Notices of Intent to propose. NASA will provide a written response within three weeks of receipt of this request.

- Be in an early career position such as a postdoctoral, tenure-track, term civil service, or an equivalent nontenured position, as long as the employing institution assumes the responsibility of submitting the proposal with the individual as the proposed PI. 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 Section 1.4.2 of 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] in order to support 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[2], tenure, or equivalent position on or before the submission deadline of this program.

- Not be a current or former recipient of the RTF or a PECASE award.

Note: Each year, NASA selects nominees for Presidential Early Career Awards for Scientists and Engineers (PECASE) from the exceptionally meritorious awardees sponsored by its research programs. PECASE awards recognize outstanding scientists and engineers who, early in their career, show exceptional potential for leadership at the frontiers of knowledge. Each Presidential award is of five-years duration. NASA does not issue a special announcement for the PECASE award. The awardees of the RTF Program constitute one (but not the only) source of nominations for the PECASE by the Astrophysics Division. If an RTF awardee is selected for the PECASE award, the duration for the combined honor is five years. Conversely, a current or former recipient of a PECASE award is not eligible to apply to the RTF.

3. Programmatic Information

3.1 Evaluation Criteria

The proposed research will be evaluated on how well it addresses the goals of the RTF program: to give early career researchers the opportunity to develop the skills necessary to lead a flight

[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.

[2] Both career conditional and career tenure civil servant appointments are referred to in this solicitation as simply career civil servants. The RTF program does not differentiate between these two types of appointments.

instrument/project and become Principal Investigators of future space astrophysics missions, to develop innovative space astrophysics technologies 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.

Proposals submitted to NASA in response to this solicitation will be evaluated with respect to the criteria specified in Appendix C of the NASA *Guidebook for Proposers*, which are intrinsic merit, relevance, and cost realism/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.
- Novel technology likely to enable innovative future space astrophysics missions. The proposed technology may be part of a suborbital activity, as long as the prospective fellow has a leading role in developing the technology and the proposed development effort is distinct from the separately funded suborbital activity.
- As a secondary factor, the potential for broader application of the technology to other NASA programs, and space-based programs of other Government agencies.

Relevance will be judged on the basis of the proposed technology to advance one or more of the three Astrophysics science themes: Cosmic Origins, Exoplanet Exploration, and Physics of the Cosmos.

3.2 <u>Submission of Proposals for the Concept Study Phase</u>

During the one-year Concept Study Phase, the Fellow should develop definitive information regarding the cost, risk, and feasibility of the proposed investigation. The content and format of the Concept Study Phase proposal should follow the *NASA Guidebook for Proposers* with the following additional guidance:

- The proposal should include a detailed budget for the one-year Concept Study Phase, plus a rough estimate of the budget required for the four-year Development Phase.

- The proposal should include a detailed work plan for the duration of the one-year Concept Study Phase, plus a notional plan for the first year of the Development Phase.

- The proposal should include a letter from the host institution indicating it recognizes that a substantial institutional commitment for laboratory space and other institutional resources will be required for the four-year Development Phase. The proposal should also contain a plan for obtaining firm institutional commitments for laboratory space and other institutional resources that will be required throughout the four-year Development Phase.

The award amount for the Concept Study Phase is judged according to the scope of the proposed work and the overall competition. Funds may be used for fellow's salary; support of students (undergraduate or graduate) and/or postdoctoral fellows who are involved in the proposed research; research expenses such as costs incurred in field experiments; purchase of equipment and/or supplies, computing, travel, etc. If research collaboration is a component of the proposal, it is presumed that the collaborator(s) have their own means of research support; that is, an RTF award may not include expenses for personnel or activities at collaborating institutions, nor salary costs for other senior personnel. Proposers may request up to $100K for the Concept Study Phase.

3.3 Submission of Concept Study Report for Entering the Development Effort

Recipients of a Concept Study RTF will be eligible to apply for a four-year Development Phase award to implement the plans developed during the Concept Study. Continued funding throughout the Development Phase is contingent upon availability of funds and satisfactory progress. Progress will be assessed by review of required annual progress reports and a progress review near the end of the second year that will be based on milestones defined in the proposal. Fellows should present a Development Phase budget request in their Concept Study Report submitted to NASA nine-months after the award of the Concept Study through NSPIRES (instructions will be provided to the PI). The content and format of the Concept Study Report are the same as those for a full proposal as described in the *NASA Guidebook for Proposers.* The Concept Study Report will be peer reviewed and a subset of the Technology Fellows will be selected to continue the fellowship and implement the plans conceived during the Concept Study.

The award amount for the Development Phase is judged according to the scope of the proposed work and the overall competition. Funds may be used for the fellow's salary, support of students (undergraduate or graduate), and/or postdoctoral fellows who are involved in the proposed research; research expenses, such as costs incurred in field experiments; purchase of equipment and/or supplies, computing, travel, etc. If research collaboration is a component of the proposal, it is presumed that the collaborator(s) have their own means of research support; that is, an RTF award may not include expenses for personnel or activities at collaborating institutions, nor salary costs for other senior personnel.

Researchers who are in tenure-track, career civil servant, or equivalent positions at the time of requesting the four-year Development Phase support may request salary for the Fellow for up to four years (including associated fringe benefits and indirect costs), plus up to $500K for institutional indirect costs, capital equipment, and other project costs. Researchers who are not in tenure-track or equivalent positions may request salary for the Fellow for up to four years (including associated fringe benefits and indirect costs), plus up to $300K for institutional indirect costs, capital equipment, and other project costs. As discussed above, salary and other expenses should be responsive to NASA's evaluation criteria on cost realism and reasonableness.

The Concept Study Report and the request for Development Phase support must include an institutional commitment for laboratory space and other institutional resources required for the proposed work. NASA strongly encourages, but does not require, that the submitting institution contribute to the cost of the proposed project. Of special interest is support by the employing institution that would provide paid release time to enable the applicant to more fully concentrate on the activities related to the proposal. Institutional support of equipment purchase and co-funding of student and/or postdoctoral support would also be recognized as a valuable contribution. Institutional commitments for these resources should be included in the Concept Study Report.

3.4 Submission of Requests for Start-up Funds

Active fellows who obtain a tenure-track, career civil servant, or equivalent position at an institution of their choice during their four-year Development Effort may request up to $200K (inclusive of indirect costs) in laboratory start-up funds (this is in addition to the $300K included in the Development Phase request). This funding is not guaranteed and is subject to peer review.

