



**National Aeronautics and Space Administration
Office of Education**

FY 2019 NASA Cooperative Agreement Notice (CAN)

**Established Program to Stimulate
Competitive Research
(EPSCoR)**

Research Announcement

Announcement Number: NNH18ZHA006C
Catalog of Federal Domestic Assistance (CFDA) Number: 43.008

Release Date:
Notice of Intent Due:
Proposals Due:

September 6, 2018
October 22, 2018
December 7, 2018

NASA Headquarters
Office of Education
Washington, DC 20546-0001

Table of Contents

- 1.0 Description of Opportunity2**
 - 1.1 Technical Description2*
 - 1.2 EPSCoR Background.....3*
 - 1.3 EPSCoR Eligibility and Proposal Acceptance4*
 - 1.4 Period of Performance4*
 - 1.5 Role of NASA EPSCoR Director4*
 - 1.6 Notice of Intent5*
- 2.0 Project Overview and Guidelines5**
 - 2.1 General.....5*
 - 2.2 Funding and Cost-Sharing5*
 - 2.3 Restrictions.....5*
 - 2.4 NASA Research Areas of Interest7*
 - 2.5 Partnerships and Interactions7*
- 3.0 Program Management8**
 - 3.1 NASA EPSCoR Program and Project Levels8*
 - 3.2 Jurisdiction Level8*
 - 3.3 Data Management Plan - Increasing Access to the Results of Scientific Research.....8*
 - 3.4 Schedule.....9*
 - 3.5 Cancellation of Program Announcement9*
 - 3.6 Inquiries.....10*
- 4.0 Proposal Review and Selection.....10**
 - 4.1 Evaluation Criteria.....10*
 - 4.2 Review and Selection Processes10*
 - 4.3 Selection Announcement.....11*
- 5.0 Award Administration Information11**
 - 5.1 Administrative, National Policy Requirements, and Intellectual Property Information.....11*
 - 5.2 Notice of Award.....12*
 - 5.3 Award Reporting Requirements.....12*
 - 5.4 Access to NASA Facilities/Systems12*
- 6.0 Updates and Submission Information12**
 - 6.1 Announcement of Updates/Amendments to Solicitation12*
 - 6.2 Electronic Submission of Proposal Information.....12*
 - 6.3 Proposal Submission Date and Time.....12*
- 7.0 Proposal Preparation13**
- 8.0 Proposal Evaluation Criteria13**
 - 8.1 Intrinsic Merit (35% of score).....14*
 - 8.2 NASA Alignment and Partnerships (35% of score)14*
 - 8.3 Management and Evaluation (15% of score)14*

8.4 Budget Justification: Narrative and Details (15%).....	15
Appendix A: NASA Mission Directorates and Center Alignment.....	17
A.1 Aeronautics Research Mission Directorate (ARMD).....	17
A.2 Human Exploration & Operations Mission Directorate (HEOMD).....	17
A.3 Science Mission Directorate (SMD)	20
A.4 The Space Technology Mission Directorate (STMD)	25
A.5 Areas of Interest for NASA Centers and JPL	26
A.5.1 Goddard Space Flight Center (GSFC).....	26
A.5.2 Ames Research Center (ARC).....	30
A.5.3 Glenn Research Center (GRC).....	30
A.5.4 Armstrong Flight Research Center (AFRC),.....	31
A.5.5 Marshall Space Flight Center (MSFC).....	31
A.5.6 Kennedy Space Center (KSC)	33
A.5.7 Jet Propulsion Laboratory (JPL).....	34
A.5.8 Johnson Space Center (JSC).....	35
A.5.9 Stennis Space Center (SSC)	37
A.5.10 Langley Research Center (LaRC)	39
Appendix B: NASA Strategic Approach	41
B.1 NASA Strategic Plan	41
B.2 NASA Education Strategic Coordination Framework	41
Appendix C: Definitions	42
Appendix D: NASA Points of Contact.....	44
D.1 Additional information regarding NASA EPSCoR can be obtained from the following:	44
D.2 NASA Research Contacts.....	44
D.3 NASA Mission Directorate Liaisons	44
D.4 NASA Center Liaisons	45
Appendix E: Proposal and Submission Information	46
E.1 Proposal Instructions and Requirements	46
E.2 Content and Form of the Proposal Submission.....	46
E.3 Notice of Intent to Propose	49
E.4 Certifications, Assurances, and Representations	49
Appendix F: Useful Web Sites.....	50

1.0 Description of Opportunity

1.1 Technical Description

The National Aeronautics and Space Administration (NASA) Office of Education, in cooperation with NASA’s Aeronautics Research Mission Directorate (ARMD), Human Exploration & Operations Mission Directorate (HEOMD), Science Mission Directorates (SMD), the Space Technology Mission Directorate (STMD), and NASA’s nine Centers, plus the Jet Propulsion

Laboratory (JPL), solicit proposals for the NASA Established Program to Stimulate Competitive Research (EPSCoR).

Each funded NASA EPSCoR proposal is expected to establish research activities that will make significant contributions to NASA's strategic research and technology development priorities and contribute to the overall research infrastructure, science and technology capabilities of higher education, and economic development of the jurisdiction receiving funding.

NASA will assign a Technical Monitor (TM) to each award. The TM will monitor the progress of the research and collaborate as required to keep the research aligned with the approved project. The awardee will provide annual reports as to the progress of the research that will be reviewed by the TM and approved by the NASA EPSCoR Project Manager. These reports will be shared with the NASA Mission Directorates Centers and JPL as necessary.

The program parameters are:

- Jurisdictions responding to this Cooperative Agreement Notice (CAN) may submit one proposal in accordance with paragraph 1.3 of this CAN, *EPSCoR Eligibility and Proposal Acceptance*. Proposals will be selected from this solicitation for FY 2019 funding.
- The maximum funding request per proposal is \$750,000. This amount is to be expended over a three-year period.
- Cost-sharing by proposers is required at a level of at least 50% of the requested NASA funds. Also, in-kind cost-sharing is allowable. Limitations regarding acceptable cost-sharing are further discussed below at Section 2.2 and 2.3.
- Jurisdictions responding to this CAN may submit one proposal. It is anticipated that three (3) to five (5) awards of up to \$750,000 to be expended over a three-year period of performance may be made under this CAN in accordance with regulatory guidance found at Title 2 Code of Federal Regulations (CFR) Part 200, Uniform Administrative Requirements, Cost Principles and Audit Requirements for Federal Awards, as adopted and supplemented by NASA through Title 2 CFR Part 1800: Federal Agency Regulations for Grants and Agreements - NASA. The exact number of awards depends on the available EPSCoR Research Budget.
- The Government's obligation to make an award is contingent upon the availability of appropriated funds from which payment can be made.

This CAN is available in electronic form through the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) and Grants.gov. ***However, all proposals shall be submitted through NSPIRES.***

To access the CAN through NSPIRES, go to <http://nspires.nasaprs.com> and click on Solicitations.

To access the CAN through Grants.gov, go to <http://www.grants.gov/search/agency.do> and select the link for NASA.

1.2 EPSCoR Background

Public Law 102-588, passed in 1992, authorized NASA to initiate NASA EPSCoR to strengthen the research capability of jurisdictions that have not in the past participated equally in competitive aerospace research activities. The goal of NASA EPSCoR is to provide seed funding that will enable jurisdictions to develop an academic research enterprise directed toward long-term, self-sustaining, nationally-competitive capabilities in aerospace and aerospace-related

research. This capability will, in turn, contribute to the jurisdiction's economic viability and expand the nation's base for aerospace research and development.

Based on the availability of funding, NASA will continue to help jurisdictions achieve these goals through NASA EPSCoR. Funded jurisdictions will be selected through a merit-based, peer-review competition.

The specific objectives of NASA EPSCoR are to:

- Contribute to and promote the development of research capability in NASA EPSCoR jurisdictions in areas of strategic importance to the NASA mission.
- Improve the capabilities of the NASA EPSCoR jurisdictions to gain support from sources outside the NASA EPSCoR program.
- Develop partnerships among NASA research assets, academic institutions, and industry.
- Contribute to the overall research infrastructure, science and technology capabilities of higher education, and economic development of the jurisdiction.

1.3 EPSCoR Eligibility and Proposal Acceptance

While proposals can be accepted only from institutions where a NASA EPSCoR Director is currently serving, *all institutions of higher education within the jurisdiction shall be made aware of this CAN and given the opportunity to submit a proposal to the EPSCoR Director.*

The latest available National Science Foundation (NSF) eligibility tables are used to determine overall jurisdiction eligibility for NASA EPSCoR. The NSF 2018 eligibility table is available at: https://www.nsf.gov/od/oia/programs/epscor/Eligibility_Tables/FY2018_Eligibility.pdf

The following jurisdictions are eligible to submit a proposal in response to this NASA EPSCoR solicitation: Alabama, Alaska, Arkansas, Delaware, Guam, Hawaii, Idaho, Kansas, Kentucky, Louisiana, Maine, Mississippi, Montana, Nebraska, Nevada, New Hampshire, North Dakota, Oklahoma, Puerto Rico, Rhode Island, South Carolina, South Dakota, U.S. Virgin Islands, Vermont, West Virginia, and Wyoming.

The estimated funding and number of proposals anticipated to be funded, as shown in this CAN under the section entitled “Summary of Key Information,” are subject to the availability of appropriated funds, as well as the submission of a sufficient number of proposals of adequate merit.

1.4 Period of Performance

NASA EPSCoR awards will support a three-year cooperative agreement. It is anticipated that this period of performance will enable the researchers to achieve the performance task objectives stated in the original proposal and/or any amendments submitted with annual progress reports and accepted by the NASA EPSCoR project office.

1.5 Role of NASA EPSCoR Director

Cooperative Agreements will be awarded to the institution of the NASA EPSCoR Director. Therefore, the NASA EPSCoR Director shall serve as the administrative Principal Investigator (PI) for, and administer, all of the jurisdiction’s NASA EPSCoR projects (see *Section 3.0, Program Management, Subsection 3.2. Jurisdiction Level* for a discussion of management responsibilities).

1.6 Notice of Intent

Jurisdictions planning to prepare a proposal package for NASA EPSCoR shall submit a Notice of Intent (NOI) to propose. To be useful to NASA EPSCoR Management for planning purposes, NOIs shall be submitted by the NASA EPSCoR Director through NSPIRES at <http://nspires.nasaprs.com> by 11:59 p.m. Eastern Time, **October 22, 2018**.

NOIs shall be submitted via NSPIRES regardless of whether the solicitation was downloaded via NSPIRES or Grants.Gov. ***Information provided in the NOI shall identify the proposed research areas of interests (Nanotechnology, Oceanography, Biology, etc.) and any desired Center, JPL, and/or Mission Directorate alignment, if known.*** See Appendix E, Section 3 of this announcement for additional details regarding NOIs.

2.0 Project Overview and Guidelines

2.1 General

Each NASA EPSCoR project shall perform scientific and/or technical research in areas that support NASA's strategic research and technology development priorities. Proposals shall emphasize developing capabilities to compete for funds from NASA and non-NASA sources outside of EPSCoR. The projects should move increasingly towards gaining support from sources outside NASA EPSCoR by aggressively pursuing additional funding opportunities offered by NASA, industry, other federal agencies, and other sources.

2.2 Funding and Cost-Sharing

A jurisdiction may request a maximum of \$750,000 from NASA per proposal. This amount is to be expended over a three (3) year performance period in accordance with the budget details and budget narrative in the approved proposal.

Cost-sharing is required at a level of at least 50% of the requested NASA funds. Although the method of cost-sharing is flexible, NASA encourages the EPSCoR jurisdiction committees to consider methods that would add value to the jurisdiction's existing research capabilities. All contributions, including cash or in-kind, shall meet the criteria contained in Title 2 CFR §1800.922.

2.3 Restrictions

In addition to the funding guidelines and requirements in the *NASA Guidebook for Proposers March 2018 Edition* located at <http://www.hq.nasa.gov/office/procurement/nraguidebook/proposer2018.pdf>.

Title 2 CFR Part 1800, the following restrictions govern the use of the federally-provided and the cost-shared portion of funds for this opportunity (referred to collectively as NASA EPSCOR funds) and are applicable to this CAN:

- Funds shall not be used to fund research carried out by non-U.S. institutions. However, U.S. research award recipients may directly purchase supplies and/or services that do not constitute research from non-U.S. sources. Also, subject to export control restrictions, 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. institution. For additional guidance on foreign participation, see the *NASA Guidebook for Proposers*.

- Travel, including foreign travel, is allowed for the meaningful completion of the proposed investigation, as well as for reporting results at appropriate professional meetings. Foreign travel to meetings and conferences in support of the jurisdiction's NASA EPSCoR research project is an acceptable use of NASA EPSCoR funds, with a limit of \$3,000 per trip for up to two (2) separate years of a jurisdiction's proposal (i.e., the maximum amount the jurisdiction can request for foreign travel is \$3,000 total in any one year and a limit of \$6,000 total for each research proposal). EPSCoR support shall be acknowledged by the EPSCoR research project number in written reports and publications. Please note that domestic travel does not have a limit. Domestic travel, which is defined as travel that does not require a passport, shall be appropriate and reasonable to conduct the proposed research.
- The construction of facilities is not an allowable cost in any of the programs solicited in this CAN. For further information on allowable costs, refer to the cost principles cited in Title 2 CFR §1800.907(a)(4), Equipment and Other Property.
- NASA EPSCoR funding shall not be used to purchase general purpose equipment, e.g., desktop workstations, office furnishings, reproduction and printing equipment, etc. as a direct charge. Special purpose equipment purchases (i.e., equipment that is used only for research, scientific, and technical activities directly related to the proposed research activities) are allowed and can be reflected as a direct charge as per Title 2 CFR §1800.907(a)(3), Equipment and Other Property.
- NASA EPSCoR funding shall not be used to support NASA civil service participation (FTE) in any research project. That funding is provided through a funding vehicle between the jurisdiction and NASA Center, such as a Space Act Agreement or other reimbursable agreement using non-EPSCoR funds. NASA EPSCoR cannot withhold funding from an award to send to a NASA Center for FTE support (including travel).
- NASA EPSCoR funds shall be expended in NASA EPSCoR institutions. If a Co-Investigator (Sc-I/Co-I) with an NASA EPSCoR award transfers to a non-EPSCoR institution, the EPSCoR funding amount, or the part of it that remains unobligated at the time of Sc-I/Co-I transfer, cannot be transferred to the non-EPSCoR institution.
- All proposed funding requests must be for expenditures that are allowable, allocable, and reasonable. Funds may only be used for the awarded project. All activities charged under indirect costs shall be allowable under 2 CFR 200, Subpart E, Cost Principles.
- Grants and Cooperative Agreements shall not provide for the payment of fee or profit to the recipient.
- Unless otherwise directed in 2 CFR 200, for changes to the negotiated indirect cost rate that occur throughout the project period, the recipient shall apply the rate negotiated for that year, regardless of whether it is higher or lower than at the time the cooperative agreement was awarded.
- Proposals shall 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.
- Any funds used for matching or cost sharing shall be allowable under 2 CFR 200.
- A non-Federal entity shall use one of the methods of procurement as prescribed in 2 CFR 200.320. As defined in 2 CFR 200.67, the micro-purchase threshold for acquisitions of supplies or services made under grant and cooperative agreement awards issued to

institutions of higher education, or related or affiliated nonprofit entities, or to nonprofit research organizations or independent research institutes is \$10,000; or such higher threshold as determined appropriate by the head of the relevant executive agency and consistent with audit findings under chapter 75 of Title 31, United States Code, internal institutional risk assessment, or State law.

