Geosciences Open Science Ecosystem (GEO OSE)

PROGRAM SOLICITATION

NSF 23-534

National Science Foundation
Directorate for Geosciences
Division of Research, Innovation, Synergies, and Education

Full Proposal Deadline(s) (due by 5 p.m. submitter's local time):

March 16, 2023

IMPORTANT INFORMATION AND REVISION NOTES

The Geosciences Open Science Ecosystem (GEO OSE) program supports an ecosystem of sustainable and networked open science activities and capabilities that foster inclusive access to data, physical collections, software, advanced computing, and other resources toward advancing research and education in the geosciences.

Any proposal submitted in response to this solicitation should be submitted in accordance with the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) that is in effect for the relevant due date to which the proposal is being submitted. The NSF PAPPG is regularly revised and it is the responsibility of the proposer to ensure that the proposal meets the requirements specified in this solicitation and the applicable version of the PAPPG. Submitting a proposal prior to a specified deadline does not negate this requirement.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Geosciences Open Science Ecosystem (GEO OSE)

Synopsis of Program:

The Geosciences Open Science Ecosystem (GEO OSE) program seeks to support sustainable and networked open science activities to foster an ecosystem of inclusive access to data, physical collections, software, advanced computing, and other resources toward advancing research and education in the geosciences. The purpose of this support is to broadly enable geoscientists to leverage expanding information resources and computing capabilities to address interdisciplinary grand challenge research questions at the forefront of the geosciences.

Priority goals for GEO OSE are to: (i) improve the openness and scientific value of the existing network of cyberinfrastructure resources in the geosciences and related fields, such as data repositories, open-source software communities, and shared computing resources (e.g., high-performance and cloud computing), including via alignment on and adoption of common data and metadata standards that advance access and interoperability; (ii) democratize access to cyberinfrastructure capabilities that enable innovative geosciences research and education, including by advancing cloud-based approaches and workflows; (iii) strengthen the capacity of current and future geoscientists to access, utilize, and collaborate within the growing ecosystem of open science resources; and (iv) contribute to advancing open science principles within the geosciences, including (but not limited to) the FAIR Guiding Principles for scientific data management and stewardship (Findable, Accessible, Interoperable, Reusable), the CARE Principles for Indigenous Data Governance (Collective Benefit, Authority to Control, Responsibility, and Ethics), and the TRUST Principles for digital repositories (Transparency, Responsibility, User focus, Sustainability, and Technology), as well as Reproducibility and Replicability.

Cognizant Program Officer(s):

Please note that the following information is current at the time of publishing. See program website for any updates to the points of contact.

- Raleigh L. Martin, telephone: (703) 292-7199, email: ramartin@nsf.gov
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Applicable Catalog of Federal Domestic Assistance (CFDA) Number(s):

- 47.050 --- Geosciences

Award Information

Anticipated Type of Award: Standard Grant or Continuing Grant

Estimated Number of Awards: 4 to 10

The number of awards will be determined based on the results of the merit review process and availability of funds.

Anticipated Funding Amount: $5,000,000 to $10,000,000

Estimated program budget, number of awards, and average award size/duration are subject to the availability of funds.

Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.
- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities.
- Other Federal Agencies and Federally Funded Research and Development Centers (FFRDCs): Contact the appropriate program before preparing a proposal for submission.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

Limit on Number of Proposals per PI or co-PI:

There are no restrictions or limits.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Not required
- **Preliminary Proposal Submission:** Not required
- **Full Proposals:**

- Full Proposals submitted via Research.gov: *NSF Proposal and Award Policies and Procedures Guide* (PAPPG) guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.
- Full Proposals submitted via Grants.gov: *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov* guidelines apply (Note: The *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide).

B. Budgetary Information

- **Cost Sharing Requirements:**

  Inclusion of voluntary committed cost sharing is prohibited.

- **Indirect Cost (F&A) Limitations:**

  Not Applicable

- **Other Budgetary Limitations:**

  Not Applicable

C. Due Dates

- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

  March 16, 2023

Proposal Review Information Criteria

Merit Review Criteria:

National Science Board approved criteria. Additional merit review criteria apply. Please see the full text of this solicitation for further information.

Award Administration Information

Award Conditions:

Additional award conditions apply. Please see the full text of this solicitation for further information.

