# Guidebook:
# Established Program to Stimulate Competitive Research (EPSCoR) Research FY 2026
# Basic Research
# This is a guidebook of a forecasted opportunity, this should not be considered a notice of funding opportunity

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|---|---|
| NOFO Released | Estimated April 2026 |
| Proposals Due | Estimated June 2026 (60 days following NOFO release date) |
| Anticipated Notification of Award | August-September 2026 |

**Funding Details**

| | |
|---|---|
| Anticipated Funding for the NOFO | $10,500,000 (over 3-year period) |
| Anticipated Number of Awards | 14 Awards |
| Expected Dollar Value | Maximum $750,000 Per Award |
| Anticipated Award Date | September 2026 |

**Program Office Contact**
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**NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES)**

NSPIRES is the NASA Solicitation and Proposal Integrated Review and Evaluation System. This web-based system supports the entire lifecycle of NASA research solicitation and selection, from the release of Notice of Funding Opportunity (NOFO) through proposal submission, the peer review and the decision process. Applicants may search for and apply for funding opportunities available at NASA through NSPIRES. For technical assistance with NSPIRES, please contact the NSPIRES Help Desk at nspires-help@nasaprs.com or (202) 479-9376, Monday through Friday, 8:00 AM – 6:00 PM ET.

The National Science Foundation (NSF) determines overall jurisdiction eligibility for NASA EPSCoR. The latest available NSF eligibility tables are used to determine overall jurisdiction eligibility for NASA EPSCoR. The NSF eligibility table is available at: https://www.nsf.gov/funding/initiatives/epscor/epscor-criteria-eligibility

**Eligible Applicants:**

| | |
|---|---|
| Alabama | Nebraska |
| Alaska | Nevada |
| Arkansas | New Hampshire |
| Delaware | New Mexico |
| Guam | North Dakota |
| Hawaii | Oklahoma |
| Idaho | Puerto Rico |
| Iowa | Rhode Island |
| Kansas | South Carolina |
| Kentucky | South Dakota |
| Louisiana | U.S. Virgin Islands |
| Maine | Vermont |
| Mississippi | West Virginia |
| Montana | Wyoming |

While proposals can be accepted only from institutions for which the NASA EPSCoR Directors are serving currently, all institutions of higher education within the jurisdiction shall be given the opportunity to propose by making them aware of this NOFO. Only one proposal per jurisdiction shall be accepted, which must be submitted by the NASA EPSCoR Jurisdiction Director (or their designee). The list of NASA EPSCoR jurisdiction directors can be found here.

**Ineligibility of Proposals That Include Participation of China or Chinese-Owned Companies**

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

## Funding Opportunity Overview Program Goals and Objectives

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.

- Enhance research capability and foster partnerships among NASA, academia, and industry in EPSCoR jurisdictions.
- Develop research capacity in areas of strategic importance to NASA.
- Contribute to jurisdictional workforce and economic development for national aerospace competitiveness.
- Support research aligned with NASA Mission Directorates and Centers
- Foster partnerships between NASA research assets, academic institutions, and industry.
- Improve the capabilities of the NASA EPSCoR jurisdictions to gain support from sources outside the NASA EPSCoR programs.

## Cost Sharing

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 set forth in 2 CFR 200.306, Cost sharing or matching. In-kind contributions are allowable as part of the cost-share requirement.

Consistent with the Controller Alert 23-04 and Public Law 96-205, title VI, section 601, the cost share is waived for the "insular areas" of : 1) the U.S. Virgin Islands and 2) Guam.

NASA-funded and/or 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.

## Content and Form of Application Submission

Detailed instructions for the preparation and submission of proposals are available in the GCAM. Applicants shall submit their proposals using electronic proposal submission via NSPIRES only. Registration in NSPIRES is required for proposal submission. Proposals shall be written in 12-

point font with 1-inch margins. NASA requires the following information be provided in this funding opportunity's grant application package:

| Required Parts of a Proposal (In Order of Assembly) | Page Limit |
|---|---|
| **Proposal Cover Page (NSPIRES web forms) including:**<br>• **Proposal Summary – limit to 4,000 characters (including spaces)**<br>• **NSPIRES cover page budget**<br>• **Proposal team members**<br>• **Other required elements** | Constrained by NSPIRES |
| **Table of Contents** | As needed |
| **Scientific/Technical/Management (S/T/M) Plan** | 15 |
| **References and Citations** | As needed |
| **Biographical Sketches for covered individuals** | No limit |
| **Current and Pending (Other) Support for covered individuals** | No limit |
| **Statements of Commitment and Letters of Support** | As needed |
| **Proposal Budget (budget) – both the budget narrative and budget details** | As needed |
| **Facilities, Equipment, and Other Resources** | As needed |
| **Table of Personnel and Work Effort** | As needed |
| **Data Management Plan** | As prescribed below |

### **Data Management** Plan (DMP)

All proposals submitted under this NOFO are required to submit a Data Management Plan (DMP) in accordance with the *NASA Plan for Increasing Access to the Results of Scientific Research* located at http://www.nasa.gov/sites/default/files/files/NASA_Data_Plan.pdf.

All proposals submitted under this NOFO are required to submit a Data Management Plan (DMP) in accordance with the NASA Plan for Increasing Access to the Results of Scientific Research located at http://www.nasa.gov/sites/default/files/files/NASA_Data_Plan.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.
- A discussion of roles and responsibilities of team members in accomplishing the DMP.

Note: If funds are required for data management activities, these must be included in the budget and budget justification sections of the proposal

In keeping with the NASA Plan for Increasing Access to the Results of Scientific Research, new terms and conditions, consistent with the Rights in Data clause in the award, information about making manuscripts and data publicly accessible may be included in each award document. As a general rule, proposals are required to provide a DMP or the proposer shall provide an explanation as to why a DMP is not necessary given the nature of the work proposed.

The DMP is not required under the following circumstances:

- This is a development effort for flight technology that will not generate any data that the proposer/recipient can release, so a DMP is not necessary.
- The data that the proposer/recipient will generate will be subject to ITAR; or
- The proposer/recipient may explain why its project is not going to generate data.
- The proposal type that requires a DMP is described in the NASA Plan for Increasing Access to the Results of Scientific Research (see above link).

Note: NSPIRES has a mandatory field for the DMP. If the DMP is not required the Proposer shall submit a statement as to why the DMP does not apply to that particular proposal.

Proposers that include a plan to archive data should allocate suitable time for this task. In addition, researchers submitting NASA-funded articles in peer-reviewed journals or papers from conferences shall make their work accessible to the public through NASA's PubSpace at https://sti.nasa.gov/submit-to-pubspace/#.

See NASA's Scientific and Technical Information Program's DMP FAQ at: https://sti.nasa.gov/faq/ and the Science Mission Directorate's DMP FAQ at http://science.nasa.gov/researchers/sara/faqs/ for more information.

**Estimated Application Submission Deadline**
**June 2026**

| Application Materials | Required or Encouraged | Estimated Due Date |
|---|---|---|
| Letters of Support | Required.<br>Note: Letters of support are only required if there is a facility or resource essential to the implementation of the proposal, and a proposal team member does not have guaranteed access to such facility or resource. By submitting a statement of commitment, the team member confirms that any facilities or resources needed for the proposal are readily available for the proposal team members(s) who require its use. | **June 2026** |
| Full Application | Required | **June 2026** |

Complete proposals must be submitted via NSPIRES June 2026. The date/time of submission will be recorded electronically by NSPIRES. All applications must be received by the established deadline. NASA will not review applications that are received after the deadline or consider these late applications for funding.

**Direct Costs Limitations**

- NASA EPSCoR funding shall not be used to purchase general purpose equipment, e.g. desktop workstations, office furnishings, reproduction, and printing equipment as a direct charge. However, 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 shall be reflected as a direct charge as per cost principles cited in the GCAM.

- 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 $4,500 per trip for up to two separate years of a jurisdiction's proposal (i.e., the maximum amount the jurisdiction can request for foreign travel is $4,500 total in any one year and a limit of $9,000 total for each research proposal). NASA EPSCoR support shall be acknowledged by the NASA EPSCoR research project number in written reports and publications.

## Application Evaluation Criteria

Proposals will be evaluated based on the following criteria:

- Relevance to NASA (35%)
- Intrinsic Merit (35%)
- Budget/Cost (15%)
- Management and Evaluation (15%)

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 generating sustained non-EPSCoR support.

**Research Focus Areas**

As stated in the NOFO, 35% of the evaluation consists of NASA alignment and partnerships; relevance to NASA priorities and collaboration plans. Research Focus Areas are provided to communicate areas of focus and priority at NASA. However, proposing directly towards a specific research focus area is not required. Proposers may submit proposals towards any topic is aligned with NASA's priorities. All proposals are required to demonstrate relevance, alignment, and impact towards NASA priorities regardless of topics

## Review and Selection Process

Proposals will be evaluated through a panel review. Each proposal that reaches the panel review phase will be evaluated by panelists who are personnel from NASA or other Federal Government agencies.

In evaluating proposals, NASA will assign one of the following overall ratings:

- **Excellent –** A comprehensive and thorough proposal of exceptional merit with one or more significant strengths. No deficiency or significant weakness exists.
- **Very Good** – A proposal having no deficiency, and which demonstrates overall competence. One or more significant strengths have been found, and strengths outbalance any weaknesses that exist.
- **Good** – A proposal having no deficiency, and which shows a reasonably sound response. There may be strengths or weaknesses, or both. Overall, weaknesses not offset by strengths do not significantly detract from the Proposer's response.
- **Fair** – A proposal with no deficiency, and which has one or more weaknesses. Weaknesses outbalance strengths.
- **Poor** – A proposal that has one or more deficiencies or significant weaknesses that demonstrate a lack of overall competence or would require a major proposal revision to correct.