The start-up support is intended to aid Fellows in establishing a research group and/or laboratory in their new position, thus enabling them to continue their NASA-funded investigation. The funds may be used for the Fellow's salary, student and research associate salaries, purchasing laboratory equipment, and other expenses associated with establishing research efforts. Requests for start-up funds may not include expenses for personnel or activities at collaborating institutions, nor salary costs for other senior personnel.

To request start-up funds, Fellows should provide a short proposal detailing the research group they plan to establish upon starting a tenure-track, career civil servant, or equivalent position. Fellows should submit their proposals for start-up funds through NSPIRES under the sponsorship of the institution at which they have obtained their new position (instructions will be provided to the PI). The proposal must describe any needed equipment and facilities and anticipated staffing plans (including the role of undergraduate students, graduate students, and postdoctoral researchers). The proposal must contain a strategy describing how the Fellow plans to sustain the research group or laboratory over the long term. A detailed budget with a narrative justification is required as part of the proposal. Fellows should also describe how the planned research group would benefit NASA and further its goals.

NASA encourages, but does not require, that the submitting institution contribute to the cost of the proposed project. 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 purchase and co-funding of student and/or postdoctoral support would also be recognized as a valuable contribution. Institutional commitments for laboratory space, matching or startup funds, and other institutional resources required for the proposed work should be included in the proposal.

Proposals for start-up funds may be submitted at any time the Fellow meets the requirements described above.

NASA does not require a data management plan for proposals to this program element.

4. Summary of Key Information

Expected program budget for first year of new awards	Concept Studies: N/A Development Phase: N/A

Number of new awards pending adequate proposals of merit	N/A
Maximum duration of awards	Two years for a new study phase; the four-year Development Effort would augment the original award and extend the period of performance; start-up funds for a current fellow would augment the original award without extending the period of performance.
Due date for Notice of Intent to propose (NOI)	N/A
Due date for proposals	N/A
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	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/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See 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	N/A
NASA point of contact concerning this program	William D. (Billy) Lightsey Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (256) 961-7039 E-mail: Billy.Lightsey@nasa.gov

D.10 NuSTAR Guest Observer – Cycle 3

NOTICE: Amended on October 24, 2016. This amendment releases final text for Program Element D.10 Nuclear Spectroscopic Telescope Array (NuSTAR) Cycle 3. This new text differs from the version from ROSES-2015 in the following ways:
1. The Phase-1 proposal due date is January 27, 2017;
2. The Cycle 3 Observing period is June 1, 2017 – May 31, 2018;
3. The policy regarding the disposition of potential conflicts between observations of proposed Cycle 3 Guest Observer (GO) targets and planned NuSTAR legacy observations of those targets is clarified (Section 1.3);
4. The minimum time required to submit requests for a feasibility analysis of observations of targets in fields designated as "heavily contaminated" is reduced to two business days (Section 1.3.1);
5. Proposals for observations of Targets of Opportunity (ToOs) submitted to this Call for Proposals may now include observations triggered from a class of objects or set of potential targets (Section 1.3.3);
6. The policy regarding the funding of joint NuSTAR X-ray Multi-Mirror Mission (XMM) proposals selected through this Call for Proposals is clarified (Section 2.1).

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 third round of Guest Observations (Cycle 3) will commence on or about June 1, 2017, and last for a nominal period of 12 months. Based upon the outcome of the 2016 NASA Astrophysics Senior Review process, NuSTAR operations are currently funded through September 30, 2018. Further details on the Cycle 3 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.

Individuals may submit proposals for two general types of observations: "standard-mode" and "Target-of-Opportunity" (ToO) (see Section 1.3.3). 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 3 Call for Proposals will have a limited exclusive-use period dependent upon the observation type. Data from approved standard-mode GO 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 are also solicited under this Call for Proposals. Prospective proposers of joint NuSTAR-XMM observations should refer to Section 1.3.1 for details concerning the evaluation and implementation of such proposals. Opportunities for carrying out NuSTAR observations in conjunction with NASA's Chandra X-ray Observatory or XMM-Newton are also available through the relevant Calls for Proposals for those observatories. Note that, for most NuSTAR pointings, "snapshot" (1 - 2 ks) observations are performed by NASA's Swift mission.

All NuSTAR public science data will be made freely available through the High Energy Astrophysics Science Archive Research Center (HEASARC) website (http://heasarc.gsfc.nasa.gov).

Funding for investigations selected under the NuSTAR GO Program is available only to individuals at U.S. institutions who are identified as PIs. U.S.-based Co-Investigators on foreign-led proposals are not eligible for funding. Individuals from non-U.S. institutions desiring to participate in this program should read Sec 1.6.1 of the *Guidebook for Proposers*. Such individuals are strongly encouraged to include a letter of commitment from their sponsoring foreign institution stating that they will bear the cost of the research.

Proposals for investigations directed primarily towards the conduct of supporting theoretical or laboratory astrophysics research or ground-based observations relevant to the NuSTAR mission are not solicited under 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, 2018. The observatory has no expendables, and the orbit lifetime is estimated at ~10-15 years from launch. Currently in its fifth 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, $\Delta E/E = 0.5$)	2×10^{-15} erg cm^{-2} s^{-1}
Sensitivity (10–30 keV) (10^6 s, 3σ, $\Delta E/E = 0.5$)	1×10^{-14} erg cm^{-2} s^{-1}
Background in HPD (10–30 keV)	8.4×10^{-4} counts s^{-1}
Strong source (>10σ) positioning	1.5″ (1σ)
ToO response time	< 24 hr
Slew rate	0.06° s^{-1}
Settling time	200 s (typically)

1.3 NuSTAR Cycle 3 General Information

The total amount of time allocated to Guest Observations during the third year of the GO phase of NuSTAR is expected to be 8.5 Ms (50% of the total observing time). Of this, it is anticipated that up to 6.5 Ms of observing time will be awarded to selected Cycle 3 investigations; of the remaining time (~ 2Ms), up to 1.5 Ms is expected to be awarded to joint NuSTAR/XMM-Newton proposals submitted to the XMM-Newton Cycle 16 Call for Proposals, and up to 0.5 Ms to NuSTAR/Chandra Joint Observing Projects proposals submitted to the Chandra Cycle 19 Call for Proposals. It is anticipated that approximately 40 investigations will be selected for implementation under the NuSTAR Cycle 3 GO program.

The remaining 50% of the observing time will be allocated through the NuSTAR Project as follows: NuSTAR legacy survey observations (~ 25% of the total observing time); NuSTAR PI discretionary time, including unsolicited ToO observations open to the scientific community (~ 15%); and, calibration observations, engineering tasks, and resolution of operational issues (~ 10%).