2.4 NASA Research Areas of Interest

NASA EPSCoR research priorities are defined by the Aeronautics Research, Human Exploration & Operations, Science, and Space Technology Mission Directorates, and NASA's nine Centers plus JPL. Each Mission Directorate, Center, and JPL covers a major area of the Agency's research and technology development efforts.

Information about current NASA research solicitations can be found on NSPIRES at <http://nspires.nasaprs.com> (select "Solicitations" and then "Open Solicitations").

Research priorities for each of the Mission Directorates, Centers, and JPL are summarized in Appendix A; also see Appendix D for detailed contact information for the NASA Point of Contact (POC) for each Mission Directorate, Center, and JPL.

2.5 Partnerships and Interactions

All institutions of higher education within an eligible jurisdiction shall be made aware of this NASA EPSCoR CAN and given the opportunity to compete. *However, all proposals shall be submitted through the jurisdiction's NASA EPSCoR Director's office.* Jurisdictions are strongly encouraged to submit proposals that demonstrate partnerships or cooperative arrangements among academia, government agencies, business and industry, private research foundations, jurisdiction agencies, and local agencies.

NASA-funded, in-kind services provided by Mission Directorates, NASA Centers, or JPL shall be identified as "NASA responsibilities" in the proposals and shall not be included in the 50% cost matching requirement.

Statements of commitment and letters of support are important components of the proposal. However, NASA does not solicit or evaluate letters of endorsement. Review the *NASA Guidebook for Proposers* for distinctions among statements of commitment, letters of support, and letters of endorsement.

Special Note: EPSCoR is teaming with the MUREP Institutional Research Opportunity (MIRO) Program to create research collaborations and long term exchange efforts. The project includes working with the senior leadership of the involved universities as well as individual researchers. Research collaborations will broaden participation for Minority Serving Institutions (MSI) and increase diversity and inclusion for faculty and student development. Research collaborations will also allow for technologies to advance at a greater rate, enable researchers to expand their capacity, leverage resources, share data, have access to labs and equipment, expand their network, and learn from other disciplines. Research collaborations can strengthen proposals to government and private industry. The project will begin with proposers being asked to consider the feasibility of developing partnerships between the jurisdiction university researchers and Minority Serving Institution (MSI) researchers. Researchers will be encouraged to participate by EPSCoR and MIRO "brokers" who will meet with them, discuss the collaboration process and arrange for formal introductions of the two parties. These brokers will meet with the state EPSCoR, MIRO, and university leadership to promote strategic and comprehensive buy-in to the project. Since both EPSCoR and MIRO supported research projects will be well aligned with NASA Mission Directorate research priorities, brokers will also make every effort to facilitate strong research

interactions with NASA Research Center scientists and engineers to increase the opportunities for faculty and student engagement. Participation in these collaborations is not required, but it is strongly encouraged.

3.0 Program Management

3.1 NASA EPSCoR Program and Project Levels

The NASA EPSCoR is a component of the Aerospace Research and Career Development Program administered by the Office of Education at NASA Headquarters. NASA EPSCoR Program Management is closely coordinated with NASA Headquarters Mission Directorates, NASA Centers, and JPL.

The NASA EPSCoR Project Office is located at the Kennedy Space Center (KSC). This Project Office has the overall responsibility for oversight, evaluation, and reporting. Technical and scientific questions about programs in this solicitation may be directed to the NASA EPSCoR Project Manager.

3.2 Jurisdiction Level

The jurisdiction's NASA EPSCoR Director will serve as the managing Principal Investigator (PI) for the award, providing leadership and administrative direction for the team from an oversight role. The submitting and awardee institution will be that of the jurisdiction's NASA EPSCoR Director. The Director is responsible for oversight and overall administrative management of the project to assure compliance with NASA EPSCoR. The Director is responsible for ensuring the timely reporting of the team's progress and accomplishment of its work.

The investigator responsible for the scientific direction and day-to-day management of the proposed work shall be listed as the Science-I (Sc-I). If the Sc-I's institution is different from the submitting institution, awards may be made to the Sc-I's institution through a subaward.

The Government's obligation to continue any award is based on satisfactory progress as detailed in the recipient's required annual progress reports. The research proposal may include an approved indirect cost rate if one has been negotiated with the Federal cognizant agency for funding of management, administrative, and oversight function of the jurisdiction's NASA EPSCoR Director. For NASA to accept less than the approved indirect cost rate, a deviation is required. If a deviation is needed, the submitter shall include its proposed indirect cost amount as part of the \$750,000 cap.

The jurisdiction's NASA EPSCoR Director shall provide guidance and updates to the Sc-Is regarding NASA policy and direction from both an Agency technical perspective and from a NASA EPSCoR programmatic standpoint. The Director shall maintain an awareness of NASA research and technology development priorities and jurisdiction research priorities. As the primary point of contact for NASA regarding EPSCoR in the jurisdiction, the Director will identify and develop opportunities for collaboration within the jurisdiction with existing EPSCoR and EPSCoR-like programs from other federal agencies. Also, the NASA EPSCoR Director will consult with appropriate jurisdiction organizations, such as the economic development commission, in addressing jurisdiction research priorities.

3.3 Data Management Plan - Increasing Access to the Results of Scientific Research

In keeping with [the NASA Plan for Increasing Access to Results of Scientific Research](#), new terms and conditions consistent with the Rights in Data clause (2 C.F.R. 1800.909) in the award, which make manuscripts and data publically accessible, may be attached to NASA EPSCoR

Research awards. All proposals shall provide a Data Management Plan (DMP) or an explanation as to why one is not necessary given the nature of the work proposed. *The DMP shall be submitted by responding to the NSPIRES cover page question about the DMP (limited to 4000 characters).* Any research project in which a DMP is not necessary shall provide an explanation in the DMP block. Example explanations:

- *This is a development effort for flight technology that will not generate any data that I can release, so a DMP is not applicable.*
- *The data that we will generate will be ITAR.*
- *Or, the submitter may explain why its project will not generate any data.*

The type of proposal that requires a DMP is described in the NASA Plan for increasing access to results of federally funded research (see [https://www.nasa.gov/sites/default/files/atoms/files/206985_2015_nasa_plan-for-web.pdf](https://www.nasa.gov/sites/default/files/atoms/files/2069852015nasa_plan-for-web.pdf)).

The DMP shall contain the following elements, as appropriate to the project:

- 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; and
- 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.)

Proposers that include a plan to archive data should allocate suitable time for this task. Unless otherwise stated, this requirement supersedes the data sharing plan mentioned in the *NASA Guidebook for Proposers*.

In addition, researchers submitting NASA-funded articles in peer-reviewed journals or papers from conferences now shall make their work accessible to the public through NASA's *PubSpace* at <https://www.nihms.nih.gov/db/sub.cgi>. *PubSpace* provides free access to NASA-funded and archived scientific publications. Research papers will be available within one year of publication to download and read.

EPSCoR has also implemented the Research Performance Progress Report (RPPR) process to collect demographic data from grant applicants for the purpose of analyzing demographic differences associated with its award processes. Information collected will include name, gender, race, ethnicity, and disability status. Submission of this information is voluntary, only available to NASA in aggregate form, and is not a pre-condition of award.

3.4 Schedule

The schedule for the review and selection of proposals for this CAN is:

Notices of Intent Due: **October 22, 2018**

Proposals Due: **December 7, 2018**

3.5 Cancellation of Program Announcement

The NASA Office of Education reserves the right to not make any awards under this CAN and/or to cancel this CAN. NASA assumes no liability (including proposal costs) for cancelling the CAN or for any entity's failure to receive such notice of cancellation.

3.6 Inquiries

Technical and scientific questions about this CAN may be directed to:

Mr. Jeppie R. Compton
Project Manager, NASA EPSCoR
Office of Education/PX-E
Kennedy Space Center, FL 32899-0001
E-mail: jeppie.r.compton@nasa.gov
Telephone: (321) 867-6988

Inquiries regarding the submission of proposal materials may be addressed to:

Ms. Althia Harris
NASA Research and Education Support Services (NRESS)
2345 Crystal Drive, Suite 500
Arlington, VA 22202-4816
E-mail: aharris@nasaprs.com
Telephone: (202) 479-9030 x310
Fax: (202) 479-0511

4.0 Proposal Review and Selection

4.1 Evaluation Criteria

Evaluation by peer review will be used to assess each proposal's overall merit. The evaluation criteria are: Intrinsic Merit, NASA Alignment and Partnerships, Management and Evaluation, and Budget Justification: Narrative and Details. A NASA Headquarters Mission Directorate panel will use the results of the peer evaluation to make funding recommendations to the selecting official. See Section 8.0, Proposal Evaluation Criteria.

4.2 Review and Selection Processes

Review of proposals submitted in response to this CAN shall be consistent with the general policies and provisions contained in the *NASA Guidebook for Proposers*, Appendix D. The evaluation criteria described in this CAN under Section 8.0, Proposal Evaluation Criteria, takes precedence over the evaluation criteria described in Section 5 of the *NASA Guidebook for Proposers*. However, selection procedures shall be consistent with the provisions of the *NASA Guidebook for Proposers*, Section 5. The selecting official for this CAN is the Associate Administrator for STEM Engagement at NASA Headquarters or his appointed representative.

The NASA Grants Officer will conduct a pre-award review of risk associated with the proposer as required by 2 CFR 200.205. For all proposals selected for award, the Grants Officer will review the submitting organization's information available through the Federal Awardee Performance and Integrity Information System (FAPIIS) and the System for Award Management (SAM) to include checks on the entity's (applicant's) core data, registration expiration date, active exclusions, and delinquent federal debt.

Prior to making a Federal award with a total amount of Federal share greater than the simplified acquisition threshold (currently \$250,000), NASA is required to review and consider any information about the applicant that is in the designated integrity and performance system

(currently FAPIIS, which is accessible through SAM at <https://www.sam.gov>) (see 41 U.S.C. 2313).

At its option, an applicant may review information about itself that NASA previously entered and that is currently in FAPIIS and may comment on such information.

NASA will consider any comments by the applicant, in addition to the other information in FAPIIS, in reaching a determination 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.

Limited Release of Proposers Confidential Business Information

For proposal evaluation and other administrative processing actions, NASA may find it necessary to release information submitted by the proposer to individuals not employed by NASA.

Business information that would ordinarily be entitled to confidential treatment may be included in the information released to these individuals. Accordingly, by submission of its proposal, the submitter hereby consents to a limited release of its confidential business information (CBI).

Except where otherwise provided by law, NASA will permit the limited release of CBI only pursuant to non-disclosure agreements signed by the assisting contractor or subcontractor, and their individual employees who may require access to the CBI to perform the assisting contract.

4.3 Selection Announcement

NASA's stated goal is to announce selections as soon as possible. However, generally NASA does not announce new selections until the funds needed for those awards are approved through the Federal budget process. Therefore, a delay in NASA's budget process may result in a delay of the selection date(s). After 180 days past the proposal's submitted date, proposers may contact the NASA EPSCoR Project Manager for a status update.

A proposer has the right to be informed of the major factor(s) that led to the acceptance or rejection of the proposal. Debriefings will be available upon request. Again, it is emphasized that non-selected proposals should be aware that proposals of nominally high intrinsic and programmatic merits may be declined for reasons entirely unrelated to any scientific or technical weaknesses.

5.0 Award Administration Information

5.1 Administrative, National Policy Requirements, and Intellectual Property Information

2 C.F.R. 200 Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards (Uniform Guidance) at http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title02/2cfr200_main_02.tpl

2 C.F.R. 1800 NASA supplement to 2 C.F.R. 200 (open word file)

https://prod.nais.nasa.gov/pub/pub_library/srba/index.html

Grants and Cooperative Agreement Manual

https://prod.nais.nasa.gov/pub/pub_library/Grant_and_CooperativeManual.doc

Award and intellectual property information is available here:

[https://prod.nais.nasa.gov/pub/pub_library/srba/Award and IP Information for Proposers.docx](https://prod.nais.nasa.gov/pub/pub_library/srba/Award_and_IP_Information_for_Proposers.docx)

5.2 Notice of Award

For selected proposals, a NASA Grants Officer will contact the business office of the proposer's institution. The NASA Grants Officer is the only official authorized to obligate the Government. For a grant or cooperative agreement, any costs that the proposer incurs within 90 calendar days before an award are at the recipient's risk in accordance with 2 CFR 200.458, & 1800.209.

5.3 Award Reporting Requirements

The reporting requirements for awards made through this CAN shall be consistent with 2 CFR 1800.902.