### Notice of Award

NASA will notify successful grant recipients of funding via a Notice of Award (NASA Form 1687) signed by the Grant Officer. This Notice of Award is the authorizing document and will be sent to the proposer's Authorized Organization Representative (AOR) via electronic delivery. All expenses before the period of performance start date listed on the Notice of Award are at the risk of the applicant until the Notice of Award is received and period of performance begins.

### Unsuccessful Proposals

Upon selection of award recipients, the PI of an unsuccessful proposal will receive a non-selection letter with an explanation of the review process and reviewers' comments about the proposal via NSPIRES.

## Reporting

NASA grant and cooperative agreement recipients are required to follow reporting requirements outlined in Appendix C of the GCAM.

Recipients of NASA funding must submit financial reports. Financial reports must be submitted via the Payment Management System (PMS) as follows:

- Semi-annual Federal Financial Reports (FFR) due no later than 30 days past the reporting period end date.
- Final Financial Status Reports/Final Federal Financial Report (FSR/FFR) are due no later than 120 days after the end of the period of performance.

## Performance Reporting

Recipients of NASA funding are required to submit Performance Reports summarizing accomplishments and challenges for the reporting period. Reports shall follow the Research Performance Progress Report (RPPR) format and requirements as outlined in the GCAM, Section 29.1.

Annual Performance Reports are due no later than 60 days prior to the anniversary of the award's period of performance (POP) start date, except in the award's final year. Awards in their final year are required to submit a Final Report in lieu of an Annual Performance Report, due no later than 120 days after the end of the POP.

Awards that are in a no-cost extension (NCE) or anticipate a no-cost extension beyond the original POP remain subject to the Annual Performance Report requirement. The Final Report shall be submitted following the end of the no-cost extension, consistent with the due dates described below.

- **Annual Performance Report**
  Due each year no later than 60 days prior to the anniversary of the award POP start date, except in the award's final year.
  Submission: Email to NSSC-Grant-Report@mail.nasa.gov, with a copy to agency-epscor@mail.nasa.gov

- **Final Performance Report**
  Due no later than 120 days after the end of the POP.
  Submission: Email to NSSC-CloseOut@mail.nasa.gov, with a copy to agency-epscor@mail.nasa.gov

### Annual Closeout Performance Report (CPR)

Annually submit the CPR performance data into the NASA STEM Gateway system (STEM Gateway) by November 30th of each calendar year. The awardee shall adhere to the STEM Gateway reporting guidelines provided by the OSTEM Performance and Evaluation (P&E) team. STEM Gateway report training will be provided by STEM Gateway Trainer & OSTEM P&E Team.

### Office of STEM Engagement Performance Metrics

NASA currently utilizes the NASA STEM Gateway registration/application and data management system (Gateway system) for analyzing annual performance data. PIs are required to timely and properly respond to data calls as requested by NASA OSTEM and utilize the Gateway system for performance data reporting. Additional communications and guidance regarding data calls and the Gateway system will be sent to award recipients from the NASA OSTEM and Activity Manager. The PI shall ensure that it has the appropriate staff and resources to facilitate data collection activities and properly complete tasks required for timely reporting to NASA.

# EPSCoR Research Focus Areas (RFA)s

## Exploration Systems Development Mission Directorate (ESDMD)

### Autonomous Systems and Robotics

*Matt Simon, matthew.a.simon@nasa.gov*

Employ software and hardware to assist the crew and operate systems during crewed and uncrewed periods. Enable robotics to conduct exploration operations including utilization activities and inspecting, maintaining, and repairing architectural elements.

### Communications, Positioning, Navigation, and Timing Systems

*Matt Simon, matthew.a.simon@nasa.gov*

In deep space and on planetary surfaces, enable reliable and high-bandwidth transmission and reception of data, precise positioning and navigation of crewed and uncrewed systems, and precise timing systems.

### Data Systems and Management

*Matt Simon, matthew.a.simon@nasa.gov*

Transfer, distribute, receive, validate, secure, decode, format, compile, and process data and commands.

### Habitation Systems

*Matt Simon, matthew.a.simon@nasa.gov*

Ensure the health and performance of astronauts in controlled environments. Interests include advances in:

- environmental monitoring
- water storage and reclamation system
- dormancy recovery
- dust mitigation
- fire safety
- lightweight habitation structures and materials

### Human Systems

*Matt Simon, matthew.a.simon@nasa.gov*

Enable human missions; this includes:

- crew
- ground personnel
- supporting systems such as extra-vehicular activity, long-duration food systems, medical capabilities, lightweight and effective exercise equipment, and radiation monitoring and mitigation.
- This also includes countermeasures for physiological, sensorimotor, and behavioral challenges of extended habitation in space.

## Infrastructure Support

*Matt Simon, matthew.a.simon@nasa.gov*

Includes facilities, systems, operations planning and control, equipment, and services needed on Earth, in space, and on planetary surfaces. This includes but is not limited to items like in-situ manufacturing, waste management, and planetary protection.

## Logistics Systems

*Matt Simon, matthew.a.simon@nasa.gov*

Logistics Systems for items, samples, and cargo include:

- Package
- Handle
- Transport
- Stage
- Condition
- Store
- Track
- Transfer

## Mobility Systems

*Matt Simon, matthew.a.simon@nasa.gov*

Move crew and cargo around the lunar and Martian surfaces, including in extreme cold environment

## Power and Thermal Systems

*Matt Simon, matthew.a.simon@nasa.gov*

Power and Thermal Systems for electricity for architectural elements include:

- Generate
- Store
- Condition
- Distribute

Support system operation and survival in exploration environments such as deep space and the lunar and Martian surfaces.

### Transportation Systems

*Matt Simon, matthew.a.simon@nasa.gov*

Convey crew and cargo to and from Earth to the Moon and Mars. This includes in-space propulsion; entry, descent, landing, and ascent systems; and cryogenic and storable propellant management and transfers.

### Utilization Systems

*Matt Simon, matthew.a.simon@nasa.gov*

Enable science and technology demonstrations

# Space Operations Mission Directorate (SOMD)

## Human Research Program (HRP)

### Human Research Program/Human Health Countermeasures Element Research Topic

*Stuart Lee, stuart.lee-1@nasa.gov*

Management and execution of a head-down tilt bed rest study, with specific emphasis on proposing measures of physical fitness and functional performance test protocols to characterize the effects of deconditioning and exercise interventions on operationally relevant tasks.

Subjects will participate in a set of tests defined as the HRP Bedrest Standard Measures, but respondents to this solicitation are invited to propose new or novel physical fitness tests, assays, or other biomarkers of cardio-respiratory and musculoskeletal performance that would inform the efficacy of the countermeasures and the individual readiness of an astronaut to perform mission critical tasks (e.g., https://pubmed.ncbi.nlm.nih.gov/31069517/ ).

Proposers will develop the necessary arrangements to implement bed rest studies in a facility that will:

- Recruit subjects and schedule bed rest campaigns,
- Monitor the health and safety of the bed rest subjects (including the provision of appropriate medical monitoring by physicians or other qualified personnel),
- Monitor compliance to the strict head-down tilt protocols,
- Coordinate admission and testing schedules,
- Coordinate implementation of the study plan
- Provide storage space for samples from HRP Standard Measures

Reduced exercise capacity (i.e., muscular strength and endurance, maximal aerobic capacity) has been documented after spaceflight and spaceflight analogs, and it is presumed that deconditioning decreases the ability of astronauts to perform mission-specific tasks. Currently there is minimal evidence regarding the physical fitness or performance levels required to achieve exploration mission objectives. Thus, the second goal of this project is to assess the relationship between measures of physical fitness and relevant biomarkers and metrics of performance of mission-relevant tasks.

**Areas of Research Interest:**

There is a long history of studying the effects of deconditioning during spaceflight analogs, such as bed rest and dry immersion, during which many different countermeasures have been tested. Given the limitations on exercise capabilities expected for the Artemis missions and missions to Mars imposed by the architecture of the space vehicle and mission objectives (i.e., limited volume, mass, power), it is unlikely that astronauts will have a full suite of ISS-like hardware. more compact and/or multi-functional countermeasure hardware will be required. Development and validation of a compact and/or multi-functional countermeasure exercise system (i.e., modality or modalities) is paramount to the success of future exploration missions.

Research proposals are sought to implement a strict 6° head-down tilt bed rest study with conditions emulating NASA standard conditions (e.g., https://pubmed.ncbi.nlm.nih.gov/31876939/ ) with duration of test at the discretion of the proposer within allowable budget. Bed rest is a well-accepted analog of spaceflight (https://pubmed.ncbi.nlm.nih.gov/26893033/ ), and many control (no exercise) and countermeasure subjects have been studied but there have been few opportunities to relate measures and indices of physical fitness to critical mission tasks (https://pubmed.ncbi.nlm.nih.gov/29620686/ , https://pubmed.ncbi.nlm.nih.gov/23011123/ ).