The NuSTAR legacy surveys represent extensions of the Galactic and Extragalactic surveys conducted during the baseline mission. 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 nontarget 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 Cycles 1 and 2 Guest Observations are available at http://heasarc.gsfc.nasa.gov/docs/nustar/nustar_prop.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 3 program will be restored to the legacy program. A list of legacy observations that are planned to be performed by the end of Cycle 3 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 3; any standard-mode, nontime-constrained Category A and B observations not observed during Cycle 3 will be carried over to Cycle 4. Time-constrained Category A and B observations not observed during Cycle 3 will be considered for possible scheduling in Cycle 4 (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 2 Category C targets that have not been scheduled prior to the Cycle 3 proposal due date may be submitted to Cycle 3. Such proposals will be considered for selection in Cycle 3 *only* if the corresponding Cycle 2 observation is not executed in Cycle 2. Multiyear observing proposals will not be accepted in Cycle 3.

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 3 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 programs in Cycle 3 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;

- 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.

Individuals considering submission of a Cycle 3 proposal for joint NuSTAR-XMM observations should consult the XMM-Newton AO-16 approved NuSTAR target list prior to submission of their proposal. Duplicate observations of the same targets by NuSTAR will typically not be awarded.

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 3. 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 3 may be carried over to Cycle 4 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 3 will *not* be carried over to Cycle 4.
- 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.

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 3 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 3;
- 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 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 programs submitted to the Chandra/NuSTAR or XMM-Newton/NuSTAR GO Program Calls for Proposals approved prior to the Cycle 3 solicitation will take precedence over NuSTAR Cycle 3 proposals with the same targets and trigger criteria.

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 3 ToO observations may be triggered until the end of the cycle. ToO observations not triggered during Cycle 3 will not be carried over to Cycle 4; such observations may be reproposed to a subsequent cycle.

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.

2. Programmatic Information

2.1 General Information

It is anticipated that up to $1.5M will be available for the support of Guest Observations during Cycle 3. 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 3. 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, limited funding for support of costs such as travel, page charges, etc., will be held in reserve for proposals with Category C targets that are executed during Cycle 3. 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 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 data. Such proposals should *not* be submitted to the U.S. XMM-Newton Guest Observer Facility.

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/C rating by the peer review panel will be invited to submit a Phase-2 (cost) 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. 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/). NuSTAR GO Proposers should follow these instructions, except where they are superseded by the instructions provided in the *ROSES Summary of Solicitation* or in this Appendix.

2.2.1. *Submission and Evaluation of Phase-1 NuSTAR GO Proposals*

Individuals submitting Phase-1 proposals to the Cycle 3 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, 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 the *ROSES Summary of Solicitation*.

The three basic evaluation criteria are given in the *ROSES Summary of Solicitation* Section VI (a) and Section C.2 of the *NASA Guidebook for Proposers* and they are Relevance, Merit, and Cost. The evaluation criterion intrinsic merit includes:

- 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 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 will evaluate the Phase-2 cost proposals for cost realism and reasonableness. Comparison of the proposed cost to available funds will be performed as specified in Section C.2 of the *NASA Guidebook for Proposers*. Subject to the conditions stated above, proposers will be notified regarding the award amount for their Cycle 3 investigation(s) by NASA upon completion of the Phase-2 review process.

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 3 awards	~ $1.5 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 in the *ROSES Summary of Solicitation*
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, 2017 (4 months after start of the Cycle 3 observing program) as a planning date for start of observations.
Page limit for Phase-1 proposals	4 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 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	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook.
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://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.

Programmatic information may be obtained from the NuSTAR Program Scientist	Louis Kaluzienski Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0365 E-mail: louis.j.kaluzienski@nasa.gov
Technical questions concerning this program element may be directed to the NuSTAR Guest Observer Program Office	Craig Markwardt NuSTAR Mission Scientist Code 662 Goddard Space Flight Center National Aeronautics and Space Administration Greenbelt, MD 20771-0001 Telephone: (301) 286-1506 E-mail: Craig.Markwardt@nasa.gov

D.11 ASTRO-H GUEST OBSERVER – CYCLE 1

NOTICE: Amended on May 9, 2016. This amendment announces that program element D.11 ASTRO-H Guest Observer - Cycle 1 will not be competed in ROSES-2016.

NASA planned to issue a call for Guest Observer proposals for the ASTRO-H mission but due to an anomaly experienced by the Hitomi spacecraft on March 26, 2016, and the subsequent loss of the mission, the planned release of this program element has been canceled.

Points of Contact

Additional information regarding the ASTRO-H Guest Observer Program may be obtained from the following individuals:

Programmatic information may be obtained from the ASTRO-H Program Scientist	Louis Kaluzienski Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0365 E-mail: louis.j.kaluzienski@nasa.gov
Technical questions concerning this program element may be directed to the ASTRO-H Program Office	Robert Petre Telephone: (301) 286-3844 E-mail: robert.petre-1@nasa.gov

D.12 ASTROPHYSICS PROBES MISSION CONCEPT STUDIES

NOTICE: Amended on August 16, 2016. This amendment creates a new opportunity in ROSES-16 in this program element, D.12 Astrophysics Probe mission concept studies. A Preproposal teleconference will occur on September 13, 2016, 1-2 pm. The dial in number for the teleconference will be 877-951-7311, passcode 4496156. Any new information that comes out of questions and answers from the teleconference or questions sent directly to the NASA point of contact will be posted in a FAQ on the NSPIRES web page for this program element. Notices of Intent are requested by September 16, 2016, and the due date for proposals is November 15, 2016.

1. Scope of Program

NASA has started preparations for the 2020 Astronomy and Astrophysics Decadal Survey (http://science.nasa.gov/astrophysics/2020-decadal-survey-planning/). One of the tasks of the 2020 Decadal Survey Committee will be to recommend a portfolio of astrophysics 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. NASA and the community are interested in providing appropriate input to the 2020 Decadal Survey regarding medium-size mission concepts, also referred to as Astrophysics Probe concepts.

To this end, NASA is soliciting proposals to conduct mission concept studies for Astrophysics Probe missions. Following peer review of the proposed mission concept studies, NASA will select a small number of proposals for 1.5 year (18 month) funded studies. Results of the selected studies will be provided by NASA as input to the 2020 Decadal Survey.