5.4 Access to NASA Facilities/Systems

All recipients shall work with NASA project/program staff to ensure proper credentialing for any individuals who need access to NASA facilities and/or systems. Such individuals include U.S. citizens and lawful permanent residents ("green card" holders).

6.0 Updates and Submission Information

6.1 Announcement of Updates/Amendments to Solicitation

Additional programmatic information for this CAN may be made available before the proposal due date. If so, such information will be added as a formal amendment to this CAN as posted at its homepage on <http://nspires.nasaprs.com>.

Any clarifications or questions and answers regarding this CAN will be posted at its homepage on <http://nspires.nasaprs.com>.

Each prospective proposer has the responsibility to regularly check this CAN's homepage for updates.

6.2 Electronic Submission of Proposal Information

On-time electronic submission via NSPIRES (<http://nspires.nasaprs.com>) is required for every proposal. Please note carefully the following requirements for submission of an electronic proposal via NSPIRES:

- Every organization that intends to submit a proposal to NASA in response to this CAN shall be registered in NSPIRES. Registration for the proposal data system shall be performed by an organization's electronic business point-of-contact (EBPOC) who holds a valid registration with the System for Award Management (SAM) <https://www.sam.gov/portal/public/SAM/>.
- Each individual team member (e.g., PI, co-investigators, etc.), including all personnel named on the proposal's electronic cover page, shall be individually registered in NSPIRES.

While every effort is made to ensure the reliability and accessibility of the website and to maintain a help center via e-mail and telephone, technical difficulties may arise at any time with the Internet, including with the user's own equipment. Thus, prospective proposers are strongly urged to familiarize themselves with the NSPIRES site and to submit the required proposal materials well in advance of the proposal submission deadline. Difficulty in registering with or using a proposal submission system (NSPIRES) is not, in and of itself, a sufficient reason for NASA to consider a proposal that is submitted after the proposal due date (see Appendix E).

6.3 Proposal Submission Date and Time

All proposals in response to this CAN shall be submitted electronically via NSPIRES (<http://nspires.nasaprs.com>). **Hard copies of the proposal will not be accepted.** Electronic

proposals shall be submitted in their entirety by 11:59 p.m., Eastern Time on the proposal due date of **December 7, 2018**.

Respondents without Internet access or that experience difficulty using the NSPIRES proposal site (<http://nspires.nasaprs.com>) may contact the Help Desk at nspires-help@nasaprs.com or call 202-479-9376 between 8:00 a.m. and 6:00 p.m. (ET), Monday through Friday, except Federal Government holidays. NSPIRES automatically identifies any proposals that are late. Proposals received after the due date may be returned without review. If a late proposal is returned, it is entirely at the proposer’s discretion whether or not to resubmit it in response to a subsequent solicitation.

7.0 Proposal Preparation

Required elements of the proposal are described below and shall be submitted as one single PDF document that is uploaded for proposal submission. Please refer to Appendix E of this announcement for NSPIRES instructions on proposal submission procedures. Section 3.6 of the *NASA Guidebook for Proposers* provides guidelines for style formats, and Section 3.7 provides guidelines for proposal content.

REQUIRED SECTIONS OF THE PROPOSAL (in order of assembly)	PAGE LIMIT
Proposal Cover Page	NSPIRES proposal cover page that is available at http://nspires.nasaprs.com/
Proposal Summary (abstract)	4,000 characters including spaces
Data Management Plan	4,000 characters, including spaces
Table of Contents	As needed
Scientific/Technical/Management Plan	15*
References and Citations	As needed
Biographical Sketches for:	
the Science Investigator (Sc-I)	2
each Co-Investigator (Co-I)	1
Current and Pending Support	As needed
Statements of Commitment and Letters of Support	As needed
Budget Justification: Narrative and Details	As needed
<ul style="list-style-type: none"> <li data-bbox="250 1501 808 1539">• <i>Includes proposed budget, itemized list detailing expenses within major budget categories, detailed subawards and summary of personnel (User’s Guide section 3.18 and Appendix C).</i> <li data-bbox="250 1547 808 1585">• <i>For grants/cooperative agreements the table of personnel and work effort should immediately follow the proposal budget and is not included in the budget.</i> 	
Facilities and Equipment	As needed
Special Notifications and/or Certifications	As needed
* includes all illustrations, tables, and figures, where each "n-page" fold-out counts as n-pages and each side of a sheet containing text or an illustration counts as a page.	

8.0 Proposal Evaluation Criteria

Successful research proposals shall provide sound contributions to both immediate and long-term scientific and technical needs of NASA, as explicitly expressed in current NASA documents and communications, as well as contribute to the overall research infrastructure, science and technology capabilities of higher education, and economic development of the jurisdiction. Successful proposals shall also include pragmatic plans for generation of sustained non-EPSCoR support.

Jurisdictions responding to this CAN may submit proposals per paragraph 1.3 above. Proposals will be evaluated based on the following criteria: Intrinsic Merit, NASA Alignment and Partnerships, Management and Evaluation, and Budget Justification: Narrative and Details. The bulleted lists after each criterion below should not be construed as any indication of priority or relative weighting. Rather, the bullets are provided for clarity and facilitation of proposal development. **Note:** *Each proposer shall provide specific information on how it determined the relevance of the proposed effort to NASA and the jurisdiction.*

8.1 Intrinsic Merit (35% of score)

- Proposed Research. Proposals shall provide a detailed narrative of the proposed research activity, including the scientific and/or technical merit of the proposed research, unique and innovative methods, approaches, concepts, or advanced technologies, and the potential impact of the proposed research on its field.
- Existing Research Proposals shall provide baseline information about current research activities within the jurisdiction in the proposed research area, including projects currently funded under NASA EPSCoR. If relevant, the narrative shall include a brief history of NASA EPSCoR Research projects in the jurisdiction, and shall include a discussion of how these previous NASA EPSCoR research projects or Research Infrastructure Development (RID) activities have helped prepare the institution and jurisdiction for and contributed to the proposed research activities. If the proposed research represents a new direction for the jurisdiction, the technical team's ability to conduct the research shall be explained. Other relevant research and technology development programs within the jurisdiction shall also be included.

8.2 NASA Alignment and Partnerships (35% of score)

- Proposals shall discuss the value of the proposed research to NASA and to the jurisdiction's research priorities.
- Proposals shall describe the use of NASA content, people, or facilities in the execution of the research activities. They should describe current and/or previous interactions, partnerships, and meetings with NASA researchers, engineers, and scientists in the area of the proposed research, and discuss how future partnerships between the institution's researchers and personnel at the Mission Directorates, Centers, and/or JPL will be fostered. The name(s) and title(s) of NASA researchers with whom the proposers will partner shall be included. NASA shall consider the utilization of NASA venues for recipients to publish their accomplishments.
- Proposals shall articulate clearly how the proposed research activities build capacity in the jurisdiction. In particular, proposers shall explain how this proposed research is related to the strategic plan for NASA EPSCoR-related research in the jurisdiction.
- Proposals shall state how they plan to develop research competitiveness both in the jurisdiction and nationally. Proposals shall delineate mechanisms for building partnerships with universities, industry, and/or other government agencies to enhance the ability of the jurisdiction to achieve its objectives, to obtain and leverage sources of additional funding, and/or to obtain essential services not otherwise available.

8.3 Management and Evaluation (15% of score) NOTE: This information does not count toward the 15 page limit for the Scientific, Technical, or Management section.

This section shall describe the management structure for the proposed research, and coordination with the jurisdiction's NASA EPSCoR project management. The following elements shall be included:

- **Personnel:** The proposal shall include a list of the personnel participating in this research program, including Principal Investigator, Science-Investigator, and all Co-Investigators, Research Associates, Post-Doctoral Fellows, Research Assistants, and other research participants. The credentials of the researchers are important; however EPSCoR includes the concept of encouraging and helping new researchers.
- **Research Project Management:** A description of the Science-I's management structure of the proposed research project, and the extent to which the project's management and research team will lead to a well-coordinated, efficiently-managed, and productive effort shall be included.
- **Multi-Jurisdiction Projects:** If the proposed research is a collaboration between more than one NASA EPSCoR jurisdiction, one jurisdiction shall be identified as the lead with additional partners identified as sub-awardees. The proposal shall detail the inter-jurisdiction management structure of the proposed research project, including a list of the participating jurisdictions, and the participating universities and agencies within each jurisdiction. Multi-jurisdictional proposals shall not exceed the \$750,000 limit.
- **Project Evaluation:** Proposals shall document the intended outcomes and offer metrics to demonstrate progress toward and achievements of these outcomes. They shall discuss metrics to be used for tracking and evaluating project progress. Milestones and timetables for achievement of specific objectives during the award period shall be presented. The proposal shall describe an appropriate evaluation plan/process to document outcomes and demonstrate progress toward achieving objectives of proposed project elements. Evaluation methodology shall be based upon reputable models and techniques appropriate to the content and scale of the project. Projects shall implement improvements throughout the entire period of performance based on ongoing evaluation evidence.
- **Results of Prior NASA EPSCoR Research Support:** Examples of accomplishments commensurate with the managerial and administrative expectations of the award shall be provided. *The EPSCoR Director will not be assessed on his/her expertise in the specific proposed research area since the Science-PI is tasked with managing the scientific/technical development progress.* The following information shall be provided: the NASA EPSCoR award number(s), the title of the projects(s); and period(s) of performance; primary outcomes resulting from the NASA EPSCoR award, including a summary discussion of accomplishments compared to the proposed outcomes from the original proposal; coordination with the research and technical development priorities of NASA, and contribution(s) to the overall research capacity of the jurisdiction.

8.4 Budget Justification: Narrative and Details (15%)

The proposed budget shall be adequate, appropriate, reasonable, and realistic, and demonstrate the effective use of funds that align with the content and text of the proposed project. Preparation guidelines for the budget can be found in the *NASA Guidebook for Proposers*, Section 3.18 and Appendix C.

A detailed budget, including both NASA provided and cost-share funds, is required. This section shall include detailed budgets for each of the three years of the funding and a summary budget for all three years. All sources of cost-sharing shall be thoroughly described and documented.

The budget will be evaluated based upon the clarity and reasonableness of the funding request. A budget narrative shall be included that discusses relevant budgetary issues such as the extent and level of jurisdiction, industrial, and institutional commitment and financial support, including resources (staff, facilities, laboratories, indirect support, waiver of indirect costs, etc.).

Appendix A: NASA Mission Directorates and Center Alignment

NASA's Mission to *pioneer the future in space exploration, scientific discovery, and aeronautics research*, draws support from four Mission Directorates and nine NASA Centers plus JPL, each with a specific responsibility.

A.1 Aeronautics Research Mission Directorate (ARMD) conducts high-quality, cutting-edge research that generates innovative concepts, tools, and technologies to enable revolutionary advances in our Nation's future aircraft, as well as in the airspace in which they will fly. ARMD programs will facilitate a safer, more environmentally friendly, and more efficient national air transportation system. Using a Strategic Implementation Plan NASA Aeronautics Research Mission Directorate (ARMD) sets forth the vision for aeronautical research aimed at the next 25 years and beyond. It encompasses a broad range of technologies to meet future needs of the aviation community, the nation, and the world for safe, efficient, flexible, and environmentally sustainable air transportation. Additional information on the Aeronautics Research Mission Directorate (ARMD) can be found at: <http://www.aeronautics.nasa.gov>.

Areas of Interest - POC: Tony Springer, tony.springer@nasa.gov

Researchers responding to the ARMD should propose research that is aligned with one or more of the ARMD programs. Proposers are directed to the following:

- ARMD Programs: <http://www.aeronautics.nasa.gov/programs.htm>
- The National Aeronautics and Space Administration (NASA), Headquarters, Aeronautics Research Mission Directorate (ARMD) Current Year version of the NASA Research Announcement (NRA) entitled, "Research Opportunities in Aeronautics (ROA)" has been posted on the NSPIRES web site at <http://nspires.nasaprs.com> (select "Solicitations" and then "Open Solicitations").

Detailed requirements, including proposal due dates are stated in appendices that address individual thrust areas. These appendices will be posted as amendments to the ROA NRA and will be published as requirements materialize throughout the year.

A.2 Human Exploration & Operations Mission Directorate (HEOMD) provides the Agency with leadership and management of NASA space operations related to human exploration in and beyond low-Earth orbit. HEO also oversees low-level requirements development, policy, and programmatic oversight. The International Space Station, currently orbiting the Earth with a crew of six, represents the NASA exploration activities in low-Earth orbit. Exploration activities beyond low Earth orbit include the management of Commercial Space Transportation, Exploration Systems Development, Human Space Flight Capabilities, Advanced Exploration Systems, and Space Life Sciences Research & Applications. The directorate is similarly responsible for Agency leadership and management of NASA space operations related to Launch Services, Space Transportation, and Space Communications in support of both human and robotic exploration programs. Additional information on the Human Exploration & Operations Mission Directorate (HEOMD) can be found at: (<http://www.nasa.gov/directorates/heo/home/index.html>).

Areas of Interest - POC: Bradley Carpenter, bcarpenter@nasa.gov

Human Research Program

The Human Research Program (HRP) is focused on investigating and mitigating the highest risks to human health and performance in order to enable safe, reliable, and productive human space exploration. The HRP budget enables NASA to resolve health risks in order for humans to safely live and work on missions in the inner solar system. HRP conducts research, develops countermeasures, and undertakes technology development to address human health risks in space

and ensure compliance with NASA's health, medical, human performance, and environmental standards.

Space Life Sciences

The Space Life Sciences, Space Biology Program has three primary goals:

- To effectively use microgravity and the other characteristics of the space environment to enhance our understanding of fundamental biological processes;
- To develop the scientific and technological foundations for a safe, productive human presence in space for extended periods and in preparation for exploration; and
- To apply this knowledge and technology to improve our nation's competitiveness, education, and the quality of life on Earth.

These goals will be achieved by soliciting research using its three program elements:

- Cell and Molecular Biology and Microbial Biology - studies of the effect of gravity and the space environment on cellular, microbial and molecular processes;
- Organismal & Comparative Biology - studies and comparisons of responses of whole organisms and their systems; and
- Developmental Biology – studies of how spaceflight affects reproduction, development, maturation and aging of multi-cellular organisms, as described in NASA's [Fundamental Space Biology Science Plan \(PDF, 7.4 MB\)](#).