Two groups of subjects will be investigated. One group should participate in the bed rest with no countermeasures (control). The second group would participate in bed rest in the same conditions but would perform nominal exercise countermeasures (aerobic and resistive) using a small light weight exercise device provided by NASA with the prescription defined by NASA subject matter experts. Subjects would participate in pre- and post-bed rest tests of physical fitness and mission-critical task performance using protocols provided by NASA. The number of subjects participating in each group should be based upon power analysis key measures of fitness (peak oxygen consumption measured during a graded cycle ergometry test and isometric mid-thigh pull).

There is paucity of published data in female astronauts and spaceflight analog subjects though one of the central goals stated for the Artemis missions is for the first woman to stand on the lunar surface. Therefore, this study should include both female and male subjects.

## Investigation Of Space Radiation Induced Parkinson's Disease and Other Late Neuro Degenerative Diseases

*Ryan Norman, ryan.b.norman@nasa.gov*

Either radiobiological experiments using neural organoid models, animal models, or analyses using previously exposed tissues (https://www.nasa.gov/osdr-about-nbisc/ ) to identify potential mechanisms and provide information for space radiation quality factors for use in risks models. For translational relevance organoids cellular compositions should represent the areas in the brain that exhibit decrements such as the striatum, substantia nigra etc. in the case of PD. Recent results from epidemiological studies of terrestrial workers exposed to radiation have shown an increased risk of Parkinson's' disease (PD) (Dauer, 2023) and work is currently ongoing to investigate other late CNS disease. While these results suggest the possibility that space radiation may also increase this risk, knowledge of an underlying mechanism as well as information needed to scale risks from terrestrial exposure to those in spaceflight are currently lacking.

Dauer LT, et al. Moon, Mars and Minds: Evaluating Parkinson's disease mortality among U.S. radiation workers and veterans in the million-person study of low-dose effects. Z Med Phys. 2024 Feb;34(1):100-110. doi: 10.1016/j.zemedi.2023.07.002. Epub 2023 Aug 1. PMID: 37537100; PMCID: PMC10919963."

## Novel High-throughput and/or High-content Screening Techniques to Identify Radiation Countermeasures

*Janice Zawaski, janice.zawaski@nasa.gov*

*Janapriya Saha, janapriya.saha@nasa.gov*

Establish innovative screening techniques, high-throughput and/or high-content screening protocols, of compound-based countermeasures (CMs) to assess their efficacy in modulating biological responses to radiation exposure relevant to the high priority health risks of cancer, cardiovascular disease, and/or central nervous system decrements. Techniques that can be used for screening cancer preventative CMs, induced by space-like radiation (high-LET) effects, are of high priority.

- This research topic does not include the discovery of novel CMs.

- Screening technique should test already approved FDA drugs.
- Radiation type and doses should be relevant to space exploration missions.
- Radiogenic cancers with poor prognosis such as lung, stomach, ovarian, liver, etc. are of highest priority

### Space Radiation Element

*Janice Zawaski, janice.zawaski@nasa.gov*

Space radiation exposure is one of numerous hazards astronauts encounter during spaceflight that impact human health. High priority health outcomes associated with space radiation exposure are carcinogenesis, cardiovascular disease (CVD), and central nervous system (CNS) changes that impact astronaut health and performance. For additional information concerning areas of interest please visit: https://humanresearchroadmap.nasa.gov/Risks/risk.aspx?i=96 )

### Use Of Human-Based Tissue Engineered Models for Characterization of Space Stressors and/or Hazard Effects

*Janapriya Saha, janapriya.saha@nasa.gov*

Complex in vitro models that mimic component of human physiology continue to evolve and show promise for various research. These tissue-engineered models, such as tissue chips, could be ideal in better understanding space flight stressors and hazards such as chronic effects of low-dose radiation exposure to the human, microgravity, etc. Research proposals are sought to establish translational value of human-based tissue models for characterization of space flight hazards and/or stressor, and countermeasure studies. Such research should include models relevant to cancer, cardiovascular health, and central nervous and immune systems. (For additional information concerning areas of interest please visit https://humanresearchroadmap.nasa.gov/Risks/ ) Selected stressor and or hazard levels should be relevant to space exploration missions.

# Space Operations Mission Directorate (SOMD)

## Commercial Space Capabilities (CSC)

### Space Operations Mission Directorate (SOMD) Commercial Space Capabilities (CSC) Topics

*Marc Timm, marc.g.timm@nasa.gov*

*Warren Ruemmele, warren.p.ruemmele@nasa.gov*

- Crewed environmental control and life support (ECLS), hygiene, waste, and housekeeping systems. Emphases include: low consumable resupply, low maintenance/high reliability, closing air and water loop, repurposing waste.
- In-space inspection, maintenance and repair external to space stations. Emphasis on systems that do not require an crew EVA.
- Materials and Processes Improvements for Chemical Propulsion State of Art
- Materials and Processes Improvements for Electric Propulsion State of Art
- Improvements to Space Solar Power State of Art (SoA)
- Small cargo return, LEO space station resupply systems, and related technologies
- Other topics in this area that have demonstrable need and support from a U.S. company(ies)

# Space Technology Mission Directorate (STMD)

## Advanced Manufacturing

*Group Contact, agency-epscor@mail.nasa.gov*

## Autonomous Systems

*Danette Allen, bonnie.d.allen@nasa.gov*

## Avionics

*Group Contact, agency-epscor@mail.nasa.gov*

Avionics interests include:

- Nanotechnology-electronics and sensors, flexible electronics
- Electronics for Extreme Temperature Environments: devices, components, and subsystems
- Microwave, Optical, and Cognitive Communications Devices, Components, and Systems: expanded bandwidth and reductions in size and power consumption

## Communications & Navigation

*Bernie Edwards, bernard.l.edwards@nasa.gov*

*Jason Mitchell, jason.w.mitchell@nasa.gov*

Communications & Navigation interests include:

- Quantum Sensors, Communications, and Networks: devices and simulations
- Communication Architectures, Networks, and Systems: integration and simulation

## Entry, Descent and Landing (EDL)

*Mike Wright, michael.j.wright@nasa.gov*

Entry systems focuses on safely delivering spacecraft to Earth and other celestial bodies. This includes:

- TPS materials development and testing
- Entry system modeling
- Aeroshell technology
- Vehicle stability
- High-speed aerocapture
- Uncertainty quantification

## Environmental Control and Life Support System (ECLSS) Lead

*Group Contact, agency-epscor@mail.nasa.gov*

## Exploration Destination, Structures, and Materials

*Mark Hilburger, mark.w.hilburger@nasa.gov*

## In Situ Resource Utilization

*Julie Kleinhenz, julie.e.kleinhenz@nasa.gov*

## In Space Transportation

*John Dankanich, john.dankanich@nasa.gov*

## Power

*Jeremiah McNatt, jmcnatt@nasa.gov*

Power and Energy Storage Systems for Aviation and Space Applications:

- Substantial mass and efficiency improvements
- Operability in challenging environments.

As well as:

- Power System Architectures
- Networks, and Systems Management
- Integration Approaches: including microgrids and power conversion and management electronics.

Also includes development of Breakthrough Concepts in, including enabling manufacturing approaches and integration:

- Photovoltaics
- Electrochemistry
- Photocatalysis
- Photo/Thermal Energy Conversion

## Propulsion Systems

*Group Contact, agency-epscor@mail.nasa.gov*

Space-Based Electric Propulsion: advanced materials, components, and systems

- Launch Propulsion Systems, Solid & Liquid
- In Space Propulsion (Cryogenics, Green Propellants, Nuclear, Fuel Elements, Solar-Thermal, Solar Sails, Electric Sails, Electrodynamic Tethers)
- Propulsion Testbeds and Demonstrators (Pressure Systems)
- Combustion Physics
- Cryogenic Fluid Management
- Turbomachinery
- Rotordynamics
- Solid Propellant Chemistry
- 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
- Low Leakage Valves

## Rendezvous & Capture

*Bo Naasz, bo.j.naasz@nasa.gov*

## Robotics

*Josh Mehling , joshua.s.mehling@nasa.gov*

- Autonomy & Robotics: Enabling complex air and space missions, and complementing humans in space
- Intelligent and Autonomous Systems: smart sensors, extreme environment instruments

### Structures/Materials

*Mark Hilburger, mark.w.hilburger@nasa.gov*

### Surface Systems

*Angela Krenn, angela.g.krenn@nasa.gov*

### Thermal

*Thomas Leimkuehler, thomas.o.leimkuehler@nasa.gov*

# Aeronautics Research Mission Directorate (ARMD)

## Aeronautics - Advanced Materials, Manufacturing Technologies & Structural Systems

*Chris Wohl, c.j.wohl@nasa.gov*

Advanced Materials for Aeronautics Applications:

- Rapid, scalable additive manufacturing
- Materials for extreme environments
- Materials manufacturing and characterization in extreme environments
- Computational modeling of the manufacturing process influence on metallic microscale and bulk properties
- Characterization and evaluation of additive manufactured, multifunctional, and sustainable materials
- Computational modeling of polymer synthesis, processing, and additive manufacturing
- Multifunctional materials supporting electric aircraft
- Composite materials supporting green aviation
- Process monitoring during composites fabrication

## Aeronautics Electronics for Both Flight Platforms and Ground Test Facilities

*Group Contact, agency-epscor@mail.nasa.gov*

## Aeronautics - Intelligent Flight Systems & Trusted Autonomy

*Group Contact, agency-epscor@mail.nasa.gov*

Aeronautics research in areas of advanced air mobility, increasingly automated and autonomous systems, robotics, and “smart cities” to enable current and future NASA missions and maintain U.S. aerospace preeminence. Development and validation of new architectures, technologies, and operations for increasingly complex and increasingly autonomous aerospace systems is accomplished by:

- Enabling robust control, vehicle performance, and mission management under nominal conditions, and contingency management under off-nominal conditions.
- Ensuring robust and flexible human-machine integration and teaming.
- Advancing technologies for vehicle and system-autonomy, robotics, and flight vehicle environment awareness.
- Developing new methods and tools for the verification, validation, and safety assurance of complex and autonomous systems.
- Developing, maintaining, and utilizing advanced experimental ground and flight test facilities and labs that enable intelligent flight systems and trusted autonomy.