Reporting Requirements:

Standard NSF reporting requirements apply.

TABLE OF CONTENTS

I. INTRODUCTION

The NSF Directorate for Geosciences (GEO) seeks to foster an open, transparent, and inclusive ecosystem of software, data, and knowledge capabilities to advance geosciences understanding and to train the next generation of geoscientists. Priorities for GEO, in tandem with related opportunities in NSF's Office of Advanced Cyberinfrastructure (OAC) and across NSF, include advancing computational and data-driven research approaches, promoting openness and broad participation, and catalyzing innovative uses of artificial intelligence and machine learning (AI/ML) in the geosciences. In this solicitation, geosciences refers to the academic research communities supported by the Geosciences Directorate at NSF, which includes the domains of atmospheric and geospace sciences, ocean sciences, Earth sciences, and polar sciences. Further details on the scientific topics that are supported in the geosciences can be found within descriptions of individual GEO programs (https://www.nsf.gov/funding/programs.jsp?org=GEO).

The 2022 National Academies of Sciences, Engineering, and Medicine (NASEM) report, *Next Generation Earth Systems Science at the National Science Foundation*, identified priority needs for a robust, integrated approach to understanding the dynamic and interconnected components of the Earth System. Among the priorities it identified, the NASEM report recommended, "NSF should promote and support collaboration, instrumentation, cyberinfrastructure, and data-sharing activities among facilities for the production of convergence research for next generation Earth Systems Science." The 2022 Office of Science and Technology Policy (OSTP) memorandum, *Ensuring Free, Immediate, and Equitable Access to Federally Funded Research*, emphasized the value of open science for expanding equitable access to research, increasing trust in science, and advancing a scientific culture of collaboration. Taken together, these reports highlight the need for a robust open science ecosystem to support advancement of Earth System understanding, and they identify national priorities for developing sustainable and robust cyberinfrastructure capabilities and for fostering an equitable, trustworthy, and collaborative scientific research enterprise.

In recent years, grassroots efforts within the scientific community have established foundational principles for open science, including the FAIR Guiding Principles for scientific data management and stewardship (Findable, Accessible, Interoperable, Reusable), the CARE Principles for Indigenous Data Governance (Collective Benefit, Authority to Control, Responsibility, and Ethics), and the TRUST Principles for digital repositories (Transparency, Responsibility, User focus, Sustainability, and Technology), as well as Reproducibility and Replicability (see NSF 23-018, "Dear Colleague Letter: Reproducibility and Replicability in Science"). In the geosciences, the NSF-sponsored EarthCube program has supported a range of activities toward sharing data and knowledge in an open, transparent, and inclusive manner. NSF's EarthCube program enabled notable advancements in the use of cyberinfrastructure in the geosciences, which have lowered barriers to accessing data and computing, fostered innovative approaches to geosciences research and education, and set the stage for future developments in open science.

In response to these community-driven principles for open science and in alignment with overall NSF and GEO priorities, this Geosciences Open Science Ecosystem (GEO OSE) solicitation supports activities to foster an ecosystem of accessible and interconnected cyberinfrastructure and collaborative approaches to maximize the openness and accessibility of research and education in the geosciences. This GEO OSE opportunity complements related efforts, including programs through NSF's Office of Advanced Cyberinfrastructure (OAC), NSF's Technology, Innovation, and Partnerships Directorate (TIP), and the NASA Transform to Open Science (TOPS) initiative. GEO OSE also emphasizes the importance of maximizing access and lowering the barrier to use of open science resources for geoscientists, including through training and coordination activities that build capacity, especially for persons and institutions currently underserved by cyberinfrastructure resources in the geosciences.

II. PROGRAM DESCRIPTION

This Geosciences Open Science Ecosystem (GEO OSE) solicitation seeks to support sustainable and networked open science activities and capabilities that foster inclusive access to data, physical collections, software, advanced computing, and other resources toward advancing research and education in the geosciences. The purpose of this support is to broadly enable geoscientists to leverage expanding information resources and computing capabilities to address interdisciplinary grand challenge research questions at the forefront of the geosciences. This solicitation encourages proposers to define their own vision for open science and offer bold and innovative approaches to respond to that vision for the advancement of the geosciences.