Further details about ongoing activities specific to Space Biology are available at:

[Space Biosciences website](#)

Physical Science Research

The Physical Science Research Program, along with its predecessors, has conducted significant fundamental and applied research, both which have led to improved space systems and produced new products offering benefits on Earth. NASA's experiments in various disciplines of physical science reveal how physical systems respond to the near absence of gravity. They also reveal how other forces that on Earth are small compared to gravity, can dominate system behavior in space.

The Physical Science Research Program also benefits from collaborations with several of the International Space Station international partners—Europe, Russia, Japan, and Canada—and foreign governments with space programs, such as France, Germany and Italy. The scale of this research enterprise promises new possibilities in the physical sciences, some of which are already being realized both in the form of innovations for space exploration to improve the quality of life on Earth.

Research in physical sciences spans from basic and applied research in the areas of:

- Fluid physics: two-phase flow, phase change, boiling, condensation and capillary and interfacial phenomena;
- Combustion science: spacecraft fire safety, solids, liquids and gasses, supercritical reacting fluids, and soot formation;
- Materials science: solidification in metal and alloys, crystal growth, electronic materials, glasses and ceramics;
- Complex Fluids: colloidal systems, liquid crystals, polymer flows, foams and granular flows; and
- Fundamental Physics: critical point phenomena, atom interferometry and atomic clocks in space.

Implementing Centers: NASA's Physical Sciences Research Program is carried out at the Glenn Research Center (GRC), Jet Propulsion Laboratory (JPL) and Marshall Space Flight Center

(MSFC). Further information on physical sciences research is available at <http://issresearchproject.nasa.gov/>.

Engineering Research

- Spacecraft: Guidance, navigation and control; thermal; electrical; structures; software; avionics; displays; high speed re-entry; modeling; power systems; interoperability/commonality; advanced spacecraft materials; crew/vehicle health monitoring; life support.
- Propulsion: Propulsion methods that will utilize materials found on the moon or Mars, “green” propellants, on-orbit propellant storage, motors, testing, fuels, manufacturing, soft landing, throttle-able propellants, high performance, and descent.
- Robotic Systems for Precursor Near Earth Asteroid (NEA) Missions: Navigation and proximity operations systems; hazard detection; techniques for interacting and anchoring with Near Earth Asteroids; methods of remote and interactive characterization of Near Earth Asteroid (NEA) environments, composition and structural properties; robotics (specifically environmental scouting prior to human arrival and later to assist astronauts with NEA exploration); environmental analysis; radiation protection; spacecraft autonomy, enhanced methods of NEA characterization from earth-based observation.
- Robotic Systems for Lunar Precursor Missions: Precision landing and hazard avoidance hardware and software; high-bandwidth communication; in-situ resource utilization (ISRU) and prospecting; navigation systems; robotics (specifically environmental scouting prior to human arrival, and to assist astronaut with surface exploration); environmental analysis, radiation protection.
- Data and Visualization Systems for Exploration: Area focuses on turning precursor mission data into meaningful engineering knowledge for system design and mission planning of lunar surface and NEAs. Visualization and data display; interactive data manipulation and sharing; mapping and data layering including coordinate transformations for irregular shaped NEAs; modeling of lighting and thermal environments; simulation of environmental interactions including proximity operations in irregular micro-G gravity fields and physical stability of weakly bound NEAs.
- Research and technology development areas in HEOMD support launch vehicles, space communications, and the International Space Station. Examples of research and technology development areas (and the associated lead NASA Center) with great potential include:
 - *Processing and Operations*
 - Crew Health and Safety Including Medical Operations (Johnson Space Center (JSC))
 - In-helmet Speech Audio Systems and Technologies (Glenn Research Center (GRC))
 - Vehicle Integration and Ground Processing (Kennedy Space Center (KSC))
 - Mission Operations (Ames Research Center (ARC))
 - Portable Life Support Systems (JSC)
 - Pressure Garments and Gloves (JSC)
 - Air Revitalization Technologies (ARC)
 - In-Space Waste Processing Technologies (JSC)
 - Cryogenic Fluids Management Systems (GRC)
 - *Space Communications and Navigation*
 - Coding, Modulation, and Compression (Goddard Spaceflight Center (GSFC))
 - Precision Spacecraft & Lunar/Planetary Surface Navigation and Tracking (GSFC)

- Communication for Space-Based Range (GSFC)
- Antenna Technology (GRC)
- Reconfigurable/Reprogrammable Communication Systems (GRC)
- Miniaturized Digital EVA Radio (JSC)
- Transformational Communications Technology (GRC)
- Long Range Optical Telecommunications (Jet Propulsion Laboratory (JPL))
- Long Range Space RF Telecommunications (JPL)
- Surface Networks and Orbit Access Links (GRC)
- Software for Space Communications Infrastructure Operations (JPL)
- TDRS transponders for launch vehicle applications that support space communication and launch services (GRC)
- *Space Transportation*
 - Optical Tracking and Image Analysis (KSC)
 - Space Transportation Propulsion System and Test Facility Requirements and Instrumentation (Stennis Space Center (SSC))
 - Automated Collection and Transfer of Launch Range Surveillance/Intrusion Data (KSC)
 - Technology tools to assess secondary payload capability with launch vehicles (KSC)
 - Spacecraft Charging/Plasma Interactions (Environment definition & arcing mitigation) (Marshall Space Flight Center (MSFC))

A.3 Science Mission Directorate (SMD) leads the Agency in four areas of research: Earth Science, Heliophysics, Planetary Science, and Astrophysics. SMD, using the vantage point of space to achieve with the science community and our partners a deep scientific understanding of our planet, other planets and solar system bodies, the interplanetary environment, the Sun and its effects on the solar system, and the universe beyond. In so doing, SMD lays the intellectual foundation for the robotic and human expeditions of the future while meeting today's needs for scientific information to address national concerns, such as climate change and space weather. At every step, SMD shares the journey of scientific exploration with the public and partners with others to substantially improve science, technology, engineering and mathematics (STEM) education nationwide. Additional information about SMD can be found at: (<http://nasascience.nasa.gov>).

Areas of Interest - POC: Kristen Erickson kristen.erickson@nasa.gov

SMD has developed science objectives and programs to answer fundamental questions in Earth and space sciences in the context of our national science agenda. The knowledge gained by researchers supporting NASA's Earth and space science program helps to unravel mysteries that intrigue us all.

- What drives variations in the Sun, and how do these changes impact the solar system and drive space weather?
- How and why are Earth's climate and environment changing?
- How did our solar system originate and change over time?
- How did the universe begin and evolve, and what will be its destiny?
- How did life originate, and are we alone?

Each of the SMD's four science divisions – Heliophysics, Earth Science, Planetary Science, and Astrophysics – makes important contributions to address national and Agency goals. The NASA 2018 Strategic Plan reflects the direction NASA has received from its Executive branch and

Congress, advice received from the nation's scientific community, the principles and strategies guiding the conduct of our activities, and the challenges SMD faces.

Heliophysics Division

Heliophysics encompasses science that improves our understanding of fundamental physical processes throughout the solar system, and enables us to understand how the Sun, as the major driver of the energy throughout the solar system, impacts our technological society. The scope of heliophysics is vast, spanning from the Sun's interior to Earth's upper atmosphere, throughout interplanetary space, to the edges of the heliosphere, where the solar wind interacts with the local interstellar medium. Heliophysics incorporates studies of the interconnected elements in a single system that produces dynamic space weather and that evolves in response to solar, planetary, and interstellar conditions.

The Agency's strategic objective for heliophysics is to **understand the Sun and its interactions with Earth and the solar system, including space weather**. The heliophysics decadal survey conducted by the National Research Council (NRC), *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>), articulates the scientific challenges for this field of study and recommends a slate of design reference missions to meet them in order to culminate in the achievement of a predictive capability to aid human endeavors on Earth and in space. The fundamental science questions are:

- What causes the Sun to vary?
- How do the geospace, planetary space environments and the heliosphere respond?
- What are the impacts on humanity?

To answer these questions, the Heliophysics Division implements a program to achieve three overarching 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 environment, and the outer reaches of our solar system; and
- 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.

See Strategic Goals of the NASA 2018 Strategic Plan for specifics, including missions currently in operation, in formulation or development, and planned for the future.

Earth Science Division

Our planet is changing on all spatial and temporal scales and studying the Earth as a complex system is essential to understanding the causes and consequences of climate change and other global environmental concerns. The purpose of NASA's Earth science program is to advance our scientific understanding of Earth as a system and its response to natural and human-induced changes and to improve our ability to predict climate, weather, and natural hazards.

NASA's ability to observe global change on regional scales and conduct research on the causes and consequences of change positions it to address the Agency's strategic objective for Earth science, which is to advance knowledge of Earth as a system to meet the challenges of environmental change, and to improve life on our planet. NASA addresses the issues and

opportunities of climate change and environmental sensitivity by answering the following key science questions through our Earth science program:

- How is the global Earth system changing?
- What causes these changes in the Earth system?
- How will the Earth system change in the future?
- How can Earth system science provide societal benefit?

These science questions translate into seven overarching science goals to guide the Earth Science Division's selection of investigations and other programmatic decisions:

- Advance the understanding of changes in the Earth's radiation balance, air quality, and the ozone layer that result from changes in atmospheric composition (Atmospheric Composition);
- Improve the capability to predict weather and extreme weather events (Weather);
- Detect and predict changes in Earth's ecosystems and biogeochemical cycles, including land cover, biodiversity, and the global carbon cycle (Carbon Cycle and Ecosystems);
- Enable better assessment and management of water quality and quantity to accurately predict how the global water cycle evolves in response to climate change (Water and Energy Cycle);
- Improve the ability to predict climate changes by better understanding the roles and interactions of the ocean, atmosphere, land and ice in the climate system (Climate Variability and Change);
- Characterize the dynamics of Earth's surface and interior, improving the capability to assess and respond to natural hazards and extreme events (Earth Surface and Interior); and
- Further the use of Earth system science research to inform decisions and provide benefits to society.

Two foundational documents guide the overall approach to the Earth science program: the NRC 2007 Earth science decadal survey (<http://www.nap.edu/catalog/11820/earth-science-and-applications-from-space-national-imperatives-for-the>) and NASA's 2010 climate-centric architecture plan (http://science.nasa.gov/media/medialibrary/2010/07/01/Climate_Architecture_Final.pdf). The former articulates the following vision for Earth science research and applications in support of society:

Understanding the complex, changing planet on which we live, how it supports life and how human activities affect its ability to do so in the future is one of the greatest intellectual challenges facing humanity. It is also one of the most challenges for society as it seeks to achieve prosperity, health, and sustainability.

The latter addresses the need for continuity of a comprehensive set of key climate monitoring measurements, which are critical to informing policy and action, and which other agencies and international partners had not planned to continue. NASA's ability to view the Earth from a global perspective enables it to provide a broad, integrated set of uniformly high-quality data covering all parts of the planet. NASA shares this unique knowledge with the global community, including members of the science, government, industry, education, and policy-making communities.

Planetary Science Division

Planetary science is a grand human enterprise that seeks to understand the history of our solar system and the distribution of life within it. The scientific foundation for this enterprise is described in the NRC planetary science decadal survey, *Vision and Voyages for Planetary Science in the Decade 2013-2022* (<http://www.nap.edu/catalog/13117/vision-and-voyages-for-planetary-science-in-the-decade-2013-2022>). Planetary science missions inform us about our neighborhood and our own origin and evolution; they are necessary precursors to the expansion of humanity beyond Earth. Through five decades of planetary exploration, NASA has developed the capacity to explore all of the objects in our solar system. Future missions will bring back samples from some of these destinations, allowing iterative detailed study and analysis back on Earth. In the future, humans will return to the Moon, go to asteroids, Mars, and ultimately other solar system bodies to explore them, but only after they have been explored and understood using robotic missions.

NASA's strategic objective in planetary science is to **ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere**. We pursue this goal by seeking answers to fundamental science questions that guide NASA's exploration of the solar system:

- How did our solar system form and evolve?
- Is there life beyond Earth?
- What are the hazards to life on Earth?

The Planetary Science Division has translated these important questions into science goals that guide the focus of the division's science and research activities:

- Explore and observe the objects in the solar system to understand how they formed and evolve;
- Advance the understanding of how the chemical and physical processes in our solar system operate, interact and evolve;
- Explore and find locations where life could have existed or could exist today;
- Improve our understanding of the origin and evolution of life on Earth to guide our search for life elsewhere; and
- Identify and characterize objects in the solar system that pose threats to Earth, or offer resources for human exploration.

In selecting new missions for development, NASA's Planetary Science Division strives for balance across mission destinations, using different mission types and sizes. Achievement of steady scientific progress requires a steady cadence of missions to multiple locations, coupled with a program that allows for a consistent progression of mission types and capabilities, from small and focused, to large and complex, as our investigations progress. The Division also pursues partnerships with international partners to increase mission capabilities and cadence and to accomplish like-minded objectives.

Astrophysics Division

Astrophysics is the study of phenomena occurring in the universe and of the physical principles that govern them. Astrophysics research encompasses a broad range of topics, from the birth of the universe and its evolution and composition, to the processes leading to the development of planets and stars and galaxies, to the physical conditions of matter in extreme gravitational fields,

and to the search for life on planets orbiting other stars. In seeking to understand these phenomena, astrophysics science embodies some of the most enduring quests of humankind.

Through its Astrophysics Division, NASA leads the nation on a continuing journey of transformation. From the development of innovative technologies, which benefit other areas of research (e.g., medical, navigation, homeland security, etc.), to inspiring the public worldwide to pursue STEM careers through its stunning images of the cosmos taken with its Great Observatories, NASA's astrophysics programs are vital to the nation.

NASA's strategic objective in astrophysics is to **discover how the universe works, explore how it began and evolved, and search for life on planets around other stars**. Three broad scientific questions flow from this objective:

- How does the universe work?
- How did we get here?
- Are we alone?