## Aeronautics Material Science, Power, and Propulsion

*Maxwell Briggs, maxwell.h.briggs@nasa.gov*

Focus on Aeronautics in the following areas:

- Power and Energy Storage Systems for Aviation and Space Applications: sustainable, reduced- and zero-carbon emission approaches, substantial mass and efficiency improvements, and operability in challenging environments
- Power System Architectures, Networks, and Systems Management and Integration Approaches: including microgrids and power conversion and management electronics
- Breakthrough Concepts in Photovoltaics, Electrochemistry, Photocatalysis, Photo/Thermal Energy Conversion: including enabling manufacturing approaches and integration
- Electronics for Extreme Temperature Environments: devices, components, and subsystems
- Microwave, Optical, and Cognitive Communications Devices, Components, and Systems: expanded bandwidth and reductions in size and power consumption
- Quantum Sensors, Communications, and Networks: devices and simulations
- Communication Architectures, Networks, and Systems: integration and simulation
- Intelligent and Autonomous Systems: smart sensors, extreme environment instruments
- Advanced Concepts in Systems Engineering for Aeronautical and Space Systems: physics-based models, machine learning, and artificial intelligence applications
- Electrified Aircraft: architectures, components, systems, and system-level simulations
- Thermal Management Systems: propulsion and/or power systems for aviation and space
- Acoustic Emission Mitigation: aviation and space propulsion applications
- Aircraft Icing: prevention, mitigation, and simulation

- Aviation Safety: simulation, system concepts, architectures
- Advanced Computational Fluid Dynamics and Systems Engineering related to aviation propulsion systems including internal and external aerodynamics, aero-thermochemistry
- Multi-Functional Materials: concepts, components, and simulations engaging mechanical, structural, electrical, thermal, energy, communications, or propulsion features, especially including applications enabled by advanced manufacturing processes
- Shape Memory Alloy Utilization: actuation, harsh environments, high-strain applications
- Advanced Metallic Alloy, Ceramic, Macromolecular, and Composite Materials and Coatings: for extreme environments, especially where enabled by advanced manufacturing processes
- Nanotechnology Applications: enhanced mechanical, thermal, electrical, chemical, electrochemical, or catalytic properties
- Fundamentals of Fluid Physics, Combustion Phenomena, Complex Fluids, and Bioengineering in reduced- or near-zero gravitational environments

## Aerosciences Evaluation and Test Capabilities & Intelligent Systems

*Harry Partridge, harry.partridge@nasa.gov*

Focus on Aeronautics and Aerosciences in the following areas:

- Aero sciences: Wind Tunnels: Testing on the ground before you take to the sky
- Air Traffic Management:
    - NextGen air transportation: Transforming the way we fly
    - Airborne science: Examining our own world & beyond from the sky
    - Airspace Systems, Unmanned aerial Systems
- Intelligent/Adaptive Systems: Complementing humans in space
    - Autonomy & Robotics: Enabling complex air and space missions, and complementing humans in space
    - Human Systems Integration: Advancing human-technology interaction for NASA missions
    - Nanotechnology-electronics and sensors, flexible electronics

## Aircraft Electrical Powertrain Modeling

*Peter Suh, peter.m.suh@nasa.gov*

## Air Vehicle Design with Flow Control

*Luther Jenkins, luther.n.jenkins@nasa.gov*

Active flow control (AFC) is the open- or closed-loop strategic addition of energy to the flow around a vehicle to affect vehicle level improvements in aerodynamics, aeroacoustic noise, and aircraft control & handling qualities. The technology has seen only limited implementations, such as niche aircraft Shin Maywa US-2 and F-4H Phantom. The emergence of new modes of aviation, such as advanced air mobility (AAM), and a global push toward sustainability, create an opportunity for AFC to be an enabling technology for revolutionary new aircraft designs for achieving NASA's sustainable aviation goals. Research is needed to develop methods to perform multidisciplinary optimization and trade studies on aircraft that incorporate AFC technologies.

## Autonomy (Collision Avoidance, Perception, and Runtime Assurance)

*Nelson Brown, nelson.brown@nasa.gov*

## Boundary-layer Transition Delay

*Luther Jenkins, luther.n.jenkins@nasa.gov*

Delaying the transition of a boundary layer plays a crucial role in improving aerodynamic performance, enhancing fuel efficiency, and reducing drag in aerospace and other fluid-dynamics-based systems. This research focus area includes development of novel strategies to maintain laminar flow over aircraft surfaces for extended periods, as well as development of actuators and considerations for integration into real-world aircraft. Laminar flow is one of the enabling technologies for NASA's sustainable aviation goals.

## Broadband Noise Prediction of Advanced Air Mobility Aircraft

*Chris Bahr, christopher.j.bahr@nasa.gov*

*Mike Doty, michael.j.doty@nasa.gov*

The emerging Advanced Air Mobility (AAM) ecosystem will require vehicle acoustic signatures that are not detrimental to nearby communities and population centers. Furthermore, the size and operating conditions of AAM propulsion systems can lead to an increased importance of broadband noise in the overall noise signature. Traditional rotorcraft noise signatures, on the other hand, tend to be dominated by tonal noise. Improved physical understanding and prediction capability for broadband noise of AAM vehicles aligns with NASA ARMD's Strategic Thrust 4 of Safe, Quiet, and Affordable Vertical Lift Air Vehicles, and there is synergy with the Revolutionary Vertical Lift Technology Project.

## Control of Flexible Structures, Modeling, System Identification, Advanced Sensors

*Matt Boucher , matthew.j.boucher@nasa.gov*

## Efficient Synthetic Turbulence Generation Methods

*Luther Jenkins, luther.n.jenkins@nasa.gov*

## Flow Visualization Methods for High-Speed Ground Test Facilities

*Brett Bathel, brett.f.bathel@nasa.gov*

## Gas Lattice Methods for Continuum (High Density) Flows

*Andrew Norris, andrew.t.norris@nasa.gov*

## High Lift Design Method for Conceptual Level Aircraft

*Chris Bahr, christopher.j.bahr@nasa.gov*

*Mike Doty, michael.j.doty@nasa.gov*

NASA continues to develop a toolset for the analysis of conceptual level aircraft from conventional types to future, advanced ultra-efficient aircraft. It is a priority need for a method that could design the high lift system to meet the landing and takeoff performance for a NASA developed aircraft model. The method should also be able to design the detailed parameters used as inputs to the NASA airframe noise prediction methods for leading edge and trailing edge high lift devices that are typically needed for commercial subsonic transport aircraft (e.g. deflection angles, chord, gap dimensions, etc.). A successful method would be required to be integrated into NASA's Model-Based Systems Analysis (MBSA) process.

## High-Order Unstructured Schemes for High-Speed Flows and Aerothermodynamics

*Ali Reza Mazaheri, ali.r.mazaheri@nasa.gov*

A critical aspect for determining the environment of high-speed vehicles with complex configurations is an accurate prediction of solution gradients, such as shear stresses, heat fluxes, pressure gradients, and density gradients. These quantities are required in reducing uncertainties in predicting turbulent flows, separation and reattachment points, and surface heat fluxes of spacecraft and hypersonic vehicles, to name a few. Furthermore, analysis of boundary layer instabilities also requires a nearly pristine set of solution gradients. The vehicles' geometrical complexities such as wings, protuberances, cavities, thermal protection systems, compression pads, reaction control surfaces, as well as complexities in the flowfield such as shocks, shock-boundary layer interactions, shock-shock interactions, separations, and vortices are the main reasons for using purely simplex (triangle and tetrahedral) elements. The high-order Discontinuous Galerkin (DG) method is one of the attractive high-order schemes that are mathematically sound and combines the benefits of both finite-volume and finite-elements schemes. In addition, DG schemes are suitable for h/p adaption and can be numerically very efficient and scalable due to its compact stencil.

## High Spatial and Temporal Resolution Velocimetry Measurements, Both Seeded and Seedless

*Paul Danehy, paul.m.danehy@nasa.gov*

## Hybrid Electric Propulsion

*Sean Clarke, sean.clarke@nasa.gov*

## HYBRID Turbulent Simulation Methods and Models to Simulate Highly Separated Turbulent Flows

*Luther Jenkins, luther.n.jenkins@nasa.gov*

## Hypersonic Structures & Sensors

*Larry Hudson, larry.d.hudson@nasa.gov*

## Machine Learning and Artificial Intelligence for Advancing CFD

*Mujeeb Malik, m.r.malik@nasa.gov*

Advanced computational fluid dynamics (CFD) tools enable superior design of aerospace vehicles at reduced cost and risk and open new frontiers in design and performance of such vehicles, which serve a wide range of NASA missions. To enable novel designs, without significant ground or flight testing, the computational tools must provide accurate predictions of physical phenomena near the edges of the flight envelopes. NASA's CFD Vision 2030 Study[1] emphasized the need for development of advanced computational tools that are robust, efficient (cost effective) and accurate.