Astrophysics Probes are envisioned to have a total lifecycle (NASA Phases A through E) cost between that of a MIDEX mission (~$400M) and ~$1B. 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. Astrophysics Science Investigation Goals

This program element solicits proposals for mission concept studies that address NASA's science objectives in astrophysics, which include discovering how the universe works, exploring how it began and evolved, and searching for life on planets around other stars. This objective is discussed in more detail in the 2014 NASA Science Plan (http://science.nasa.gov/about-us/science-strategy/) and the 2013 NASA Astrophysics Visionary Roadmap (http://science.nasa.gov/science-committee/subcommittees/nac-astrophysics-subcommittee/astrophysics-roadmap/).

3. Programmatic Information

The goal of the Astrophysics Probes mission concept studies is to develop scientific, technical, and cost information to be used as input to the 2020 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.

3.1 Proposal Evaluation and Awards

The three basic evaluation criteria are given in the ROSES Summary of Solicitation Section VI (a) and Section C.2 of the NASA *Guidebook for Proposers* and they are Relevance, Merit, and Cost. In addition to the evaluation factors given in the NASA *Guidebook for Proposers*, the evaluation factors will include:

- The scientific merit of the science goals of the mission concept proposed for study,
- The value of the proposed study given any previous or ongoing (e.g., large mission concept) mission concept studies,
- The relevance of the proposed mission concept to the scientific goals of the Astrophysics Division, as described above (Section 2), and
- The likelihood that the proposed mission concept will be in the ~$400M to ~$1B range.

The total budget available for this solicitation is ~$1M. NASA will select 5-8 proposals with awards to the Principal Investigator (PI) in the range of ~$100K - $150K. NASA has separately budgeted the cost of design laboratory runs and final cost assessment (see Section 3.4).

3.2 Proposal Guidelines

The 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 material in Section 2.3.5 of the *NASA Guidebook for Proposers* (see reference in Section 5 below), the Scientific/Technical/Management section of proposals for this program element must include the following additional items:

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 Astrophysics. 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, both space- and ground-based, should be addressed;

2) A clear description of the current readiness levels for mission critical technologies, especially any not currently under development at NASA, and a rationale supporting the stated readiness levels in the proposal, including, where possible, laboratory or field demonstrations of the technologies;
3) A sound justification of why a Probe-size mission is required to address the science goals; concepts for missions that can be realized within the Astrophysics Explorers Program will be considered noncompliant and will not be considered for selection;
4) For mission concepts already studied in the past or ongoing (see Section 3.1 above), a robust justification of the value of the proposed additional study;
5) A rationale detailing why it is expected that the mission should be feasible for less than ~$1B; and
6) A detailed management plan, including a statement of work to be undertaken over the proposed period of performance (not to exceed 1.5 years, or 18 calendar months).

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. For more information see the 2016 *Guidebook for Proposers*, Section 1.6.1. "Proposals Involving Non-U.S. Organizations".

In recent years, NASA has conducted detailed studies of a few probe-size mission concepts (e.g., exoplanet probe studies[1]; gravitational wave mission architecting studies[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 2.2 of 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.

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 to enlist the assistance of either the Jet Propulsion Laboratory's (JPL's) Advanced Projects Design Team (Team X) or Goddard Space Flight Center's (GSFC's) Integrated Design Center (IDC). Team X and IDC will provide space system analysis and development of conceptual designs, including:

- design of spacecraft, science instrument(s), and their interface;

[1] https://exoplanets.nasa.gov/exep/studies/probe-scale-stdt/
[2] http://pcos.gsfc.nasa.gov/studies/gravitational-wave-mission.php

- 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 a NASA design laboratory, if selected, must include that intent in the body of the proposal and specify whether it will be IDC or Team X, for NASA planning purposes. A budget for utilizing these facilities will be held by NASA and will be provided by NASA directly to JPL or GSFC; the cost of these studies should not be included in the proposed budget. The design labs will be available during the period September – December 2017.

3.4.2 *Independent Cost Assessments*

At the end of the concept study's period of performance, NASA will conduct an independent cost assessment of all the selected mission concept studies using NASA cost assessment capabilities and experts. The purpose will be to validate the mission cost to ensure that the cost estimates submitted by each study meet the life mission life cycle cost criteria (between $400M and $1B). The proposer can assume minimal involvement (if needed) in the NASA cost assessment. NASA will hold a budget for these cost assessments; the cost of these studies should not be included in the proposed budget.

3.5 Reporting to NASA

A quarterly status briefing will be provided to NASA by the selected proposers in the form of a quad chart. A template for the quad chart will be provided by NASA.

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 January 7-11, 2018, meeting of the American Astronomical Society (AAS). The final concept study report will be made publicly available. The final report should include: science case and measurement(s) requirements, mission concept/architecture, telescope 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.

4. Summary of Key Information

Expected program budget for Cycle 1 awards	~$1M
Expected number of new awards pending adequate proposals of merit	5-8
Maximum duration of awards	18 months

Preproposal teleconference	September 13, 2016, 1-2 pm, 877-951-7311 passcode 4496156
Due date for electronic submission of Notice of Intent to propose (NOI)	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for electronic submission of proposal	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Anticipated selection date	February 2017
Planning date for start of investigation	March 2017
Anticipated award end date	September 2018
Anticipated study report due to NASA	September 2018
Community Workshop at 231st AAS Meeting	January 7-11, 2018 (anticipated)
Page limit for the central Science- Technical-Management section	15 pages
Relevance	This program is relevant to the Astrophysics questions and goals in the NASA Science Plan. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
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 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 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	NNH16ZDA001N-APROBES
NASA point of contact concerning this program	Rita Sambruna Probes Program Officer Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-2166 E-mail: rita.m.sambruna@nasa.gov

D.13 ASTROPHYSICS EXPLORERS U.S. PARTICIPATING INVESTIGATORS

NOTICE: Amended on October 21, 2016. The due date for mandatory notices of intent has been extended to October 27, 2016.

Amended on September 15, 2016. This amendment presents a new solicitation in ROSES-2016: D.13, Astrophysics Explorers U.S. Participating Investigator (APEX USPI) Program, released in conjunction with the SALMON-2 AO PEA R: Astrophysics Explorers Mission of Opportunity. Mandatory notices of intent are required by October 27 ~~13~~, 2016, and proposals are due December 15, 2016.

1. Scope of Program

1.1 Introduction

This ROSES program element for Astrophysics Explorers U.S. Participating Investigator (APEX USPI) is released in conjunction with the Second Stand Alone Mission of Opportunity Notice (SALMON-2) Announcement of Opportunity (AO) Program Element Appendix (PEA) R: Astrophysics Explorers Mission of Opportunity. The purpose is to solicit potential Astrophysics Explorers 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 this solicitation must comply with the requirements in this ROSES-2016 NASA Research Announcement (NRA) and in this Astrophysics Explorers USPI program element. Proposals submitted in response to this solicitation are not required to comply with the requirements in the SALMON-2 AO.