Each of these questions is accompanied by a science goal that shapes the Astrophysics Division's efforts towards fulfilling NASA's strategic objective:

- 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 up our universe; and
- Discover and study planets around other stars, and explore whether they could harbor life.

The scientific priorities for astrophysics are outlined in the NRC decadal survey *New Worlds, New Horizons in Astronomy and Astrophysics* (<http://www.nap.edu/catalog/12951/new-worlds-new-horizons-in-astronomy-and-astrophysics>). These priorities include understanding the scientific principles that govern how the universe works; probing cosmic dawn by searching for the first stars, galaxies, and black holes; and seeking and studying nearby habitable planets around other stars.

The multidisciplinary nature of astrophysics makes it imperative to strive for a balanced science and technology portfolio, both in terms of science goals addressed and in missions to address these goals. All the facets of astronomy and astrophysics—from cosmology to planets—are intertwined, and progress in one area hinges on progress in others. However, in times of fiscal constraints, priorities for investments must be made to optimize the use of available funding. NASA uses the prioritized recommendations and decision rules of the decadal survey to set the priorities for its investments.

NASA's Astrophysics Division has developed several strategies to advance these scientific objectives and respond to the recommendations outlined in the decadal survey on a time horizon of 5-10 years.

NASA's highest priority for a new strategic astrophysics mission is the Wide Field Infrared Survey Telescope (WFIRST), the number one priority for large-scale missions of the decadal survey. NASA plans to be prepared to start a new strategic astrophysics mission when funding becomes available. NASA also plans to identify opportunities for international partnerships, to reduce the Agency's cost of the mission concepts identified, and to advance the science objectives of the decadal survey. NASA will also augment the Astrophysics Explorer Program to the extent that the budget allows. Furthermore, NASA will continue to invest in the Astrophysics Research

Program to develop the science cases and technologies for new missions and to maximize the scientific return from operating missions.

A.4 The Space Technology Mission Directorate (STMD) is responsible for developing the crosscutting, pioneering, new technologies, and capabilities needed by the agency to achieve its current and future missions.

STMD rapidly develops, demonstrates, and infuses revolutionary, high-payoff technologies through transparent, collaborative partnerships, expanding the boundaries of the aerospace enterprise. STMD employs a merit-based competition model with a portfolio approach, spanning a range of discipline areas and technology readiness levels. By investing in bold, broadly applicable, disruptive technology that industry cannot tackle today, STMD seeks to mature the technology required for NASA's future missions in science and exploration while proving the capabilities and lowering the cost for other government agencies and commercial space activities.

Research and technology development takes place at NASA Centers, at JPL, in academia and industry, and leverages partnerships with other government agencies and international partners. STMD engages and inspires thousands of technologists and innovators creating a community of our best and brightest working on the nation's toughest challenges. By pushing the boundaries of technology and innovation, STMD allows NASA and our nation to remain at the cutting edge. Additional information on STMD can be found at: (http://www.nasa.gov/directorates/spacetech/about_us/index.html).

Areas of Interest - POC: Joseph Grant joseph.grant-1@nasa.gov

STMD expands the boundaries of the aerospace enterprise by rapidly developing, demonstrating, and infusing revolutionary, high-payoff technologies through collaborative partnerships. STMD employs a merit-based competition model with a portfolio approach, spanning a wide range of space technology discipline areas and technology readiness levels. Research and technology development takes place at NASA Centers, academia, and industry, and leverages partnerships with other government agencies and international partners.

STMD executes its mission according to the following tenets:

- Advancing transformative and crosscutting technologies that can be directly infused into future missions;
- Investing in a comprehensive portfolio covering low to high technology readiness levels;
- Competitively selecting research by academia, industry, and NASA Centers based on technical merit;
- Executing with lean structured projects with clear start and end dates, defined budgets and schedules, established milestones, and project level authority and accountability;
- Operating with a sense of urgency and informed risk tolerance to infuse quickly or terminate judiciously;
- Partnering with other NASA Mission Directorates, other government agencies, and the private sector to leverage resources, establish customer advocacy, and support US commercial aerospace interests; and
- Delivering new inventions, enabling new capabilities and creating a pipeline of NASA and national innovators.

Current space technology topics of particular interest include:

- Advanced manufacturing methods for space and in space
- Autonomous in-space assembly of structures and spacecraft
- Ultra-lightweight materials for space applications
- Materials and structures for extreme environments (high temperature, pressure)

- Extreme environment (including cryogenic) electronics for planetary exploration
- Advanced robotics for extreme environment sensing, mobility, and manipulation
- Deep space optical communication
- Extremely High Frequency microwave technologies for communication, remote sensing, and navigation
- Advanced power generation, storage, and transfer for deep space missions
- Advanced entry, decent, and landing systems for planetary exploration
- Efficient in situ resource utilization to produce items required for long-duration deep space missions including fuels, water, oxygen, food, nutritional supplements, pharmaceuticals, building materials, polymers (plastics), and various other chemicals
- Radiation mitigation for deep space crewed missions
- Biological approaches to environmental control and life support systems
- Autonomous systems for deep space missions
- Advanced telescope technologies for exoplanet imaging
- Low size, weight, and power components for small spacecraft including high-bandwidth communication from space to ground, inter-satellite communication, relative navigation and control for swarms and constellations, precise pointing systems, power generation and energy storage, thermal management, system autonomy, miniaturized instruments and sensors, robotic assembly/manufacturing, and in-space propulsion
- Enabling technologies for low-cost small spacecraft launch vehicles
- Advancements in engineering tools and models supporting Space Technology focus areas

Applicants are strongly encouraged to familiarize themselves with the roadmap document most closely aligned with their space technology interests. The individual roadmap documents may be downloaded at the following link: <http://www.nasa.gov/offices/oct/home/roadmaps/index.html>.

NASA's STMD current year version of the NASA Research Announcement (NRA) entitled, "Space Technology Research, Development, Demonstration, and Infusion" has been posted on the NSPIRES web site at <http://nspires.nasaprs.com> (select "Solicitations" and then "Open Solicitations"). The NRA provides detailed information on specific proposals being sought across STMD programs.

A.5 Areas of Interest for NASA Centers and JPL

Examples of Center research interest areas include these specific areas from the following Centers. If no point of contact (POC) is listed or contact information is needed, please contact the POC using contact information listed in Appendix D.

A.5.1 Goddard Space Flight Center (GSFC), POC: James L. Harrington,
james.l.harrington@nasa.gov

GSFC's areas of interest include:

Applied Engineering and Technology Directorate: POC: Danielle Margiotta,
Danielle.V.Margiotta@nasa.gov

- **Advanced Manufacturing** - facilitates the development, evaluation, and deployment of efficient and flexible additive manufacturing technologies (ref: NAMI.org)
- **Advanced Multi-functional Systems and Structures** - novel approaches to increase spacecraft systems resource utilization
- **Micro - and Nanotechnology - Based Detector Systems** - research and application of these technologies to increase the efficiency of detector and optical systems

- **Ultra-miniature Spaceflight Systems and Instruments** - miniaturization approaches from multiple disciplines - materials, mechanical, electrical, software, and optical - to achieve substantial resource reductions
- **Systems Robust to Extreme Environments** - materials and design approaches that will preserve designed system properties and operational parameters (e.g. mechanical, electrical, thermal), and enable reliable systems operations in hostile space environments.
- **Quantum Sensing**
- **Radiation Hardened Integrated Circuits**
- **Spaceflight Applications of Artificial Intelligence**
- **Neuromorphic Computing**
- **Additive Manufacturing Enabled Miniaturized and Optimized System Design**
- **Spacecraft Navigation Technologies**
 - Spacecraft GNSS receivers, ranging crosslink transceivers, and relative navigation sensors
 - Optical navigation and satellite laser ranging
 - Deep-space autonomous navigation techniques
 - Software tools for spacecraft navigation ground operations and navigation analysis
 - Formation Flying
- **Automated Rendezvous and Docking (AR&D) techniques**
 - Algorithm development
 - Pose estimation for satellite servicing missions
 - Sensors (e.g., LiDARs, natural feature recognition)
 - Actuation (e.g., micro propulsion, electromagnetic formation flying)
- **Mission and Trajectory Design Technologies**
 - Mission design tools that will enable new mission classes (e.g., low thrust planetary missions, precision formation flying missions)
 - Mission design tools that reduce the costs and risks of current mission design methodologies
 - Trajectory design techniques that enable integrated optimal designs across multiple orbital dynamic regimes (i.e. earth orbiting, earth-moon libration point, sun-earth libration point, interplanetary)
- **Spacecraft Attitude Determination and Control Technologies**
 - Modeling, simulation, and advanced estimation algorithms
 - Advanced spacecraft attitude sensor technologies (e.g., MEMS IMU's, precision optical trackers)
 - Advanced spacecraft actuator technologies (e.g. modular and scalable momentum control devices, 'green' propulsion, micropropulsion, low power electric propulsion)
- **CubeSats** - Participating institutions will develop CubeSat/Smallsat components, technologies and systems to support NASA technology demonstration and risk reduction efforts. Student teams will develop miniature CubeSat/Smallsat systems for: power generation and distribution, navigation, communication, on-board computing, structures (fixed and deployable), orbital stabilization, pointing, and de-orbiting. These components, technologies and systems shall be made available for use by NASA for integration into NASA Cubesat/Smallsats. They may be integrated into complete off-the-shelf "CubeSat/Smallsat bus" systems, with a goal of minimizing "bus" weight/power/volume/cost and maximizing available "payload" weight/power/volume. NASA technologists will then use these components/systems to develop payloads that demonstrate key technologies to prove concepts and/or reduce risks

for future Earth Science, Space Science and Exploration/Robotic Servicing missions.
POC: Thomas P. Flatley (Thomas.P.Flatley@nasa.gov)

- **On-Orbit Multicore Computing** - High performance multicore processing for advanced automation and science data processing on spacecraft. There are multiple multicore processing platforms in development that are being targeted for the next generation of science and exploration missions, but there is little work in the area of software frameworks and architectures to utilize these platforms. It is proposed that research in the areas of efficient inter-core communications, software partitioning, fault detection, isolation & recovery, memory management, core power management, scheduling algorithms, and software frameworks be done to enable a transition to these newer platforms. Participating institutions can select areas to research and work with NASA technologists to develop and prototype the resulting concepts. POC: Alan Cudmore (Alan.p.cudmore@nasa.gov)
- **Integrated Photonic components and systems** - Integrated photonic components and systems for Sensors, Spectrometers, Chemical/biological sensors, Microwave, Sub-millimeter and Long-Wave Infra-Red photonics, Telecom- inter and intra satellite communications.
- **Radiation Effects and Analysis**
 - Flight validation of advanced event rate prediction techniques
 - New approaches for testing and evaluating 3-D integrated microcircuits and other advanced microelectronic devices
 - End-to-end system (e.g., integrated component level or higher) modeling of radiation effects
 - Statistical approaches to tackle radiation hardness assurance (i.e., total dose, displacement damage, and/or single-event effects) for high-risk, low-cost missions

Sciences and Exploration Directorate POC: Blanche Meeson, Blanche.W.Meeson@nasa.gov

The Sciences and Exploration Directorate at NASA Goddard Space Flight Center (GSFC) (<http://science.gsfc.nasa.gov>) is the largest Earth and space science research organization in the world. Its scientists advance understanding of the Earth and its life-sustaining environment, the Sun, the solar system, and the wider universe beyond. All are engaged in the full life cycle of satellite missions and instruments from concept development to implementation, analysis and application of the scientific information, and community access and services.

- The **Earth Sciences Division** plans, organizes, evaluates, and implements a broad program of research on our planet's natural systems and processes. Major focus areas include climate change, severe weather, the atmosphere, the oceans, sea ice and glaciers, and the land surface. To study the planet from the unique perspective of space, the Earth Science Division develops and operates remote-sensing satellites and instruments. We analyze observational data from these spacecraft and make it available to the world's scientists and policy makers. The Division conducts extensive field campaigns to gather data from the surface and airborne platforms. The Division also develops, uses, and assimilates observations into models that simulate planetary processes involving the water, energy, and carbon cycles at multiple scales up to global. Lidar altimetry for forest ecosystem structure and for measurements related to the cryospheric aerosols.

POC: Eric Brown de Colstoun (eric.c.browndecolsto@nasa.gov)

- The **Astrophysics Science Division** conducts a broad program of research in astronomy, astrophysics, and fundamental physics. Individual investigations address issues such as the nature of dark matter and dark energy, which planets outside our solar system may harbor life, and the nature of space, time, and matter at the edges of black holes. Observing photons, particles, and gravitational waves enables researchers to probe astrophysical objects and processes. Researchers develop theoretical models, design experiments and hardware to test theories, and interpret and evaluate observational data, High Resolution X-ray Spectroscopy and Time Domain Astronomy (TBD)

POC: Amber Straughn (Amber.n.Straughn@nasa.gov)

- The **Heliophysics Science Division** conducts research on the Sun, its extended solar-system environment (the heliosphere), and interactions of Earth, other planets, small bodies, and interstellar gas with the heliosphere. Division research also encompasses Geospace, Earth's magnetosphere and its outer atmosphere, and Space Weather—the important effects that heliospheric disturbances have on spacecraft and terrestrial systems. Division scientists develop spacecraft missions and instruments, systems to manage and disseminate heliophysical data, and theoretical and computational models to interpret the data. Possible heliophysics-related research include: advanced software environments and data-mining strategies to collect, collate and analyze data relevant to the Sun and its effects on the solar system and the Earth (“space weather”); and advanced computational techniques, including but not limited to parallel architectures and the effective use of graphics processing units, for the simulation of magnetized and highly dynamic plasmas and neutral gases in the heliosphere. Development of a ground-based, low-light camera capable of detecting artificial auroral emission at visible wavelengths. Ground-based measurements of energetic electron precipitation, including riometers, Very Low Frequency receivers and possibly imagers for lower energies. Hardware installation/maintenance as well as the modeling tools to extract particle precipitation information from these observations. Development of novel instrumentation for gamma-ray and neutron imaging and spectroscopy with applications ranging from heliophysics to astrophysics and planetary science. Development or sustainment of citizen science programs with research goals relevant to Heliophysics, such as Aurorasaurus or Solar Storm watch (Zooniverse).