Toward that end, the vision study developed a research roadmap that included recommended developments along multiple swim lanes such as:

- High-performance computing (HPC)
- Physical modeling
- Numerical algorithms and high order methods
- Geometry modeling and mesh generation/adaptation
- Knowledge extraction.

Machine learning (ML) and artificial intelligence (AI) techniques can play an important role in making progress along these swim lanes resulting in computational capabilities that would help accomplish the 2030 vision goals. Use of ML and AI techniques that would help make revolutionary progress along one or more of the technology development areas highlighted in the vision study.

These advanced computational tools are needed not only by various ARMD projects and programs (e.g., AAVP, TACP) but also other NASA missions requiring planetary entry.

1. https://ntrs.nasa.gov/api/citations/20140003093/downloads/20140003093.pdf

## Machine Learning for Turbulent or Transitional Flow Modeling

*David Lockard, d.p.lockard@nasa.gov*

## Modular GPU-Based Chemically Reacting Solver with Stiff Integrator

*Andrew Norris, andrew.t.norris@nasa.gov*

## Multi-Physics High-Fidelity Approaches for Advanced or Emerging Computer Architectures

*David Lockard, d.p.lockard@nasa.gov*

## Novel Material Concepts to Extend the Frequency Range of Acoustic Liners

*Chris Bahr, christopher.j.bahr@nasa.gov*

## Novel Noise Reduction Concepts for Urban Air Mobility (UAM) Propulsors

*Chris Bahr, christopher.j.bahr@nasa.gov*

## Supersonic Research (Boom Mitigation and Measurement)

*Ed Haering, edward.a.haering@nasa.gov*

## Systems Modeling for Next Generation Aircraft

*Ben Phillips, benjamin.d.phillips@nasa.gov*

To realize the full potential of Aviary, subsystem and component level models for new technologies are necessary to build. The focus of this research is to generate optimization ready Aviary aircraft subsystem models to enable conceptual aircraft design for vehicles entry into service in the 2050 timeframe.

Efforts within the Transformational Tools and Technologies Project and the Advanced Air Transport Technology Project have focused on creating the next generation conceptual aircraft design tool, Aviary. Aviary combines capabilities of legacy codes with modern code architecture, is tightly integrated with state-of-the-art optimization tools (OpenMDAO) and enables the design space exploration and optimization of novel aircraft concepts.

Unconventional aircraft and new technologies will likely need to be developed over the next decade to maintain US dominance in the aircraft market, while enabling aircraft to exploit the least expensive energy sources. Although the current aircraft market is primarily based on aviation fuel, the uncertainty of future demand and supply may change the optimal selection of energy source to yield the lowest cost per seat-mile for passenger planes, and volumetric weight per mile for cargo planes. There are a significant number of challenges associated with new aircraft types and yet-to-be-developed technologies. A primary challenge is the modeling of alternative and hybrid energy sources within the context of an aircraft design framework. It is difficult to analyze these new concepts at a conceptual design level, as legacy tools lack the ability to model new technologies or account for the interactions between subsystems without resorting to high-fidelity analysis or performing a significant number of manual iterations.

## Uncertainty Quantification for High-Fidelity Multidisciplinary (e.g., Aeroelastic, Aeroacoustic) Analysis for Aircraft Flight

*David Lockard, d.p.lockard@nasa.gov*

## Uncertainty Quantification for Stochastic Probability Density Function (PDF) Methods

*Andrew Norris, andrew.t.norris@nasa.gov*

## Urban Air Mobility (UAM) Envelope Protection

*Shaun McWherter, shaun.c.mcwherter@nasa.gov*

## Urban Air Mobility (UAM) Vehicle Handling and Ride Qualities

*Curt Hanson, curtis.e.hanson@nasa.gov*

## Wall Models for Non-Equilibrium and Separated Flows in Wall-Modeled Large-Eddy Simulations (WMLES)

*Luther Jenkins, luther.n.jenkins@nasa.gov*

Eddy-resolving methods such as direct numerical simulations (DNS), wall-resolved Large-Eddy Simulations (WRLES), and wall-modeled Large-Eddy Simulations (WMLES) are becoming increasingly adopted due to their accuracy in predicting wall-bounded turbulent flows, especially flows with separations. DNS and WRLES methods are computationally too expensive for flows over complex geometries and at high Reynolds numbers, due to the large grid resolution required near the wall. WMLES remedies this problem by modeling the inner layer of the boundary layer and resolving only the outer part of the boundary layer. Currently, one-dimensional equilibrium models are employed to model the inner layer in the WMLES. This model becomes less accurate in non-equilibrium boundary layer flows with adverse pressure gradients and flow separations. Improved wall models are needed in these flows. This project solicits proposals to develop new wall models in non-equilibrium flows to improve the accuracy of the WMLES. This work supports efforts by the Transformation Tools and Technologies Project to develop simulation capabilities for developing, analyzing, and certifying air vehicles. Such capabilities are critical to assess and evaluate technologies and configurations required to achieve NASA's aircraft efficiency and sustainability goals.

### Weather Sensors for Advanced Air Mobility (AAM) Applications

*Group Contact, agency-epscor@mail.nasa.gov*

# Science Mission Directorate (SMD)

# Astrophysics

## Astrophysics

*Hashima Hasan, hhasan@nasa.gov*

**Research Focus Areas:**

- 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
- Discover and study planets around other stars, and explore whether they could harbor life

**Description:**

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
- Discover and study planets around other stars, and explore whether they could harbor life

To address these Astrophysics goals, the Astrophysics Research Analysis and Technology Program invites a wide range of astrophysics science investigations from space that can be broadly placed in the following categories.

- The development of new technology components covering all wavelengths and fundamental particles, that can be applied to future space flight missions. This includes, but is not limited to, detector development, and optical components such as primary or secondary mirrors, coatings, gratings, filters, cryogenics systems, and spectrographs. Specifically, the Astrophysics Division prioritizes technology needs and gaps for future strategic missions, based on inputs from the community and subject matter experts. This information, including the technology gaps, are updated every two years, and the most recent relevant document is the Astrophysics Biennial Technology Report 2024 (ABTR-2024) (available at: https://apd440.gsfc.nasa.gov/images/tech/2024_ABTR.pdf )
- New technologies and techniques that may be tested by flying them on suborbital platforms such as rockets and balloons that are developed and launched by commercial suborbital flight providers or from NASA's launch range facilities, or by flying them on small and innovative orbital platforms such as CubeSats.
- Studies in laboratory astrophysics that enable analysis of astrophysical data from NASA telescopes. Examples of these studies could include atomic and molecular data and properties of plasmas explored under conditions approximating those of astrophysical environments.
- Theoretical studies and simulations that advance the goals of the astrophysics program
- Analysis of data that could lead to original discoveries from space astrophysics missions. This could include the compilations of catalogs, statistical studies, algorithms and pattern recognition, artificial intelligence applications, development of data pipelines, etc.

The goals of the Science Mission Directorate's (SMD) Astrophysics Research Program, defined in SMD's Science 2020-2024: A Vision for Scientific Excellence (available at https://soma.larc.nasa.gov/lws/pdf_files/2020-2024_Science-TAGGED.pdf ). This NASA Science Plan, and the report of National Academy of Sciences Decadal Survey on Astronomy and Astrophysics 2020, Pathways to Discovery in Astronomy and Astrophysics for the 2020s,(available at https://www.nap.edu/catalog/26141/pathways- to-discovery-in-astronomy-and-astrophysics for-the-2020s ).

These investigations can include theory, simulation, data analysis, and technology development. Information on the relevant Astrophysics research program and missions are available at https://science.nasa.gov/astrophysics.

# Science Mission Directorate (SMD)

# Biological and Physical Sciences (BPS)

## Combustion Science

*Group Contact, agency-epscor@mail.nasa.gov*

**Research Focus Areas:**

- Spacecraft fire safety
- Droplets
- Gaseous – premixed and non-premixed
- High pressure – transcritical combustion and supercritical reacting fluids
- Solid fuels
- Carbon free fuels

**Description:**

Improve combustion processes, leading to added benefits to human health, comfort, and safety.

Flammability of solid fuels to advance fire safety research.

Develop carbon-free and carbon-neutral transportation fuels.

Effects that can be studied in the absence of buoyancy-driven flows caused by Earth's gravity. Research conducted without the interference of buoyant flows can lead to an improvement in combustion efficiency, producing a considerable economic and environmental impact. Combustion science is also relevant to a range of challenges for long-term human exploration of space that involve reacting systems in reduced and low gravity. These challenges include - spacecraft fire prevention; fire detection and suppression; thermal processing of regolith for oxygen and water production; thermal processing of the Martian atmosphere for fuel and oxidizer production; and processing of waste and other organic matter for stabilization and recovery of water, oxygen and carbon. Substantial progress in any of these areas will be accelerated significantly by an active reduced-gravity combustion research program.