Proposals submitted in response to the SALMON-2 AO PEA R solicitation will be reviewed at the same time as proposals submitted in response to this ROSES program element for Astrophysics Explorers U.S. Participating Investigators.

A single selection meeting will select proposals, and all Explorers selections will be funded from the same Explorers future mission budget; there is no separate budget for Explorers USPIs.

1.2 Background

One of NASA's strategic objectives is to discover how the universe works, explore how it began and evolved, and search for life on planets around other stars. Further information on NASA's strategic goals may be found in NASA Policy Directive (NPD) 1001.0B, *NASA 2014 Strategic Plan*, available through NODIS or the Astrophysics Explorers Mission of Opportunity Program Library, https://explorers.larc.nasa.gov/APMIDEX2016/MO/programlibrary.html.

The NASA Science Mission Directorate (SMD) addresses this strategic objective by conducting astrophysics investigations designed to address the following science goals:

- Probe the origin and destiny of our universe, including the nature of black holes, dark energy, dark matter, and gravity;
- Explore the origin and evolution of the galaxies, stars, and planets that make our universe; and,
- Discover and study planets around other stars and explore whether they could harbor life.

Further information on the goals and objectives of NASA's astrophysics programs may be found in the *NASA 2014 Science Plan*, and in *Enduring Quests Daring Visions, NASA Astrophysics in the Next Three Decades*, available through the Program Library.

1.3 Science and Program Objectives

NASA solicits proposals for Explorers USPI investigations that address any astrophysics objective as outlined in Section 1.2 of this program element. Investigations that address NASA goals in other areas, such as Earth science, planetary science, or heliophysics, are not solicited in this program element.

2. Programmatic Considerations

Notices of Intent (NOI) to propose are mandatory. Proposals that are not preceded by an NOI by the due date given in Section 3 may be returned without review.

2.1 Proposal Opportunity Period and Schedule

The schedule that applies to this Explorers USPI program element is given in Section 3.

A Preproposal Conference will be held by teleconference in accordance with the schedule in Section 3 of this program element. Further information, including logistics, will be available at the 2016 Astrophysics Explorers homepage (http://explorers.larc.nasa.gov/APMIDEX2016) prior to the Preproposal Conference.

2.2 Proposal Requirements and Constraints

2.2.1 Type of Investigation

A proposed investigation as a U.S. Participating Investigator on a non-NASA space mission may be as a Co-I for an instrument, experiment, or technology demonstration that is being built and flown by a sponsor agency other than NASA. The Co-I role 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 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 as a Partner Mission of Opportunity (PMO) proposal through the "Astrophysics Explorers Mission of Opportunity" described in Program Element Appendix R of the SALMON-2 AO.

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. astrophysics science community access to a highly valued scientific data set.

The proposed investigations can vary in duration, to include just the prime science mission phase, or to begin at the post confirmation development phase (e.g., for calibration analysis) through the prime mission operational phase, depending on the science requirements of the investigation. All investigations shall include adequate time for data analysis and archiving following the conclusion of the prime mission phase.

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.

2.2.2 Cost Constraints

For individual investigators, the cost for selected proposals is expected to be on the order of $125K per selected investigation per year through the prime science mission phase, plus one year for additional data analysis and archiving for the baseline scientific investigation. For a team of investigators, the cost is expected to be on the order of $125K per investigator per year, up to a maximum combined team total of on the order of $1M per year, through the prime science mission phase, plus one year for additional data analysis and archiving.

Proposals must include archiving data such as raw data, reduced data (Level 2), instrument calibration data, observation geometry ancillary data, and derived products at an appropriate data archive.

NASA reserves the right to make no selection if there are no proposals of appropriate merit.

2.2.3 Duration of Award and Cover Page Budgets

Proposals should be for the entire duration of the proposed investigation. This may be no more than through the prime science mission, plus one year for additional data archiving for the baseline scientific investigation. The budget justification in the body of the proposal should cover this entire period. Note that ROSES-2016 requires redaction of salary and indirect rate information from the proposal document, and requires a "Total Budget" file to be uploaded separately from the proposal document. Note also that proposers can only enter the first five years of budget into the cover page of the NSPIRES web interface, but this is simply an artifact of the NSPIRES system.

2.2.4 Technical Requirements and Constraints

In addition to the requirements given in ROSES, all proposed investigations must also demonstrate: (1) their formal relationship with the sponsoring agency's mission (e.g., selected participant, invited participant, or proposed participant); (2) the status of the mission within the sponsoring agency (i.e., Preliminary Study (Pre-Phase A); Concept Study and Technology Development (Phase A); Preliminary Design and Technology Completion (Phase B); Final Design and Fabrication (Phase C); System Assembly, Integration and Test, and Launch (Phase D); Operations and Sustainment (Phase E)), including the level of commitment that the sponsoring agency has made to complete development; (3) a description of the type and the characteristics of the data from this investigation, as well as any ancillary science data, that will be archived as part of this investigation, and a description of the arrangements and resources included in the proposal to ensure the timely delivery of the necessary data in the required format; and (4) a detailed explanation of how the astrophysics science community benefits from this participation.

2.3 Proposal Evaluation Factors

Proposers are reminded that the evaluation criteria for this solicitation are given in the *NASA Guidebook for Proposers* (see Section 3 below for reference). These criteria are intrinsic merit, relevance to NASA's strategic goals and objectives, and cost realism and reasonableness. In addition to the factors given in the *NASA Guidebook for Proposers*, the evaluation criterion "intrinsic merit" specifically includes the following factors:

2.3.1 Scientific Merit of the Proposed Investigation

The information provided in a proposal will be used to assess the intrinsic scientific merit of the proposed investigation. The factors for scientific merit include the following:

- Factor A-1. Compelling nature and scientific priority of the proposed investigation's science goals and objectives. This factor includes the clarity of the goals and objectives; how well the goals and objectives reflect program, Agency, and National priorities; the potential scientific impact of the investigation on program, Agency, and National science objectives; and the potential for fundamental progress, as well as filling gaps in our knowledge relative to the current state of the art.
- Factor A-2. Programmatic value of the proposed investigation. This factor includes the unique value of the investigation to make scientific progress in the context of other ongoing and planned missions; the relationship to the other elements of NASA's science programs; how well the investigation may synergistically support ongoing or planned

missions by NASA and other agencies; and the necessity for a space mission to realize the goals and objectives.