POC: Doug Rabin (Douglas.Rabin@nasa.gov)

- The **Solar System Exploration Division** builds science instruments and conducts theoretical and experimental research to explore the solar system and understand the formation and evolution of planetary systems. Laboratories within the division investigate areas as diverse as astrochemistry, planetary atmospheres, extrasolar planetary systems, earth science, planetary geodynamics, space geodesy, and comparative planetary studies. To study how planetary systems form and evolve, division scientists develop theoretical models as well as the investigations and space instruments to test them. The researchers participate in planetary and Earth science missions, and collect, interpret, and evaluate measurements. Ultra-miniaturized instrumentation for in situ planetary exploration. Examples include miniature mass spectrometers or lab on a chip devices for chemical analysis of planetary environments. Instrumentation and measurement protocols for detection of biosignatures in planetary missions. Examples include derivatization chemistry utilized for gas chromatograph mass spectrometer analysis or robotic systems for acquisition, manipulation, and processing of samples acquired from the surface or atmosphere of a planet or its moon.

POC: Lora Bleacher (Lora.V.Bleacher@nasa.gov)

Scientists in all four divisions publish research results in the peer-reviewed literature, participate in the archiving and public dissemination of scientific data, and provide expert user support.

A.5.2 Ames Research Center (ARC), POC: Danielle Carmichael
(danielle.n.carmichael@nasa.gov)

ARC enables exploration through selected development, innovative technologies, and interdisciplinary scientific discovery. ARC provides leadership in the following areas of interest: astrobiology; small satellites; entry descent and landing systems; supercomputing; robotics and autonomous systems; life sciences and environmental controls; and air traffic management.

- [Entry systems](#): *Safely delivering spacecraft to Earth & other celestial bodies*
- [Supercomputing](#): *Enabling NASA's advanced modeling and simulation*
- [NextGen air transportation](#): *Transforming the way we fly*
- [Airborne science](#): *Examining our own world & beyond from the sky*
- [Low-cost missions](#): *Enabling high value science to low Earth orbit, the moon and the solar system*
- [Biology & astrobiology](#): *Understanding life on Earth and in space*
- [Exoplanets](#): *Finding worlds beyond our own*
- [Autonomy & robotics](#): *Complementing humans in space*
- [Lunar science](#): *Rediscovering our moon*
- [Human factors](#): *Advancing human-technology interaction for NASA missions*
- [Wind tunnels](#): *Testing on the ground before you take to the sky*

Additional ARC core competencies include:

- Space Sciences
- Applied Aerospace and Information Technology
- Biotechnology
- Synthetic biology
- Biological Sciences
- Earth Sciences
- High Performance Computing,
- Intelligent Systems
- Quantum Computing
- Nanotechnology-electronics and sensors.
- Small Spacecraft and Cubesats
- Airspace Systems
- Augmented Reality
- Digital materials

A.5.3 Glenn Research Center (GRC), POC: Mark David Kankam, Ph.D.
mark.d.kankam@nasa.gov

GRC's areas of interest include research, technology, and engineering engagements including:

- Acoustics
- Advanced Energy (Renewable Wind and Solar, Coal Energy and Alternative Energy)
- Advanced Microwave Communications

- Aeronautical and Space Systems Analysis
- Computer Systems and Networks
- Electric (Ion) Propulsion
- Icing and Cryogenic Systems
- Instrumentation, Controls and Electronics
- Fluids, Computational Fluid Dynamics (CFD) and Turbomachinery
- Materials and Structures, including Mechanical Components and Lubrication
- Microgravity Fluid Physics, Combustion Phenomena and Bioengineering
- Nanotechnology
- Photovoltaics, Electrochemistry-Physics, and Thermal Energy Conversion
- Propulsion System Aerodynamics
- Space Power Generation, Storage, Distribution and Management
- Systems Engineering

The above engagement areas relate to the following key GRC competencies:

- Air-Breathing Propulsion
- Communications Technology and Development
- In-Space Propulsion & Cryogenic Fluids Management
- Power, Energy Storage and Conversion
- Materials and Structures for Extreme Environment
- Physical Sciences and Biomedical Technologies in Space

A.5.4 Armstrong Flight Research Center (AFRC), POC: Dave Berger, dave.e.berger@nasa.gov

AFRC's areas of interest include:

Autonomy (Collision Avoidance, Separation assurance, formation flight, peak seeking control)

(POC: Jack Ryan, AFRC-RC)

- Adaptive Control
(POC: Curt Hanson, AFRC-RC)
- Hybrid Electric Propulsion
(POC: Starr Ginn, AFRC-R)
- Control of Flexible Structures using distributed sensor feedback
(POC: Marty Brenner, AFRC-RS; Peter Suh, AFRC-RC)
- Supersonic Research (Boom mitigation and measurement)
(POC: Ed Haering, AFRC-RA)
- Supersonic Research (Laminar Flow)
(POC: Dan Banks, AFRC-RA)
- Environmental Responsive Aviation
(POC: Mark Mangelsdorf, AFRC-RS)
- Hypersonic Structures & Sensors
(POC: Larry Hudson, AFRC-RS)
- Large Scale Technology Flight Demonstrations (Towed Glider)
(POC: Steve Jacobson, AFRC-RC)
- Aerodynamics and Lift Distribution Optimization to Reduce Induced Drag
(POC: Al Bowers, AFRC-R)

A.5.5 Marshall Space Flight Center (MSFC), POC: Frank Six, frank.six@nasa.gov

MSFC's areas of interest include:

Propulsion Systems

- Launch Propulsion Systems, Solid & Liquid
- In Space Propulsion (Cryogenics, Green Propellants, Nuclear, Fuel Elements, Solar-Thermal, Solar Sails, Tethers)
- Propulsion Test beds and Demonstrators (Pressure Systems)
- Combustion Physics
- Cryogenic Fluid Management
- Solid Ballistics
- Rapid Affordable Manufacturing of Propulsion Components
- Materials Research (Nano Crystalline Metallics, Diamond Film Coatings)
- Materials Compatibility
- Computational Fluid Dynamics
- Unsteady Flow Environments
- Acoustics and Stability
- Solid Ballistics
- Rapid Affordable Manufacturing of Propulsion Components
- Materials Research (Nano Crystalline Metallics, Diamond Film Coatings)
- Materials Compatibility
- Computational Fluid Dynamics
- Unsteady Flow Environments
- Acoustics and Stability

Space Systems

- In Space Habitation (Life Support Systems and Nodes, 3D Printing)
- Mechanical Design & Fabrication
- Small Payloads (For International Space Station, Space Launch System)
- In-Space Asset Management (Automated Rendezvous & Capture, De-Orbit, Orbital Debris Mitigation, Proximity Operations)
- Radiation Shielding
- Thermal Protection
- Electromagnetic Interference
- Advanced Communications
- Small Satellite Systems (CubeSats)
- Structural Modeling and Analysis
- Spacecraft Design (CAD)

Space Transportation

- Mission and Architecture Analysis
 - Advanced Manufacturing
 - Space Environmental Effects and Space Weather
 - Lander Systems and Technologies
 - Small Spacecraft and Enabling Technologies (Nanolaunch Systems)
 - 3D Printing/Additive Manufacturing/Rapid Prototyping
 - Meteoroid Environment
 - Friction Stir and Ultrasonic Welding
 - Advanced Closed-Loop Life Support Systems
 - Composites and Composites Manufacturing
 - Wireless Systems
-

- Ionic Liquids
- Guidance, Navigation and Control (Autonomous, Small Launch Vehicle)
- Systems Health Management
- Martian Navigation Architecture/Systems
- Planetary Environment Modeling
- Autonomous Systems (reconfiguration, Mission Planning)

Science

- Replicated Optics
- Large Optics (IR, visible, UV, X-Ray)
- High Energy Astrophysics (X-Ray, Gamma Ray, Cosmic Ray)
- Solar, Magnetospheric and Ionospheric Physics
- Radiation Mitigation/Shielding
- Earth Science Applications
- Convective and Severe Storms Research
- Climate Dynamics
- Lightning Research
- Geochronology, Geochemistry, Atmospheres and Interiors of Planetary Bodies
- Physical Science Informatics
- Biophysics (Protein Crystals)

A.5.6 Kennedy Space Center (KSC), by Roadmap Technical Area (TA), POC Michael Lester, gregory.m.lester@nasa.gov

KSC's areas of interest include:

- TA 4.0 Robotics and Autonomous Systems
Barbara Brown, barbara.l.brown@nasa.gov, Ph: 321-867-1720
 - 4.1 Sensing and Perception
 - 4.1.4 Natural, Man-Made Object, and Event Recognition
 - 4.3 Manipulation
 - 4.3.6 Sample Acquisition and Handling
 - 4.5 System-Level Autonomy
 - 4.5.3 Autonomous Guidance and Control
- TA 6.0 Human Health, Life Support, and Habitation Systems
Charlie Quincy, charles.d.quincy@nasa.gov, Ph: 321-867-8383
 - 6.1 Environmental Control and Life Support Systems and Habitation Systems
 - 6.1.1 Air Revitalization
 - 6.1.2 Water Recovery and Management
 - 6.1.3 Waste Management
- TA 7.0 Human Exploration Destination Systems
Stanley Starr, stanley.o.starr@nasa.gov, Ph: 321-861-2262
 - 7.1 In-Situ Resource Utilization
 - 7.1.1 Destination Reconnaissance, Prospecting, and Mapping
 - 7.1.2 Resource Acquisition
 - 7.1.3 Processing and Production
 - 7.1.4 Manufacturing Products and Infrastructure Emplacement
 - 7.2 Sustainability and Supportability
 - 7.2.4 Food Production, Processing, and Preservation

- TA 13.0 Ground and Launch Systems
Robert Johnson, robert.g.johnson@nasa.gov, Ph: 321-867-7373
 - 13.2 Environmental Protection and Green Technologies
 - 13.2.5 Curatorial Facilities, Planetary Protection, and Clean Rooms
 - 13.3 Reliability and Maintainability
 - 13.3.3 On-Site Inspection and Anomaly Detection and Identification
 - 13.3.6 Repair, Mitigation, and Recovery Technologies
- KSC SBIR, **Mike Vinje**, michael.e.vinje@nasa.gov, Ph: 321-861-3874
 - Standardized Interfaces (a USB port for space)
 - A substantial portion of pre-launch processing involves the integration of spacecraft assemblies to each other or to the ground systems that supply the commodities, power or data. Each stage or payload requires an interface that connects it to the adjacent hardware which includes flight critical seals or connectors and other components. Development and adoption of simplified, standardized interfaces holds the potential of reducing the cost and complexity of future space systems, which increases the funding available for flight hardware and drives down the cost of access to space for everyone.

A.5.7 Jet Propulsion Laboratory (JPL), NASA's only Federally Funded Research and Development Center (FFRDC), POC: Linda Rodgers, linda.l.rodgers@jpl.nasa.gov

JPL's areas of interest include:

- Solar System Science
 Planetary Atmospheres and Geology; Solar System characteristics and origin of life; Primitive solar systems bodies; Lunar science; Preparing for returned sample investigations
- Earth Science
 Atmospheric composition and dynamics; Land and solid earth processes; Water and carbon cycles; Ocean and ice; Earth analogs to planets; Climate Science
- Astronomy and Fundamental Physics
 Origin, evolution, and structure of the universe; Gravitational astrophysics and fundamental physics; Extra-solar planets and star and planetary formation; Solar and Space Physics; Formation and evolution of galaxies
- In-Space Propulsion Technologies
 Chemical propulsion; Non-chemical propulsion; Advanced propulsion technologies; Supporting technologies
- Space Power and Energy Storage
 Power generation; Energy storage; Power management & distribution; Cross-cutting technologies
- Robotics, Tele-Robotics and Autonomous Systems
 Sensing; Mobility; Manipulation technology; Human-systems interfaces; Autonomy; Autonomous rendezvous & docking; Systems engineering
- Communication and Navigation
 Optical communications & navigation technology; Radio frequency communications; Internetworking; Position, navigation and timing; Integrated technologies; Revolutionary concepts
- Human Exploration Destination Systems
 In-situ resource utilization and Cross-cutting systems

- Science Instruments, Observatories and Sensor Systems
Science Mission Directorate Technology Needs; Remote Sensing instruments/sensors; Observatory technology; In-situ instruments/sensor technologies
- Entry, Descent and Landing Systems
Aerobraking, aerocapture and entry systems; Descent; Landing; Vehicle system technology
- Nanotechnology
Engineered materials; Energy generation and storage; Propulsion; Electronics, devices and sensors
- Modeling, Simulation, Information Technology and Processing
Flight and ground computing; Modeling; Simulation; Information processing
- Materials, Structures, Mechanical Systems and Manufacturing
Materials; Structures; Mechanical systems; Cross cutting
- Thermal Management Systems
Cryogenic systems; Thermal control systems (near room temperature); Thermal protection systems

A.5.8 Johnson Space Center (JSC), POC: Kamlesh Lulla, kamlesh.p.lulla@nasa.gov

JSC's areas of interest include:

- In-space propulsion technologies
- Energy Storage technologies-Batteries, Regenerative Fuel cells
- Robotics and TeleRobotics
- Crew decision support systems
- Immersive Visualization
 - Virtual windows leading to immersive environments and telepresence systems
- Human Robotic interface
- Flight and Ground communication systems
 - Audio
 - Array Microphone Systems and processing
 - Large bandwidth (audio to ultra-sonic) MEMs Microphones
 - Front end audio noise cancellation algorithms implementable in FPGAs-example Independent Component Analysis
 - Audio Compression algorithms implementable in FPGAs.
 - COMSOL Acoustic modeling
 - Sonification Algorithms implementable in DSPs/FPGAs
 - Video
 - Ultra High Video Compressions
 - H265 Video Compression
 - Rad-Tolerant Imagers
 - Lightweight/low power/radiation tolerant displays
- Advanced habitat systems
- GN&C for descent systems
- Large body GN&C
- Human system performance modeling
- Imaging and information processing
 - Lightweight/Low power Display Technology
 - Scalable software-implementable graphics processing unit