Flammability of solid fuels to advance fire safety research: Specifically, testing is necessary to understand the fire performance of representative spacecraft and planetary habitat materials at all g-levels (Microgravity, Lunar, Martian, and Earth gravity). Study is needed of these materials at a research level - ignition, flame spread, size, heat output, radiation, $O_2$ level, g level, etc. In 1-g and drop tower. Also, to organize results by type of materials. Also, to use these gravity dependent data for the improvement of computational models. The goal is to use the experimental results and numerical simulations to support NASA material flammability testing, material controls, and habitat/vehicle designs which depend on g-level. Use of the NASA Glenn Research Center (GRC) drop is a useful method to achieve 5 seconds of microgravity and, with the use of the centrifuge drop rig, any partial gravity levels as well. The POCs for the GRC 5 second drop tower facility are David Urban, david.urban@nasa.gov and Nancy Hall, nancy.r.hall@nasa.gov

Develop carbon-free and carbon-neutral transportation fuels: Airlines have committed to reduce carbon emissions by 50% by 2050 (relative to 2005 levels). Doing this requires (1) moving to carbon-neutral feedstocks that are drop-in replacements for petroleum-based fuels (PBFs, i.e., biofuels that have a closed-carbon cycle) and (2) moving whenever possible to carbon-free fuels (e.g., ammonia) that have no carbon footprint. Given the capital cost of aircraft an airplane put into service today will still be in operation 20+ years from today. There are needs for drop-in replacements for PBFs that will enable current generation aircraft to remain in service for their entire service life. Low-gravity research proposals that will improve our understanding of the kinetics, flame structure, and product emission from carbon-free and carbon-neutral fuels will facilitate use of these fuels in the transportation sector.

## Fluid Physics

*Group Contact, agency-epscor@mail.nasa.gov*

**Research Focus Areas:**

- Adiabatic two-phase flow
- Boiling and condensation
- Capillary flow
- Interfacial phenomena
- Cryogenic propellant storage and transfer

**Description:**

The goal of the microgravity fluid physics program is to understand fluid behavior of physical systems in space, providing a foundation for predicting, controlling, and improving a vast range of technological processes.

Specifically, in reduced gravity, the absence of buoyancy and the stronger influence of capillary forces can have a dramatic effect on fluid behavior. For example, capillary flows in space can pump fluids to higher levels than those achieved on Earth. In the case of systems where phase-change heat transfer is required, experimental results demonstrate that bubbles will not rise under pool boiling conditions in microgravity, resulting in a change in the heat transfer rate at the heater surface. The microgravity experimental data can be used to verify computational fluid dynamics models. These improved models can then be utilized by future spacecraft designers to predict the performance of fluid conditions in space exploration systems such as air revitalization, solid waste management, water recovery, thermal control, cryogenic storage and transfer, energy conversion systems, and liquid propulsion systems. Some examples include: Nuclear fission Rankine power cycle for future space missions (Moon, Mars) and deep space missions, Vapor Compression heat pump for planetary bases (Moon, Mars), Thermal Control Systems and advanced Life Support Systems for spacecraft and Cryogenic systems, such as nuclear thermal propulsion, fuel depots, tank chill-down.

Development of innovative and transformative pressure control strategies that allows efficient, reliable and lossless storage and transfer of cryogenic propellants. Understanding the phase change and transport of volatile fluids in microgravity is essential to preserve propellants on orbit and allowing refueling operation is space to carry out and sustain long-duration human planetary exploration missions to Moon, Mars and beyond. The need for scientific understanding and discoveries of liquid/vapor phase change phenomena in the absence of gravity will remain valuable in providing the foundation for development of next generation of light weight thermal management and power generation systems. Novel technologies will be based on multi-physics phenomena, such as the electro-hydrodynamically driven cooling devices. Also, there is a need to develop a fundamental understanding of two-phase flow condensation heat transfer in reduced gravity. Areas of interest include the observation of the condensate film and relevant temperature measurements. Condensation research is relevant to spacecraft thermal control, humidity control, water recovery and certain power generation systems.

Improved passive thermal management of electronics, batteries, high capability sensors, power system heat rejection, etc. for future spacecraft and planetary habitat systems. Due to the potential to extract heat at significantly higher heat flux levels, oscillating heat pipes (OHP) offer the promise of significantly higher efficiencies compared to conventional heat pipes used on today's spacecraft. However, the underlying liquid-vapor fluid dynamics (distinct liquid plugs and vapor plugs), interfacial phenomena, and two-phase heat transfer in the pulsating flows of OHPs are not well understood. It is imperative that a physical model that can predict the performance of an OHP be developed. An instrumented, ground-based OHP experiment to provide insight into the mechanisms, fundamental processes and governing equations.

## Fundamental Physics

*Mike Robinson, michael.p.robinson@nasa.gov*

**Research Focus Areas:**

- Quantum coherence and entanglement
- Quantum interferometry and precision measurements
- Properties of quantum matter
- Quantum phenomena in many-body systems
- Particle Physics
- General Relativity

**Description:**

Research in quantum physics that will lead to transformational outcomes, such as the discovery of phenomena at the intersection of quantum mechanics and general relativity that inform a unified theory, the direct detection of dark matter via atom interferometry or atomic clocks, and the creation of exotic quantum matter than cannot exist on Earth.

Space offers a unique environment for experimental physics in many areas. Current areas of focus for NASA's Fundamental Physics program are cold atom physics, the application of cold atom technologies to research in quantum science and general relativity.

A primary objective of NASA's solicitations in Fundamental Physics is to engage the skills of the U.S. research community to establish and maintain a world-leading program in space-based quantum science. Quantum mechanics is one of the most successful theories in physics. It describes the very small, such as atoms and their formation into the complex molecules necessary for life, to structures as large as cosmic strings. The behavior of exotic matter such as superfluids and neutron stars is explained by quantum mechanics, as are everyday phenomena such as the transmission of electricity and heat by metals. The frontline of modern quantum science involves cross-cutting fundamental and applied research. For example, world-wide efforts concentrate on harnessing quantum coherence and entanglement for applications such as the enhanced sensing of electromagnetic fields, secure communications, and the exponential speed-up of quantum computing. This area is tightly coupled to research on the foundations of quantum mechanics, which involves exotica such as many-worlds theory and the interface between classical and quantum behavior. Another frontier encompasses understanding how novel quantum matter— such as high-temperature superconductivity and topological states— emerges from the interactions between many quantum particles. Quantum science is also central to the field of precision measurement, which seeks to expand our knowledge of the underlying principles and symmetries of the universe by testing ideas such as the equivalence between gravitational and inertial mass.

Quantum physics is a cornerstone of our understanding of the universe. The importance of quantum mechanics is extraordinarily wide ranging, from explaining emergent phenomena such as superconductivity, to underpinning next-generation technologies such as quantum computers, quantum communication networks, and sensor technologies. Laser-cooled cold atoms are a versatile platform for quantum physics on Earth, and one that can greatly benefit from space-based research. The virtual elimination of gravity in the reference frame of a free-flying space vehicle enables cold atom experiments to achieve longer observation times and colder temperatures than are possible on Earth.

## Soft Matter/Complex Fluids

*Group Contact, agency-epscor@mail.nasa.gov*

**Research Focus Areas:**

- Quantum coherence and entanglement
- Quantum interferometry and precision measurements
- Properties of quantum matter
- Quantum phenomena in many-body systems
- Particle Physics

- General Relativity

**Description:**

Investigate the fundamental principles that organize the structure and functionality of materials such as active and soft matter, and to study the fundamental laws that govern the behavior of systems that are far from equilibrium.

Soft Matter comprises a large class of deformable materials, including colloids, microemulsions, foams, liquid crystals, and granular material. Studying these systems focuses on gaining insight into many diverse fields such as phase transitions, nucleation and crystal growth, coarsening, glass formation, chaos, field theory, dusty plasmas and much more. Complex fluids are a subset of soft materials that can flow and exhibit non-Newtonian rheology. Research in soft matter and complex fluids can provide foundational knowledge for NASA's exploration of planetary surfaces such as, forces on particles, particle charging and agglomeration in complex plasmas or the complex rheology during the flow of a lunar regolith derived slurry to produce construction materials. Furthermore, terrestrial applications are relevant in industries such as pharmaceutical, chemical, plastics, soap and detergent, electronic display, and petroleum. Because of the relatively large size of the basic structures, gravitational forces dominate and cause sedimentation, buoyancy-driven convective flows, hydrostatic pressure gradients, jamming, drainage, etc. Weaker forces such as surface tension and entropic forces, completely masked on Earth, can become dominant in space. In addition, particles can remain suspended without gravitational forces. In weightlessness external fields such as thermal, magnetic, electric and acoustic can be used without the impediments of gravity to create and investigate tunable soft matter (e.g. colloidal) systems.

## Materials Science

*Group Contact, agency-epscor@mail.nasa.gov*

**Research Focus Areas:**

- Glasses and ceramics
- Granular materials
- Composite materials
- Metals
- Polymers and organics
- Semiconductors

**Description:**

Improve the understanding of materials properties that will enable the development of higher-performing materials and processes for use both in space and on Earth.

Demonstrate the feasibility of creating lunar construction "concrete" materials.

The unique features of the microgravity environment, where gravity-driven phenomena, such as sedimentation and thermosolutal convection, are nearly negligible. On Earth, natural convection leads to dendrite deformation and clustering, whereas in microgravity, in the absence of buoyant flow, the dendritic structure is nearly uniform. Major types of research that can be investigated include solidification effects and the resulting morphology, as well as accurate and precise measurement of thermophysical property data. This data can be used to develop computational models. The ability to predict microstructures accurately is a promising computational tool for advancing materials science and manufacturing.

Demonstrate the feasibility of creating lunar construction "concrete" materials: alkali-activation of regolith simulant. Specifically, to conduct 1-g ground studies to understand the solidification, microstructure and properties of the construction material using alternative binders (regolith simulant replacing cement) and alkaline solution (replacing water) to form a geopolymer. Also, to measure the mechanical properties of the solidified material. Future applications of lunar construction materials include launch pads, habitats, and other components of lunar infrastructure.