- Factor A-3. Likelihood of scientific success. This factor includes how well the anticipated measurements support the goals and objectives; the adequacy of the anticipated data to complete the investigation and meet the goals and objectives; and the appropriateness of the mission requirements for guiding development and ensuring scientific success.

This evaluation will result in narrative text, including specific major and minor strengths and weaknesses, as well as an appropriate adjectival rating for the scientific merit of the investigation.

2.3.2 Scientific Implementation Merit and Feasibility of the Investigation

The information provided in a proposal will be used to assess merit of the plan for completing the proposed investigation, including the scientific implementation merit, feasibility, resiliency, and probability of scientific success of the proposed investigation. The factors for scientific implementation merit and feasibility include the following:

- Factor B-1. Merit of the instruments and mission design for addressing the science goals and objectives. This factor includes the degree to which the proposed mission will address the goals and objectives; the appropriateness of the selected instruments and mission design for addressing the goals and objectives; the degree to which the proposed instruments and mission can provide the necessary data; and the sufficiency of the data gathered to complete the scientific investigation.
- Factor B-3. Merit of the data analysis, data availability, and data archiving plan. This factor includes the merit of plans for data analysis and data archiving to meet the goals and objectives; to result in the publication of science discoveries in the professional literature; and to preserve data and analysis of value to the science community. Considerations in this factor include assessment of planning and budget adequacy and evidence of plans for well-documented, high-level data products and software usable to the entire science community; assessment of adequate resources for physical interpretation of data; reporting scientific results in refereed journals; and assessment of the proposed plan for the timely release of the data to the public domain for enlarging its science impact.
- Factor B-5. Probability of science team success. This factor will be evaluated by assessing the experience, expertise, and organizational structure of the science team. The role of each Co-Investigator will be evaluated for necessary contributions to the proposed investigation; the inclusion of Co-Is who do not have a well defined and appropriate role may be cause for downgrading of the proposal.

This evaluation will result in narrative text, including specific major and minor strengths and weaknesses, as well as an appropriate adjectival rating for the scientific implementation merit and feasibility of the scientific investigation.

2.4 Award Management

Awards will likely be executed directly from NASA Headquarters, although NASA reserves the right to implement them through a NASA Center in order to facilitate coordination with related flight projects that the Center may be carrying out.

3. Summary of Key Information

Expected program budget for first year of new awards	See Sections 2.2.2 and 2.2.3
Number of new awards pending adequate proposals of merit	Up to two awards.
Maximum duration of awards	Through the end of the Prime Mission plus one year for data analysis and archiving.
Preproposal Conference	October 6, 2016 by teleconference. For more information, see http://explorers.larc.nasa.gov/APMIDEX2016
Due date for required Notice of Intent to propose (NOI)	October **27** ~~13~~, 2016
Due date for proposals	December 15, 2016
Planning date for start of investigation	No earlier than 9 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	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	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 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	NNH16ZDA001N-APEXUSPI

NASA point of contact concerning this program	Dr. Wilton T. Sanders Astrophysics Explorers Program Scientist Mail Stop 3U23 NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-1319 E-mail: wilton.t.sanders@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-2016 NASA Research Announcement (NRA). At the time of the initial release of this NRA, there are three such programs, see below.

2. Data Management Plans

Most proposals to ROSES-2016 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 Tropical 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 only the Earth Science 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 elements of the Astrobiology Program, the Mars Exploration Program, the Outer Planets

Program (all in the Planetary Science Division) and Exoplanet research in the Astrophysics Division. 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-2016, typically 90 days in advance of their established Proposal Due Dates.

E.2 TOPICAL WORKSHOPS, SYMPOSIA, AND CONFERENCES

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 solicitation across SMD is described in Section 2. Section 3 describes how proposals submitted in response to this solicitation 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 solicitation; 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 solicitation is directed at scientific and technical events of interest to SMD, not education, public outreach, or administrative conferences.

Where other ROSES program elements specifically solicit for events, proposals must be submitted in response to those solicitations instead of this one.

3. Relevance to SMD's Goals and Objectives

Proposals submitted in response to this solicitation 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-2016; 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 Proposal Goal

The goal of any proposed activity must be to enable science, and the 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 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 solicitation.

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, in order to achieve a balanced portfolio is to be expected. 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 selected proposals. 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, which can be found at http://nasascience.nasa.gov/researchers/sara/library-and-useful-links/SMD2009memo.pdf.

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 solicitation 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 solicitation.

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.

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 31, 2017
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 Chapter 2 of 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	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	NNH16ZDA001N-TWSC
NASA point of contact concerning this program	Max Bernstein Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-0879 E-mail: sara@nasa.gov

E.3 EXOPLANETS RESEARCH

NOTICE: May 9, 2016. The Planetary Science Division point of contact for this program element has been changed to Dr. Christina Richey. New text is in bold.

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. 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.

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.

1. Scope of Program

The Exoplanets Research Program solicits basic research proposals that support directly the scientific goals of advancing our knowledge and understanding of exoplanetary systems. Its objectives are the detection and characterization of exoplanets (including their surfaces, interiors, and atmospheres) and exoplanetary systems, including the determination of their compositions, dynamics, energetics, and chemical behaviors.

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 proposals that don’t directly contain observational studies will be judged upon the perceived impact of the proposed work upon the interpretation of observations of exoplanetary systems.

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;
- observationally characterize exoplanets and their atmospheres in order to inform target and operational choices for current NASA missions, and/or 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.

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 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. The observations must directly support the goals of the Exoplanet Research Program call and must also include scientific analysis and publication. Proposals that are focused on aiding in the detection of new exoplanets and/or characterization of exoplanets are also required to specifically address the contribution of the proposed work towards furthering the scientific goals of NASA's space missions, including future planned missions (if relevant).

2. Programmatic Information

2.1 Exclusions

The breadth of this call inevitably results in overlap in subject matter between this and other ROSES-2016 program elements.

Proposals aimed at identification and characterization of signals and/or properties of extrasolar planets that may harbor intelligent life are not within the scope of this program. Research aimed at investigating the habitability of an exoplanet should be submitted to the Habitable Worlds program element (E.4). Proposals in these research areas are not solicited in this program element.

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-2016 (Appendix D.2).

Investigations with the primary objective of developing or commissioning instruments or maintaining and operating observing facilities, are not solicited in this program.

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).

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

The Planetary Science Division Early Career Fellowships (ECF) program (see C.16) supports the development of individual research programs of outstanding scientists early in their careers and to stimulate research careers in the areas supported by the Planetary Science Division.