- Simulation and modeling
- Materials and structures
- Lightweight structure
- Human Spaceflight Challenges
 - <http://humanresearchroadmap.nasa.gov/explore/>
- Human System Interfaces
 - OLED Technology Evaluation for Space Applications
 - Far-Field Speech Recognition in Noisy Environments
 - Radiation Hardened Graphics Processing
 - Human Computer Interaction design methods (Multi-modal and Intelligent Interaction) and apparatuses
 - Human Systems Integration, Human Factors Engineering: state of the art in Usability and performance assessment methods and apparatus.
 - Humans Systems Integration Inclusion in Systems Engineering
- ECLSS
 - Air Revitalization
 - Advanced water, O₂ and CO₂ monitoring and sensors
 - Advance thermally regenerated ionic fluids for CO₂ and Humidity Control
 - Water Recovery and Management
 - Brine water recovery systems and wastewater treatment chemical recover for reuse or repurpose
 - Waste Management
 - Advance wastewater treatment systems (lower toxicity, recoverable)
 - Advanced trace contaminant monitoring and control technology
 - Quiet fan technologies
- Active Thermal Control
 - Lightweight heat exchangers and cold plates
 - Condensing heat exchanger coatings with robust hydrophilic, antimicrobial properties
 - Development and demonstration of wax and water-based phase change material heat exchangers
- EVA
 - Pressure Garment
 - Portable Life Support System
 - Power, Avionics and Software
- Autonomous Rendezvous and Docking
- Crew Exercise
 - Small form Equipment
 - Biomechanics
- EDL (thermal)
- Wireless and Comm Systems
 - Wireless Energy Harvesting Sensor Technologies
 - Robust, Dynamic Ad hoc Wireless Mesh Communication Networks
 - Radiation Hardened EPCglobal Radio Frequency Identification (RFID) Readers
 - Computational Electromagnetics (CEM) Fast and Multi-Scale Methods/Algorithms
 - EPCglobal-type RFID ICs at frequencies above 2 G
- Radiation and EEE Parts
 - Monitoring
 - Mitigation and Biological countermeasures
 - Protection systems

- Space weather prediction
- Risk assessment modeling
- Wearable Tech
 - Wearable Sensors and Controls
 - Wearable Audio Communicator
 - Wearable sensing and hands-free control
 - Tattooed Electronic Sensors
- In-Situ Resource Utilization
 - Mars atmosphere processing
 - CO₂ collection, dust filtering, Solid Oxide CO₂ electrolysis, Sabatier, reverse water gas shift
 - Lunar/Mars regolith processing
 - Regolith collection and drying
 - Water collection and processing, water electrolysis
 - Methane/Oxygen liquefaction and storage

A.5.9 Stennis Space Center (SSC), POC: Nathan Sovik, nathan.a.sovik@nasa.gov

SSC's areas of interest include:

- Active and Passive Nonintrusive Remote Sensing of Propulsion Test Parameters
- Intelligent Integrated System Health Management (ISHM) in Rocket Test-Stands
- Advanced Non-Destructive Evaluation Technologies
- Advanced Propulsion Systems Testing
- Cryogenic Instrumentation and Cryogenic, High Pressure, and Ultrahigh Pressure Fluid Systems
- Ground Test Facilities Technology
- Propulsion System Exhaust Plume Flow Field Definition and Associated Plume Induced Acoustic & Thermal Environments
- Vehicle Health Management/Rocket Exhaust Plume Diagnostics

Propulsion Testing

Active and Passive Nonintrusive Remote Sensing of Propulsion Test Parameters

The vast amount of propulsion system test data is collected via single channel, contact, intrusive sensors and instrumentation. Future propulsion system test techniques could employ passive nonintrusive remote sensors and active nonintrusive remote sensing test measurements over wide areas instead of at a few discrete points. Opportunities exist in temperature, pressure, stress, strain, position, vibration, shock, impact, and many other measured test parameters. The use of thermal infrared, ultraviolet, and multispectral sensors, imagers, and instruments is possible through the SSC sensor laboratory.

Intelligent Integrated System Health Management (ISHM) in Rocket Test-Stands

SHM is a capability used to determine the condition of every element of a system continuously. ISHM includes detection of anomalies, diagnosis of causes, and prognosis of future anomalies; as well as making available (to elements of the system and the operator) data, information, and knowledge (DIaK) to achieve optimum operation. In this context, we are interested in methodologies to embed intelligence into the various elements of rocket engine test-stands, e.g., sensors, valves, pumps, tanks, etc. Of particular interest is the extraction of qualitative interpretations from sensor data in order to develop a qualitative assessment of the operation of the various components and processes in the

system. The desired outcomes of the research are: (1) to develop intelligent sensor models that are self-calibrating, self- configuring, self- diagnosing, and self- evolving (2) to develop intelligent components such as valves, tanks, etc., (3) to implement intelligent sensor fusion schemes that allow assessment, at the qualitative level, of the condition of the components and processes, (4) to develop a monitoring and diagnostic system that uses the intelligent sensor models and fusion schemes to predict future events, to document the operation of the system, and to diagnose any malfunction quickly, (5) to develop architectures/taxonomies/ontologies for integrated system health management using distributed intelligent elements, and (6) to develop visualization and operator interfaces to effectively use the ISHM capability.

Advanced Non-Destructive Technologies

Advances in non-destructive evaluation (NDE) technologies are needed for fitness-for-service evaluation of pressure vessels used in rocket propulsion systems and test facilities. NDE of ultra-high pressure vessels with wall thicknesses exceeding 10 inches require advanced techniques for the detection of flaws that may affect the safe use of the vessels.

Advanced Propulsion Systems Testing

Innovative techniques will be required to test propulsion systems such as advanced chemical engines, single- stage-to-orbit rocket plane components, nuclear thermal, nuclear electric, and hybrids rockets. New and more cost-effective approaches must be developed to test future propulsion systems. The solution may be some combination of computational- analytical technique, advanced sensors and instrumentation, predictive methodologies, and possibly subscale tests of aspects of the proposed technology.

Cryogenic Instrumentation and Cryogenic, High Pressure, and Ultrahigh Pressure Fluid Systems

Over 40 tons of liquefied gases are used annually in the conduct of propulsion system testing at the Center. Instrumentation is needed to precisely measure mass flow of cryogenics starting with very low flow rates and ranging to very high flow rates under pressures up to 15,000 psi. Research, technology, and development opportunities exist in developing instruments to measure fluid properties at cryogenic conditions during ground testing of space propulsion systems. Both intrusive and nonintrusive sensors, but especially nonintrusive sensors, are desired.

Ground Test Facilities Technology

SSC is interested in new, innovative ground-test techniques to conduct a variety of required developmental and certification tests for space systems, stages/vehicles, subsystems, and components. Examples include better coupling and integration of computational fluid dynamics and heat transfer modeling tools focused on cryogenic fluids for extreme conditions of pressure and flow; advanced control strategies for non-linear multi-variable systems; structural modeling tools for ground-test programs; low-cost, variable altitude simulation techniques; and uncertainty analysis modeling of test systems.

Propulsion System Exhaust Plume Flow Field Definition and Associated Plume Induced Acoustic & Thermal Environments

Background: An accurate definition of a propulsion system exhaust plume flow field and its associated plume induced environments (PIE) are required to support the design efforts necessary to safely and optimally accomplish many phases of any space flight mission from sea level or simulated altitude testing of a propulsion system to landing on and returning from the Moon or Mars. Accurately defined PIE result in increased safety,

optimized design and minimized costs associated with: 1. propulsion system and/or component testing of both the test article and test facility; 2. any launch vehicle and associated launch facility during liftoff from the Earth, Moon or Mars; 3. any launch vehicle during the ascent portion of flight including staging, effects of separation motors and associated pitch maneuvers; 4. effects of orbital maneuvering systems (including contamination) on associated vehicles and/or payloads and their contribution to space environments; 5. Any vehicle intended to land on and return from the surface of the Moon or Mars; and finally 6. The effects of a vehicle propulsion system on the surfaces of the Moon and Mars including the contaminations of those surfaces by plume constituents and associated propulsion system constituents.

Current technology status and requirements to optimally accomplish NASA's mission: In general, the current plume technology used to define a propulsion system exhaust plume flow field and its associated plume induced environments is far superior to that used in support of the original Space Shuttle design. However, further improvements of this technology are required: 1. in an effort to reduce conservatism in the current technology allowing greater optimization of any vehicle and/or payload design keeping in mind crew safety through all mission phases; and 2. to support the efforts to fill current critical technology gaps discussed below. PIE areas of particular interest include: single engine and multi-engine plume flow field definition for all phases of any space flight mission, plume induced acoustic environments, plume induced radiative and convective ascent vehicle base heating, plume contamination, and direct and/or indirect plume impingement effects.

Current critical technology gaps in needed PIE capabilities include: 1. An accurate analytical prediction tool to define convective ascent vehicle base heating for both single engine and multi-engine vehicle configurations. 2. An accurate analytical prediction tool to define plume induced environments associated with advanced chemical, electrical and nuclear propulsion systems. 3. A validated, user friendly free molecular flow model for defining plumes and plume induced environments for low density external environments that exist on orbit, as well as interplanetary and other planets.

Vehicle Health Management/Rocket Exhaust Plume Diagnostics

A large body of UV-Visible emission spectrometry experimentation is being performed during the 30 or more tests conducted each year on the Space Shuttle Main Engine at SSC. Research opportunities are available to quantify failure and wear mechanisms, and related plume code validation. Related topics include combustion stability, mixture ratio, and thrust/power level. Exploratory studies have been done with emission/absorption spectroscopy, absorption resonance spectroscopy, and laser induced fluorescence. Only a relatively small portion of the electromagnetic spectrum has been investigated for use in propulsion system testing and exhaust plume diagnostics/vehicle health management.

A.5.10 Langley Research Center (LaRC), POC: Gamaliel (Dan) Cherry,
Gamaliel.R.Cherry@nasa.gov

LaRC's areas of interest include:

- Intelligent Flight Systems – Revolutionary Air Vehicles
(POC: Guy Kemmerly 757-864-5070)
- Atmospheric Characterization – Active Remote Sensing
(POC: Malcolm Ko 757-864-8892)

- Systems Analysis and Concepts - Air Transportation System Architectures & Vehicle Concepts (POC: Michael Marcolini 757-864-3629)
- Advanced Materials & Structural System – Advanced Manufacturing (POC: David Dress 757-864-5126)
- Aerosciences - Trusted Autonomy (POC: Sharon Graves 757-864-5018)
- Entry, Decent & Landing - Robotic Mission Entry Vehicles (POC: Keith Woodman 757-864-7692)
- Measurement Systems - Advanced Sensors and Optical Measurement (POC: Tom Jones 757-864-4903)

Appendix B: NASA Strategic Approach

B.1 NASA Strategic Plan

The NASA 2018 Strategic Plan focuses on the development of science, technology, engineering, and mathematics (STEM) disciplines along with the engagement of academic institutions and students in accomplishing the vision and mission of NASA. NASA contributes to national efforts for achieving excellence in STEM education through a comprehensive education portfolio implemented by the Office of Education, the Mission Directorates, and the NASA Centers. NASA will continue the Agency's tradition of investing in the Nation's education programs and supporting the country's educators who play a key role in preparing, inspiring, exciting, encouraging, and nurturing the young minds of today that will manage and lead the Nation's laboratories and research centers of tomorrow.

NASA Mission:

Drive advances in science, technology, aeronautics, and space exploration to enhance knowledge, education, innovation, economic vitality, and stewardship of Earth.

NASA Strategic Goals:

1. Expand the frontiers of knowledge, capability, and opportunity in space.
2. Advance understanding of Earth and develop technologies to improve the quality of life on our home planet.
3. Serve the American public and accomplish our Mission by effectively managing our people, technical capabilities, and infrastructure.

NASA Strategic Goals and Objectives relevant to education

Objective 1.2: *Conduct research on the International Space Station (ISS) to enable future space exploration, facilitate a commercial space economy, and advance the fundamental biological and physical sciences for the benefit of humanity.*

Objective 2.4: *Advance the Nation's STEM education and workforce pipeline by working collaboratively with other agencies to engage students, teachers, and faculty in NASA's missions and unique assets.*

Objective 3.1: *Attract and advance a highly skilled, competent, and diverse workforce, cultivate an innovative work environment, and provide the facilities, tools, and services needed to conduct NASA's missions.*

B.2 NASA Education Strategic Coordination Framework

NASA will continue the Agency's tradition of investing in the nation's education programs and supporting the country's educators who play a key role in preparing, inspiring, exciting, encouraging, and nurturing the young minds of today who will be the workforce of tomorrow.

NASA will continue to pursue three major education goals:

- Strengthening NASA and the Nation's future workforce
- Attracting and retaining students in science, technology, engineering and mathematics, or STEM, disciplines
- Engaging Americans in NASA's mission. The plan encompasses all education efforts undertaken by NASA and guides the Agency's relationships with external education partners.