# Science Mission Directorate (SMD)

# Earth Science Division

## Earth Science Division

*Yaitza Luna-Cruz, yaitza.luna-cruz@nasa.gov*

*Laura Lorenzoni, laura.lorenzoni@nasa.gov*

**Requirements:**

For Earth Science, the proposals must include the following two requirements:

A. Propose innovative research that uses the following recently launched Earth Science missions (SWOT, TEMPO, PACE, and NISAR).
B. Include a collaboration with the Early Career Research First Immersion in Earth Science to Action (FIES2A).

***NOTE: Please see Earth System Science Scope Appendix at bottom of the document***

**Description:**

**Requirement A: Propose innovative research that uses the recently launched Earth Science missions listed below**

Proposers should leverage products and algorithms previously developed by science teams for the mission(s) previously listed to ensure proposed investigations are unique and build on the existing capabilities of the sensor(s). The proposed science should advance state-of-the-art approaches and should include a brief description of risk mitigation to the approach. Only minor (not to exceed 20% of the total budget) and well justified laboratory and/or field data collection to support specific science questions will be considered. It is recommended that proposers place emphasis on addressing science gaps rather than the development of new products, although developing new products is permissible so long as it is novel, while enabling the team to answer their stated science questions

It is strongly suggested that proposers review the mission home pages, listed below in alphabetical order.

- NASA-ISRO Synthetic Aperture Radar (NISAR): https://science.nasa.gov/mission/nisar/
- Plankton, Aerosol, Cloud, ocean Ecosystem (PACE): https://pace.gsfc.nasa.gov/
- Surface Water and Ocean Topography (SWOT): https://swot.jpl.nasa.gov/mission/overview/
- Tropospheric Emissions: Monitoring of Pollution (TEMPO): https://tempo.si.edu/

Proposals submitted in response to this program element will be expected to characterize uncertainties and quantify errors associated with data, analytical approaches, model results, and scientific interpretations, and must do so within the body of the proposal; a description in the Open Science and Data Management Plan should include how proposers will be reported with the data and products to be shared and archived.

Proposals that incorporate non-NASA data, including international satellite data, commercial satellite data, and social science data are also welcome but the main source must be NASA data from the missions mentioned above. Proposals may also utilize data acquired via NASA's Commercial SmallSat Data Acquisition (CSDA) Program (available at no cost to U.S. Government-funded researchers). Any data proposed to be analyzed from any source, including NASA and other satellite data, ancillary data, and data from commercial sources, must be publicly available, in the sense that these data are openly accessible. Proposals should reflect the principles of Open Science as described on the Earthdata website

Proposals planning to request High-End Computing (HEC) should follow the HEC Program guidance. The HEC program provides a specialized computational infrastructure to support NASA's research community. Any need for HEC resources must be justified by completing a request for resources for inclusion with the proposal. The PI completes and submits a request in the HEC Request Management System (RMS) at https://request.hec.nasa.gov/. The purpose of this step is to inform reviewers at NASA of your computational needs, and if the proposal is selected, establish eligibility to use HEC resources. The form includes a written justification of how the computational resources would support the investigation as well as a multi-year resource-phasing plan, in annual increments, identifying the computing time and data storage requirements covering the duration of the proposed award period. If your proposal is selected for funding, your HEC request will be evaluated by the SMD's HEC Allocation Authority. SMD allocates quarterly in October, January, April and July. Out-of-cycle allocation requests are handled on a case-by-case basis. The HEC program will then issue letters identifying yearly allocations of HEC resources for the duration of the project, which again may differ from your request due to limited availability of resources. However, PIs may submit requests to increase or decrease allocations of HEC resources if there are unexpected changes to computational needs.

**Requirement B: Collaboration with Earth Science Division (ESD) Early Career Research (ECR) First Immersion in Earth Science to Action (FIES2A)**

ESD is committed to enabling early engagement to cultivate a variety of Earth science communities and to support workforce development. The ESD Early Career Research Program (ECR) creates opportunities to advance the development and implementation of the Earth Science to Action Strategy. ECR is striving for excellence in Earth science by supporting outstanding and innovative scientific research, enabling greater participation through scientific leadership, fostering a sense of community through sustained relationships, and making Earth science data more usable and impactful for all. One of several ECR opportunities includes the First Immersion in Earth Science to Action (FIES2A). FIES2A provides an opportunity for young Earth science-interested students, including community college and early undergraduate students, to get immersed in a workforce development experience to conduct Earth science research. By providing this first immersion, ECR is exposing students to NASA Earth science information, data, and resources highlighting these as national assets and contributing to training the future workforce.

Proposers must host and allocate funds for 3 students over each summer to be part of a FIES2A Summer Cohort (each summer for the duration of the grant). Proposers must work in collaboration with ECR for planning and logistics. Proposals must include a summer project plan, which includes the feasibility of the proposed research, alignment with requirement A of this solicitation, an appropriate scope for undergraduate capabilities and mentorship responsibilities, and a timeline reasonability (10-week interns with additional time for mentor planning)

FIES2A/EPSCoR Requirements:

- Students research projects must be aligned with proposed research in requirement A.
- Institution must allocate a stipend of $8,200 per student per summer in the budget, a computer (if applicable), and physical space (lab or office).
- Institution should follow OSTEM intern eligibility and selection criteria.
- Institution should assign a mentor to guide and oversee the 3 students over the summer and be the liaison between the institution and ECR.
- ECR will assign a NASA FIES2A Mentor to provide additional scientific and technical support from the appropriate ESD mission/sphere.

- FIES2A Summer Cohort dates vary per year. Here is an estimated timeline for 2027 (Start June 7 and end August 6). Additional dates:
    - ECR FIES2A Team Meeting: ~Early December
    - Student selection by: ~Early May
    - Final FIES2A Cohort Presentations: August 6

# Science Mission Directorate (SMD)

## Heliophysics Division

### Heliophysics

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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.

In this framework, the Heliophysics Research Program is guided by Science 2020-2024: A Vision for Scientific Excellence and any more up to date versions of the Science Plan (available at https://science.nasa.gov/about-us/science-strategy ) and by the 2013 National Research Council Decadal Strategy for Solar and Space Physics report, Solar and Space Physics: A Science for a Technological Society (www.nap.edu/catalog.php?record_id=13060).

The decadal survey articulates the scientific challenges for this field of study and recommends a slate of design reference missions to meet them, 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 objectives:

- Explore and characterize the physical processes in the space environment from the Sun to the heliopause and throughout the universe

- Advance our understanding of the Sun's activity, and the connections between solar variability and Earth and planetary space environments, the outer reaches of our solar system, and the interstellar medium
- Develop the knowledge and capability to detect and predict extreme conditions in space to protect life and society and to safeguard human and robotic explorers beyond Earth

The program supports theory, modeling, and data analysis utilizing remote sensing and in situ measurements from a fleet of missions; the Heliophysics System Observatory (HSO). Frequent CubeSats, suborbital rockets, balloons, and ground-based instruments add to the observational base. Investigations that develop new observables and technologies for heliophysics science are sought.

Supported research activities include projects that address understanding of the Sun and planetary space environments, including the origin, evolution, and interactions of space plasmas and electromagnetic fields throughout the heliosphere. The program seeks to characterize these phenomena on a broad range of spatial and temporal scales, to understand the fundamental processes that drive them, to understand how these processes combine to create space weather events, and to enable a capability for predicting future space weather events.

The program supports investigations of the Sun, including processes taking place throughout the solar interior and atmosphere and the evolution and cyclic activity of the Sun. It supports investigations of the origin and behavior of the solar wind, energetic particles, and magnetic fields in the heliosphere and their interaction with the Earth and other planets, as well as with the interstellar medium.

The program also supports investigations of the physics of magnetospheres, including their formation and fundamental interactions with plasmas, fields, and particles and the physics of the terrestrial mesosphere, thermosphere, ionosphere, and auroras, including the coupling of these phenomena to the lower atmosphere and magnetosphere. Proposers may also review the information in the ROSES-24 Heliophysics Research Program Overview B.01_Helio Overview.pdf (nasaprs.com) for further information about the Heliophysics Research Program

# Science Mission Directorate (SMD)

## Planetary Science Division

### Planetary Science Division

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The Planetary Science Exploration Technology Office (PESTO), managed by the Planetary Science Division, sponsors technology development that addresses the broad strategic objective to "Ascertain the content, origin, and evolution of the Solar System and the potential for life elsewhere." To pursue this objective, the Planetary Science Division has strategic goals and objectives that guide the focus of the division's science research and technology development activities. As described in the NASA 2023 Science Strategic Plan (https://science.nasa.gov/about-us/science-strategy ), these are:

- Discover:
    - Expand human knowledge through new scientific discoveries
        - 1.2: Understand the Sun, solar system, and universe
- Explore:
    - Extend human presence to the Moon and on towards Mars for sustainable long-term exploration, development, and utilization
        - 2.1: Explore the surface of the Moon and deep space
- Innovate:
    - Catalyze economic growth and drive innovation to address national challenges
        - 3.1: Innovate and advance transformational space technologies

The NASA Planetary Science strategic objective is to advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space.