Applicants requesting consideration for ECF may include an additional page to their Curriculum Vitae to provide information that can be used by reviewers to evaluate the Principal Investigator's (PI's) future research contributions and the potential for leadership within the scientific community. Please see Program Element C.16 of ROSES-2016 for more information on the two-step process for the ECF program and the criteria for evaluating candidates.

Astrophysics early career technologists are encouraged to apply to the Nancy Grace Roman Technology Fellowship program element (see D.9). Note that starting in ROSES 2016 this program is being offered in alternate years and will next be competed in ROSES 2017.

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.

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-2 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-2016 proposal. This is a reminder that all proposals submitted to ROSES-2016 must strictly conform to the formatting rules in Section IV of the *Summary of Solicitation* and Chapter 2 of 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 in the *Summary of Solicitation* of this NRA.
Due date for Step-2 proposals	See Tables 2 and 3 in the *Summary of Solicitation* of this NRA.
Planning date for start of investigation	January 1, 2017
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 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	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. See also Section IV in the *ROSES Summary of Solicitation* and Chapter 3 of 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	NNH16ZDA001N-XRP
NASA points of contact concerning this program	**Christina Richey [Changed May 9, 2016]** Planetary Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-**2206** Email: **christina.r.richey@NASA.gov** Martin Still Astrophysics Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-4462 Email: martin.still@nasa.gov

E.4 HABITABLE WORLDS

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 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 2.6 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) and Exoplanet research in the Astrophysics Division. 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 Priorties: 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. 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, 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 Appendix C.1. However, highly-rated programs of strong programmatic relevance to the Astrophysics Division will be considered for funding by the Astrophysics Division. 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 Section 2.3.5 of 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), and C.19 New Frontiers Data Analysis Program (NFDAP; to be released later this year), 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 Planetary Major Equipment (PME). See Program Element C.17 for information on how to append a PME request to a regular Habitable Worlds research proposal or submit a stand-alone PME 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. The Two-Step Submission Process

To facilitate the early recruitment of a conflict-free review panel, given the nature of the new calls, 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.

2.6.1 *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-2 proposal is encouraged or not, at which point they will be able to submit Step-2 proposals.

2.6.2 *Step-2 Proposal*

This is a reminder that all proposals submitted to ROSES-2016 must strictly conform to the formatting rules in Chapter IV of this announcement and Chapter 2 of 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.

2.7 Duration and Size of Awards

NASA anticipates that most proposals will seek three years of funding. Proposals for less than three years are encouraged for projects that can be completed on shorter timescales. In rare cases, funding for the proposed fourth year may be provided, if the need for the longer duration is sufficiently well justified. The appropriateness of the proposed funding period will be reviewed, and adjustments may be requested. Programmatic balance may limit the opportunities for funding in some areas.

The average size of awards resulting from Step-2 proposals submitted to Habitable Worlds in ROSES-2014 was ~$160 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 response to ROSES-2015 that 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

Proposals to this program element may include an application for an Early Career Fellowships (ECF). See Program Element C.16 for a description of the application and evaluation process.

2.9 Access to the Antarctic

Proposals to this program element must follow the rules given in Appendix C.1, §3.7, when requesting access to 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 Section 2.3 of 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 Appendix C.1, Section 3.6, 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 Appendix C.1, Section 3.5). 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. 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 in the *ROSES Summary of Solicitation*.

Due date for Step-2 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	6 months after proposal due date.
Page limit for the central ScienceTechnicalManagement section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance	This program is relevant to the Planetary Science 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	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 Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of 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	NNH16ZDA001N-HW
NASA points of contact concerning this program	Mitch Schulte Planetary Science Division NASA Headquarters Washington, DC 20546 Telephone: (202) 358-2127 E-mail: mitchell.d.schulte@nasa.gov Mary Voytek Planetary Science Division NASA Headquarters Washington, DC 20546 Telephone: (202) 358-1577 E-mail: mary.voytek-1@nasa.gov and

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E.5 INTERDISCIPLINARY SCIENCE FOR ECLIPSE 2017

NOTICE: Step-1 proposals are due October 27, 2016. Step-2 proposals are due November 30, 2016.

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 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. The standard rules for Appendix B, as laid out in program element B.1 apply, to this program element. Data management plans will be collected as part of the NSPIRES cover pages.

1. Scope of the Program

1.1 Overview

A total solar eclipse is widely regarded as one of the most incredible natural phenomenon visible from Earth. On August 21, 2017, a total solar eclipse will traverse the continental U.S. from Oregon to South Carolina. For approximately 90 minutes, city after city along the centerline will experience two to nearly three minutes of darkness during daytime as totality moves from west to east. While the path of totality will cover a swath only 60 miles wide, the contiguous U.S. States will see at least 65% of the Sun disappear behind the Moon during its progression of phases. It is estimated that a large fraction of the population in North America will witness this natural event (http://eclipse2017.nasa.gov/).

The purpose of this program element is to support development of new research or enhancement of existing research, applied to the 2017 eclipse. NASA is seeking proposals that would utilize the unique opportunity presented by the solar eclipse to study the Sun, Earth, Moon, astronomy, and/or space science, including the ionosphere-thermosphere-mesosphere (ITM) system. Building on existing partnerships and the use of interdisciplinary or citizen science approaches is encouraged. All proposals must demonstrate links to the 2017 solar eclipse.

This initiative complements NASA's capabilities of observing the Sun and the Sun-Earth-Moon system globally from space thereby supporting NASA's mission to "drive advances in science, technology, aeronautics, space exploration, economic vitality, and stewardship of the Earth." More specifically it supports Objective 1.4 from the NASA Strategic Plan to "understand the Sun and its interactions with Earth and the solar system, including space weather" by advancing the use of traditional science and citizen science approaches in scientific research during the total solar eclipse of 2017. It does so by directly supporting scientific research and development and deployment of existing and/or new technology.

1.2. Scientific Focus

The Interdisciplinary Science for Eclipse (ISE) initiative is using this program element to take advantage of the coast-to-coast eclipse over a period of approximately 90 minutes to promote sensor (space and ground) and camera development and deployment, as well as traditional science, citizen science, and crowdsourcing platforms or techniques, applied to the study of the Sun, Earth, Moon, astronomy, and/or space science, which includes ionosphere-thermosphere-mesosphere (ITM) system.