Appendix C: Definitions

- Center – Refers to one of the nine NASA Centers plus the Jet Propulsion Laboratory (JPL). For purposes of collaboration in NASA EPSCoR, JPL is included in the NASA Center category.
- Cooperative Agreement – An award of federal assistance used to carry out a public purpose of support or stimulation authorized by a law. A cooperative agreement is similar to a grant with the exception that NASA and the award recipient are each expected to be substantially involved for the performance of the project. Cooperative agreements are managed pursuant to the policies set forth in 2 CFR Part 200, 2 CFR Part 1800, and the NASA Grant and Cooperative Agreement Manual.
- Directorate – One of NASA’s Mission Directorates—Aeronautics Research (ARMD), Human Exploration & Operations (HEOMD), Space Technology (STMD), and Science (SMD).
- Jurisdiction – States or commonwealths eligible to submit proposals in response to this CAN.
- NASA Research Contact – The NASA Research Contact is the primary NASA point of contact during the proposal writing stage for the proposed research area. If the proposer has contacted and received permission from a NASA scientific or technical person, that individual may be listed in the proposal as the NASA Research Contact. Otherwise the NASA Research Contact is the University Affairs Officer at the Center, or the NASA Mission Directorate contact at NASA Headquarters. (See Appendix D.)
- Partnership – A reciprocal and voluntary relationship between the project personnel and NASA, industry, or other partners, to cooperatively achieve the goals of the proposed research.
- Principal Investigator (PI) – For this EPSCoR CAN, the Principal Investigator is the jurisdiction’s EPSCoR director. The Principal Investigator has an appropriate level of authority and is responsible for proper conduct of the research, including appropriate use of funds and administrative requirements such as the submission of the scientific progress reports to the Agency. The PI is the administrator for the proposal.
 - Science-I – For this CAN, one Co-I should be designated as the Science-I for those cases where the person leading the scientific direction of the proposed work is not the PI. The formally stated PI will still be held responsible for the overall direction of the effort and use of funds.
 - Co-Investigator (Co-I) – A Co-I is a member of the proposal’s investigation team who is a critical “partner” for the conduct of the investigation through the contribution of unique expertise and/or capabilities.
 - Co-I/Institutional-PI – A Co-I at an organization other than that of the PI institution, who is making a major contribution to the proposal and serves as the point of contact at the Co-I’s institution, may also be designated as the Co-I/Institutional-PI. For this CAN, the Science-I may also serve as a Co-I/Institutional-PI. In these cases, the individual should be identified as the Science-I in the proposal cover page.
- Research area – One of the areas of research interest for the NASA Mission Directorate(s).

- Research Group – A group of researchers that undertakes one of the specific research areas proposed.
- Research Student – A student (undergraduate, graduate, or postdoctoral) who receives a research appointment in direct support of the NASA EPSCoR research in the research proposals.
- Technical Monitor – A NASA scientific or technical person designated by the NASA EPSCoR office to monitor the research project.

Appendix D: NASA Points of Contact

D.1 Additional information regarding NASA EPSCoR can be obtained from the following:

Mr. Jeppie R. Compton
Project Manager, NASA EPSCoR
Office of Education
NASA Kennedy Space Center, Bldg. M6-0399, PX-E
Kennedy Space Center, FL 32899-0001
Phone: (321) 867-6988
E-mail: Jeppie.R.Compton@nasa.gov

D.2 NASA Research Contacts

Technical and scientific questions about research opportunities in this announcement may be directed to the appropriate contact below. Discussions of research with appropriate NASA Center or JPL personnel are strongly encouraged.

D. 3 NASA Mission Directorate Liaisons

<p><u>Aeronautics Research Mission Directorate</u> <i>Karen Rugg</i> Lead, Communications and Education NASA Headquarters Phone: (202) 358-2197 karen.l.rugg@nasa.gov</p>	<p><u>Science Mission Directorate</u> <i>Kristen Erickson</i> Director, Science Engagement & Partnerships NASA Headquarters Phone: (202) 358-1017 kristen.erickson@nasa.gov</p>
<p><u>Human Exploration & Operations Mission Directorate</u> <i>Bradley Carpenter</i> Space Life and Physical Sciences Research and Applications Division NASA Headquarters Phone: (202) 358-0826 BCarpenter@nasa.gov</p>	<p><u>Space Technology Mission Directorate</u> <i>Joseph Grant</i> Education Lead NASA Headquarters Phone: (202) 358-0070 Joseph.Grant@nasa.gov</p>

D.4 NASA Center Liaisons

<p>Ames Research Center <i>Brenda Collins</i> Chief, Education and Public Outreach Phone: (650) 604-3540 brenda.j.collins@nasa.gov</p>	<p>Kennedy Space Center <i>Michael Lester</i> Engineering Technology Utilization and Communications Phone: (321) 861-6723 gregory.m.lester@nasa.gov</p>
<p>Armstrong Flight Research Center <i>Dave Berger</i> University Affairs Officer Phone: (661) 276-5712 dave.e.berger@nasa.gov</p>	<p>Langley Research Center <i>Gamaliel (Dan) Cherry</i> University Affairs Officer Phone: (757) 864-6113 Gamaliel.R.Cherry@nasa.gov</p>
<p>Goddard Space Flight Center <i>James L. Harrington</i> Computer Research and Development Phone: (301) 286-4063 james.l.harrington@nasa.gov</p>	<p>Glenn Research Center <i>Mark David Kankam, Ph.D.</i> University Affairs Officer Dir. of NASA Space & Aeronautics Academy at Glenn Phone: (216) 433-6143 Mark.D.Kankam@nasa.gov</p>
<p>Jet Propulsion Laboratory <i>Linda Rodgers</i> University Programs Administrator Phone: (818) 354-3274 Linda.L.Rodgers@jpl.nasa.gov</p>	<p>Marshall Space Flight Center <i>Norman (Frank) Six</i> University Affairs Officer Office of Academic Affairs (HS30) Phone: (256) 961-0678 Norman.F.Six@nasa.gov</p>
<p>Johnson Space Center <i>Kamlesh Lulla</i> Director, University Research Collaborations and Partnership Office Phone: (281) 483-3065 Kamlesh.P.Lulla@nasa.gov</p>	<p>Stennis Space Center <i>Mitch Krell, Ph.D.</i> Data Analysis Phone: (228) 688-1821 mitch.krell@nasa.gov</p>

Appendix E: Proposal and Submission Information

E.1 Proposal Instructions and Requirements

All information needed to respond to this solicitation is contained in this Cooperative Agreement Notice (CAN) and in the companion *NASA Guidebook for Proposers March 2018 Edition* located at <http://www.hq.nasa.gov/office/procurement/nraguidebook/proposer2018.pdf>.

Proposers are responsible for understanding and complying with the *NASA Guidebook for Proposers*' 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.

The introductory material, as well as the appendices, of the *NASA Guidebook for Proposers* provide additional information about the entire CAN 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.

E.2 Content and Form of the Proposal Submission

- Electronic Proposal Submission

All proposals submitted in response to this CAN must be submitted in a fully electronic form. **No hard copy proposals will be accepted.** Electronic proposals shall be submitted by the authorized organization representative (AOR) at the proposal Principal Investigator's (PI) institution. Electronic submission by the AOR serves as the required original signature by an authorized official of the proposing institution.

Proposers shall submit proposals in response to this CAN via electronic proposal submission through NSPIRES, located at <http://nspires.nasaprs.com> (see below). NASA plans to use the NSPIRES system to facilitate the review process.

Note carefully the following requirements for submission of an electronic proposal via NSPIRES:

- Every institution that intends to submit a proposal to NASA in response to this CAN shall be registered in NSPIRES. Registration for the proposal data system shall be performed by an institution's electronic business point-of-contact (EBPOC) having a valid registration with the System for Award Management (SAM) [formerly known as the Central Contractor Registry (CCR)].
- Any institution requesting NASA funds through the proposed investigation shall be listed on the Proposal Cover Page. NASA will not fund institutions that are not included on the Proposal Cover Page.
- Each individual team member named on the proposal's electronic cover page shall be individually registered in NSPIRES.
- Each individual team member named on the proposal's electronic cover page shall specify an institutional affiliation. The institutional affiliation specified shall be the institution through which the team member is participating in the proposed investigation. If the individual has multiple affiliations, then this institution may be different from the individual's primary employer or preferred mailing address.

Generally, an electronic proposal consists of one or more electronic forms, including an electronic cover page and one or more attachments. The attachments contain all sections

of the proposal, including the project description as well as all required and allowed appendices; see the “Proposal Format and Contents” section below for further requirements.

Submission of electronic proposals via NSPIRES requires several coordinated actions from the proposing institution. In particular, when the PI has completed entry of the data requested in the required electronic forms and attachment of the allowed PDF attachments, including the project description section, an official at the PI’s institution who is authorized to make such a submission, referred to as the AOR, shall 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 accounts in NSPIRES. Note that if one individual is acting in both the PI and AOR roles, he/she shall ensure that all steps in the process are taken, including submitting the institution’s proposal.

- Proposal Format and Contents

All proposals submitted in response to this CAN shall include the appropriate required electronic forms available through NSPIRES.

The project description and other required sections of the proposal shall be submitted as *SEARCHABLE*, unlocked PDF files that are attached to the electronic submission in NSPIRES. Proposers shall comply with any format requirements specified in this CAN and in the *NASA Guidebook for Proposers*, Section 3. Only appendices/attachments that are specifically requested in either this CAN or in the *NASA Guidebook for Proposers* for Proposers will be permitted; proposals containing additional appendices/attachments may be declared noncompliant. The *NASA Guidebook for Proposers*, Section 3, provides detailed guidelines on the content of proposals applicable to this CAN. Additionally, this CAN’s Section 7.0. on Proposal Preparation provides a listing of required content elements.

In the event the information in this CAN is different from or contradicts the information in the *NASA Guidebook for Proposers*, the information in this CAN takes precedence.

Important note on creating PDF files for upload: It is essential that all PDF files generated and submitted meet the NASA requirements below. This will ensure that the submitted files can be transferred into NSPIRES. At a minimum, it is the proposer’s responsibility 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 the NASA requirements may be declared noncompliant and not submitted to peer review for evaluation.

- Additional Requirement for Budget Format

In addition to the budget summary information provided in NSPIRES:

Cover Page forms: all proposers shall include more detailed budgets and budget justifications, including detailed subcontract/subaward budgets, in a format of their own choosing in the *Budget Justification*. For this CAN, this additional budget must be divided into two parts, the “*Budget Justification: Narrative*” and the “*Budget Justification: Details*,” both as described in the *NASA Guidebook for Proposers*, Section 3.18.

The *Budget Justification: Narrative* includes the *Table of Proposed Work Effort* and the description of facilities and equipment, as well as the rationale and basis of estimate for all components of cost including procurements, travel (destination, purpose and number of travelers), publication costs, and all subawards/subcontracts. The *Table of Proposed Work Effort* shall include the names and/or titles of all personnel (including postdoctoral fellows and graduate students, where known) necessary to perform the proposed investigation, regardless of whether these individuals require funding from the current proposal. The number of person-months each person is expected to devote to the project must be given for each year.

The *Budget Justification: Details* shall include the detailed proposed budget including all of the Other Direct Costs, Total Cost Share/Match and Other Applicable Costs specified in the *NASA Guidebook for Proposers*.

A proposer's failure to provide sufficient budget justification and data in the *Budget Justification: Narrative* (including the *Table of Proposed Work Effort*) and the *Budget Justification: Details* will prevent the peer review from appropriately evaluating the cost realism of the proposed effort. A finding by the peer review of "insufficient information to properly evaluate cost realism" shall be considered a proposal weakness. Inconsistent information between these budget descriptions and the proposal text shall also be considered a proposal weakness.

- Submission of Proposals via NSPIRES, the NASA Proposal Data System

In order to submit a proposal via NSPIRES, this CAN requires that the proposer register key data concerning the intended submission with NSPIRES; NSPIRES is accessed at <http://nspires.nasaprs.com>. Potential applicants are strongly urged to access this site well in advance of the proposal due date(s) 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 (Co-I's), shall be registered in NSPIRES and that such individuals shall perform this registration themselves; no one may register a second party, even the Principal Investigator 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.

All proposals submitted via NSPIRES in response to this CAN shall include a required electronic *Cover Page* form that is accessed at <http://nspires.nasaprs.com>. This form comprises 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 if the proposal is selected; and a *Budget Summary* of the proposed research effort. Unless specified in the program description itself, no other forms are required for proposal submission via NSPIRES. See the *NASA Guidebook for Proposers* for further details.

The required elements of the proposal, including the project description, shall be submitted as one PDF document that is attached to the *Cover Page* using the tools in NSPIRES. The complete proposal is submitted as a single, *SEARCHABLE*, unlocked PDF document that contains the complete proposal, including the project description section and budget justification, assembled in the order provided in this CAN and uploaded using the tools in NSPIRES. One advantage of submitting the proposal as one PDF document is that it is easy to upload.

NSPIRES will provide a list of all elements that make up an electronic proposal, and the system will conduct an element check to identify any item(s) that is (are) apparently missing or incomplete. The element check may produce warnings and/or identify errors. Uploading the proposal in one PDF file is likely to create warnings as part of the element check. These warnings should be ignored as such warnings do not preclude proposal submission.

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 on-line 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 (except Federal holidays), 8:00 a.m. – 6:00 p.m. Eastern Time.

E.3 Notice of Intent to Propose

A brief Notice of Intent (NOI) to propose is required for the submission of proposals to this CAN. The information contained in an NOI is used for planning purposes and to help expedite the proposal review activities and, therefore, is of considerable value to both NASA and the proposer. NOIs shall be submitted by the jurisdiction NASA EPSCoR Director through NSPIRES (<http://nspires.nasaprs.com>). Grants.gov does not support NOI submittal. Note that NOIs may be submitted within NSPIRES directly by the proposal's PI; no action by an organization's AOR is required to submit an NOI. The NOI, at a minimum, shall include a clear descriptive title and/or a scientific/technical summary of the anticipated research. The NOI shall:

- Identify the Mission Directorate(s)/Centers with which the proposal should be aligned (if known)
- Identify the areas of expertise required for the research
- Identify the Science-I

E.4 Certifications, Assurances, and Representations

The AOR's signature on the Proposal Cover Page automatically certifies that the proposing organization has read and is in compliance with all certifications, assurances, and representations as detailed in 2 CFR Part 1800, Appendix A.

Appendix F: Useful Web Sites

- NASA
<http://www.nasa.gov>
- NASA Office of Education
http://STEM_Engagement.nasa.gov
- NASA EPSCoR
<http://www.nasa.gov/offices/education/programs/national/epscor/home/index.html>
- Vision for Space Exploration
http://www.nasa.gov/missions/solarsystem/explore_main.html
- NASA Centers & Facilities
<http://www.nasa.gov/offices/education/centers/index.html>
- Guidebook for Proposers Responding to a NASA Research Announcement
<http://www.hq.nasa.gov/office/procurement/nraguidebook>
- NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES)
<http://nspires.nasaprs.com>
- NASA Grants and Cooperative Agreements
http://naistst1.nais.nasa.gov/pub/pub_library/srba/index.html