In order to address these goals and objectives, PESTO invites a wide range of planetary science and astrobiology technology development investigations. Example topics for technology developments include, but are not limited to the following:

- Technology developments for supporting the understanding the formation and evolution of the Solar System and (exo) planetary systems in general, and of the planetary bodies, satellites, and small bodies in these systems;
- Technology developments for supporting the understanding materials present, and processes occurring, in the early stages of Solar System history, including the protoplanetary disk;
- Technology developments the supporting the understanding planetary differentiation processes;
- Technology developments for supporting evaluation of extraterrestrial materials, including meteorites, cosmic dust, presolar grains, and samples returned by the Apollo, Stardust, Genesis, and Hayabusa missions;
- Technology developments for supporting the understanding of properties of planets, satellites (including the Moon), satellite and ring systems, and smaller Solar System bodies such as asteroids and comets;

- Technology developments for supporting the understanding of the coupling of a planetary body's intrinsic magnetic field, atmosphere, surface, and interior with each other, with other planetary bodies, and with the local plasma environment;
- Technology developments for supporting the understanding of the origins, evolution, and properties of the atmospheres of planetary bodies (including satellites, small bodies, and exoplanets);
- Technology developments for supporting the understanding of the knowledge of the history of the Earth and the life upon it as a guide for determining the processes and conditions that create and maintain habitable environments and to search for ancient and contemporary habitable environments and explore the possibility of extant life beyond the Earth;
- Technology developments for supporting the understanding of the origin and early evolution of life, the potential of life to adapt to different environments, and the implications for life elsewhere;
- Technology developments for supporting the understanding to provide the fundamental research and analysis necessary to characterize exoplanetary systems;
- Technology developments for supporting the understanding of the chemistry, astrobiology, dynamics, and energetics of exoplanetary systems;
- Technology developments for supporting astronomical observations of our Solar System that contribute to the understanding of the nature and evolution of the Solar System and its individual constituents;
- Technology developments for supporting the inventory and characterization of the population of Near-Earth Objects (NEOs) or mitigate the risk of NEOs impacting the Earth;
- Technology developments for evaluating and preventing forward and backward contamination during planetary exploration, methods to minimize such contamination, and standards in these areas for spacecraft preparation and operating procedures;
- Technology developments for supporting the enhancement of the scientific return of NASA Planetary Science Division missions through the analysis of data collected by those missions;
- Advancement of laboratory- or spacecraft-based (including small satellites, e.g., CubeSats) instrument technologies that show promise for use in scientific investigations on future planetary missions; and
- Analog studies, laboratory experiments, or fieldwork to increase our understanding of Solar System bodies or processes and/or to prepare for future missions.

The technologies needed to support NASA Planetary Science Division may be found in the Planetary Science Technology Strategy document (https://www1.grc.nasa.gov/space/pesto/tech-dev-plan/ ), which includes the Planetary Science Prioritized Technology Focus Areas:

- Instrumentation, with an emphasis on:
  - In Situ Search for Life/Astrobiology
- Sample Containment and Return
  - Planetary Protection and Contamination Control
  - Thermal Protection and Control
  - Sample Manipulation
- Autonomy
  - Global Positioning System (GPS) deprived navigation
  - Surface (planetary) operations
  - On-board science data processing
  - Ground Operations
- Robotics, with an emphasis on Advanced Mobility for:
  - Aerial Rovers in Extreme Environments
  - Subsurface Access (including drilling)
- Higher-efficiency power conversion technology for radioisotope system

Proposers may also review the information in the ROSES Planetary Science Research Program Overview for further information about the Planetary Science Research Programs.

# Earth System Science Scope Appendix

Compelled by our planet's rapid change, the Earth Science Division (ESD) is exploring and innovating to understand the Earth system, make new discoveries, and enable solutions for the benefit of all (e.g. Earth Science to Action Strategy). ESD's investments in technology, global observation data, groundbreaking foundational science and applications deliver trusted actionable Earth science data that support the US economy, national security through valuable information and tools, decision-making that affects human health, and improve the nation's ability to forecast and respond to natural hazards and improve quality of life.

For Earth Science, this NOFO requests proposals that focus on innovative uses of recently launched Earth Science missions. Proposals must demonstrate the relevance of the research activities to support one or more of the ESD Programs as described in ROSES-2025 A.1 Earth Science Research Overview, as well as the Earth System Science Research Program website for additional details. Earth Science welcomes research supporting state and local preparedness. Proposals must include the following two requirements:

**Requirement A:** Use of ESD Missions – SWOT, TEMPO, PACE, and NISAR

Proposals must incorporate observations from Surface Water Ocean Topography (SWOT), Tropospheric Emissions: Monitoring of POllution (TEMPO), Plankton, Aerosol, Cloud, ocean Ecosystem (PACE), and/or NASA-ISRO Synthetic Aperture Radar (NISAR) (listed in order of launch date; note there is no specific mission priority in this solicitation) to address science questions related to the Earth system. Proposals must justify how the proposed work will significantly advance foundational knowledge of our home planet using the innovative capabilities of the mission(s), particularly by better quantifying change in processes and/or constituents across scales.

Proposers should leverage products and algorithms previously developed by science teams for the mission(s) previously listed to ensure proposed investigations are unique and build on the existing capabilities of the sensor(s). The proposed science should advance state of the art approaches and should include a brief description of risk mitigation to the approach. Only minor (not to exceed 20% of the total budget) and well justified laboratory and/or field data collection to support specific science questions will be considered. It is recommended that proposers place emphasis on addressing science gaps rather than the development of new products, although developing new products is permissible so long as it is novel, while enabling the team to answer their stated science questions.

It is strongly suggested that proposers review the mission home pages, listed below in alphabetical order.

- NISAR: https://science.nasa.gov/mission/nisar/
- PACE: https://pace.gsfc.nasa.gov/
- SWOT: https://swot.jpl.nasa.gov/mission/overview/
- TEMPO: https://tempo.si.edu/

Proposals submitted in response to this program element will be expected to characterize uncertainties and quantify errors associated with data, analytical approaches, model results, and scientific interpretations, and must do so within the body of the proposal; a description in the Open Science and

Data Management Plan should include how proposers will be reported with the data and products to be shared and archived.

Proposals that incorporate non-NASA data, including international satellite data, commercial satellite data, and social science data are also welcome but the main source must be NASA data from the missions mentioned above. Proposals may also utilize data acquired via NASA’s Commercial SmallSat Data Acquisition (CSDA) Program (available at no cost to U.S. Government-funded researchers). Any data proposed to be analyzed from any source, including NASA and other satellite data, ancillary data, and data from commercial sources, must be publicly available, in the sense that these data are openly accessible. Proposals should reflect the principles of Open Science as described on the Earthdata website.

Proposals planning to request High-End Computing (HEC) should follow the HEC Program guidance. The HEC program provides a specialized computational infrastructure to support NASA’s research community. Any need for HEC resources must be justified by completing a request for resources for inclusion with the proposal. The PI completes and submits a request in the HEC Request Management System (RMS) at https://request.hec.nasa.gov/. The purpose of this step is to inform reviewers at NASA of your computational needs, and if the proposal is selected, establish eligibility to use HEC resources. The form includes a written justification of how the computational resources would support the investigation as well as a multi-year resource-phasing plan, in annual increments, identifying the computing time and data storage requirements covering the duration of the proposed award period. If your proposal is selected for funding, your HEC request will be evaluated by the SMD’s HEC Allocation Authority. SMD allocates quarterly in October, January, April and July. Out of cycle allocation requests are handled on a case-by-case basis. The HEC program will then issue letters identifying yearly allocations of HEC resources for the duration of the project, which again, may differ from your request due to limited availability of resources. However, PIs may submit requests to increase or decrease allocations of HEC resources if there are unexpected changes to computational needs.

**Requirement B:** Collaboration with ESD ECR FIES2A

ESD is committed to enabling early engagement to cultivate a variety of Earth science communities and to support workforce development. The ESD Early Career Research Program (ECR) creates opportunities to advance the development and implementation of the Earth Science to Action Strategy. ECR is striving for excellence in Earth science by supporting outstanding and innovative scientific research, enabling greater participation through scientific leadership, fostering a sense of community through sustained relationships, and making Earth science data more usable and impactful for all. One of several ECR opportunities includes the First Immersion in Earth Science to Action (FIES2A). FIES2A provides an opportunity for young Earth science-interested students, including community college and early undergraduate students to get immersed in a workforce development experience to conduct Earth science research. By providing this first immersion, ECR is exposing students to NASA Earth science information, data, and resources highlighting these as national assets and contributing to train the future workforce.

Proposers must host and allocate funds for 3 students over each summer to be part of a FIES2A Summer Cohort (each summer for the duration of the grant). Proposers must work in collaboration with ECR for planning and logistics. Proposals must include a summer project plan, which includes the feasibility of the proposed research, alignment with requirement A of this solicitation, an appropriate scope for undergraduate capabilities and mentorship responsibilities, and a timeline reasonability (10-week interns with additional time for mentor planning).

FIES2A/EPSCoR Requirements:

- Students research projects must be aligned with proposed research in requirement A.
- Institution must allocate a stipend of $8,200 per student per summer in the budget, a computer (if applicable), and physical space (lab or office).
- Institution should follow OSTEM intern eligibility and selection criteria.
- Institution should assign a mentor to guide and oversee the 3 students over the summer and be the liaison between the institution and ECR.
- ECR will assign a NASA FIES2A Mentor to provide additional scientific and technical support from the appropriate ESD mission/sphere.
- FIES2A Summer Cohort dates vary per year. Here is an estimated timeline for 2027 (Start June 7 and end August 6). Additional dates:
    - ECR FIES2A Team Meeting: ~Early December
    - Student selection by: ~Early May
    - Final FIES2A Cohort Presentations: August 6