While solar eclipses are perhaps best known for their stunning visual beauty and detailed structure of the innermost corona, the shadow of the eclipse can also cause changes in the geospace environment and Earth's atmosphere. This long duration circumstance might provide opportunities to study responses in the Earth's atmosphere, particularly the ionosphere-thermosphere-mesosphere (ITM) system, to a known change in incoming solar radiation.

Regardless of the scientific focus, the type of proposals, or sources of data, proposals may aim to address eclipse science at the local, regional, continental, or global scales. These approaches could complement NASA spacecraft observations by providing increased temporal or spatial sampling, or contribute to the validation of NASA data products derived from spacecraft observations, or deploy innovative sensors, or use other innovative ways and/or a combination of the above to enhance the utility of NASA's observation systems from space, air, and land during this unique opportunity.

2. Types of Proposals for Interdisciplinary Science for Eclipse

An important goal of the ISE initiative is to promote ground- and space-based observations related to the study of the solar eclipse. This initiative is especially interested in receiving interdisciplinary proposals. Preference is given to proposals that include both collection of data and application of these data to utilize the solar eclipse for the study of the Sun, Earth, Moon, space science, and astronomy. Proposals should not simply explain how the measurement could be used, but should actually include tasks that use the resulting data to, for example, improve models, guide observations, or other relevant tasks. This broad goal can be achieved using "traditional" science and/or citizen science approaches.

For the purpose of this program element, "citizen science approaches" is defined as efforts or projects which use voluntary public participation in the scientific endeavor, including – but not limited to – formulating research questions, conducting experiments, collecting and analyzing data collected by citizen and/or professional scientists, interpreting results, making new discoveries, and/or developing new/existing technologies and applications. Crowdsourcing, another frequently used term describing voluntary contributions, is included under citizen science in this program element. (See the Federal Crowdsourcing and Citizen Science Toolkit for further explanations and guidance: https://crowdsourcing-toolkit.sites.usa.gov/). Citizen science is distinguished from public outreach in that the primary purpose of involving the public is to make contributions to science.

Possible areas of interest include, but are not limited to:

- Design and manufacture of hardware to contribute to and enhance the science of the inner corona during the total solar eclipse;
- Ionospheric thermospheric, and mesospheric investigations using the eclipse as a point response function and observing with GPS receiver networks;

- Viewing eclipse-induced changes in the upper atmosphere using space-based assets;
- Viewing atmospheric response under the shadow of the Moon with earth science assets;
- Understanding atmospheric responses (chemical, dynamic, systematic) by observing Earth from other satellite systems (e.g., DSCOVR, ISS, Cubesats);
- Coordination with network of high-altitude balloons to observe the eclipse from the stratosphere.

3. Proposal Preparation, Submission, and Evaluation

To be relevant, proposals must demonstrate how the proposed investigation would use traditional science and/or citizen science approaches in scientific research to utilize the solar eclipse to study the Sun, Earth, Moon, astronomy and/or space science, which includes the ionosphere-thermosphere-mesosphere (ITM) system, as described in Section 2.

All proposals must demonstrate how the proposed investigation would fully achieve the specific objectives and goals proposed. A goal is understood to have a broad scope while an objective is understood as a more narrowly focused part of a strategy to achieve a goal. Proposed investigations must achieve their proposed objectives; however, the investigation might only make progress toward a goal without fully achieving it.

3.1 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-2016 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-2016 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 (PI), Co- Investigators (Co-Is), 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.

3.1.1 *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 (i.e., abstract) 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 proposal summary is entered directly into a text field in NSPIRES. No PDF attachment is permitted for Step-1 proposal submission. The Step-1 proposal must include the following information:

- The science goals and objectives to be addressed by the proposal;
- A listing of the 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 connecting the eclipse to the study of the Sun, Earth and Moon, astronomy and/or space science which includes the ionosphere-thermosphere-mesosphere (ITM) system.

Proposers will be notified by NSPIRES when they are able to submit their Step-2 proposals.

3.1.2 *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-2016 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.

3.1.3 *Step-2 Proposal Format*

The process for preparation and submission of the Step-2 (full) proposals is the same for any other ROSES proposal. Guidelines for content and formatting full proposals are specified in the *NASA Guidebook for Proposers* and the *ROSES-2016 Summary of Solicitation*.

Proposals are restricted to ten (10) pages for the Scientific/Technical/Management section and must include the following sections with the preferred order:

- The science objectives and perceived impact of the proposed work to the state of knowledge in the field; references to existing work in the field should be limited to that which is needed to justify the value of the science proposed;
- The data and methodology to be employed in conducting the proposed research; the proposal must demonstrate (1) that the data are appropriate to address the science objectives and (2) that the methodology is both appropriate and feasible to make substantial progress on the science objectives;
- The relevance of the proposed work to the goals of connecting the eclipse to the study of the Sun, Earth and Moon; space science; and astronomy.
- 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 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.

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.

- 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.

3.2 Step-2 Evaluation Criteria

Step-2 proposals that are not compliant with format requirements may be rejected without review. See Section IV (b) (ii) of the *ROSES-2016 Summary of Solicitation* and the *NASA Guidebook for Proposers* for details.

Compliant proposals will be evaluated according to the criteria specified in Section C.2 of the *NASA Guidebook for Proposers*. These criteria are intrinsic scientific and technical merit, relevance, and cost realism/reasonableness.

The evaluation of scientific and technical merit will include:

- Compelling nature and scientific priority of the proposed investigation's science goals and objectives, including the importance of the problem, the unique value of the investigation to make scientific progress, 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.
- Technology development proposals need to demonstrate that they can achieve their goals within the schedule and budget of the award.

Based on the science and technical factors, the evaluation will consider the overall potential science impact and probability of success of the investigation.

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.

Moreover, proposals that are interdisciplinary (i.e., including work outside of that normally funded by the Heliophysics Division) may be contingent on funds from the other Science Mission Directorate Divisions.

4. Summary of Key Information

Expected annual program budget for new awards	~ $0.8 M (Heliophysics contribution)
Number of new awards pending adequate proposals of merit	Investigations including instrument deployment: ~4 (~$100k/award); Other research awards: ~8 (~$50k/award)
Maximum duration of awards	1 year
Due date for Step-1 proposal	**October 27, 2016**
Due date for Step-2 proposal	**November 30, 2016**
Date for start of investigation	No earlier than January 1, 2017.
Page limit for the central Science-Technical-Management section of proposal	10 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
File size limit for the proposal	20MB
Relevance	This program is relevant to the Science goals of the Heliophysics, Planetary, Astrophysics, and Earth Science divisions stated 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-2016 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-2016 Summary of Solicitation* and Section 3.3 of 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	NNH16ZDA001N-ISE

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