A variety of efforts and approaches will be needed to foster open science for the geosciences, including (but not limited to) enhancements to existing cyberinfrastructure capabilities, community/cohort building around open science practices, and training activities that broaden access to and usability of existing resources.

Major priorities for this GEO OSE solicitation are to:

1. Improve the openness and scientific value of the existing network of cyberinfrastructure resources in the geosciences and related fields, such as data repositories, open-source software communities, and shared computing resources (e.g., high-performance and cloud computing), including via alignment on and adoption of common data and metadata standards that advance access and interoperability;
2. democratize access to data, software, physical collections, computing, and other capabilities that enable innovative geosciences research and education, including by advancing cloud-based approaches and workflows that reduce barriers to use and increase opportunities for collaboration, especially for persons and institutions underserved by the existing ecosystem of cyberinfrastructure resources for geosciences;

3. strengthen the capacity of current and future geoscientists to access, utilize, and collaborate within the growing ecosystem of open science resources, including through training, coordination, and cohort-building activities, especially for persons and institutions currently underrepresented in the geosciences; and
4. contribute to advancing open science principles within the geosciences, including (but not limited to) the FAIR, CARE, and TRUST Principles, as well as Reproducibility and Replicability.

This solicitation supports activities across this spectrum of priority areas.

Proposals in response to this solicitation may be submitted to either of two tracks that acknowledge the range of readiness levels across geosciences communities. The selection of tracks should primarily be determined by the size and scope of proposed efforts:

- **Track 1:** These awards support smaller-scale activities to advance early stage GEO OSE activities. It is expected that supported projects will facilitate broad stakeholder involvement and address community-driven open science needs in the geosciences. Track 1 projects may include the development of pilot capabilities or community-building activities that advance a vision for open science within geosciences domains. Projects should guide the future design, development, and deployment of GEO OSE resources, possibly via future Track 2 projects. Funding will be provided for 2 years with a maximum budget size of $400,000 per project.
- **Track 2:** These awards target larger-scale activities aimed at providing an accessible and sustainable ecosystem of GEO OSE resources. Projects should engage a range of stakeholders, including geoscientists and technologists, and they should be designed to leverage the existing open science ecosystem and in response to demonstrated community needs. Projects must address plans for long-term sustainability of outcomes. Submission to Track 2 does not require prior Track 1 support. Funding will be provided for 3 years with budget size commensurate with the size and scope of the project up to about $1,600,000.

Specific Requirements:

Proposals submitted in response to this solicitation must address the following Specific Requirements. Proposals will be evaluated on how successfully they meet these requirements (see Section VI.A, Merit Review Principles and Criteria):

1. **Geosciences Advancement:** Proposals must address how proposed activities will contribute to demonstrated needs for advancing geosciences research and/or education. Proposed activities should attract and include broad participation of geoscientists in the relevant domains throughout the duration of the project, starting in the first year. Projects should help to unlock new applications of geoscientific information and/or computing capabilities toward advancing geosciences understanding. Proposed open science developments should broadly benefit geosciences research and/or education communities beyond the immediate proposal team.
2. **Open Science Alignment:** Proposals must articulate a vision for advancing open science efforts within the geosciences, including how they envision and define open science for their target communities and how they will build on the existing ecosystem of open science and/or computational resources. Efforts that include infrastructure-building should demonstrate how they leverage, federate with, and/or expand the value of existing cyberinfrastructure (e.g., data, software, workflows, standards, high-performance computing, cloud) toward advancing a sustainable, interoperable network of open science resources for geoscientists. Efforts that include broadening access should demonstrate how they lower barriers and enhance the usability of existing open science resources (e.g., widely used datasets, software, techniques, etc.), including through capacity building, developing communities of practice, catalyzing partnerships, and/or demonstrating value of data reuse (e.g., new techniques for evaluation and peer-review).

Utilizing Shared Computing Resources:

This solicitation does *not* support the development of new computer hardware capabilities or significant hardware acquisition. PIs are encouraged to consider using the wide range of NSF-supported advanced shared computing resources for their computational needs, including the Advanced Cyberinfrastructure Coordination Ecosystem: Services & Support (ACCESS) program (https://access-ci.org/) and related initiatives through NSF's Office of Advanced Cyberinfrastructure. PAPPG Chapter II.E.7 provides additional information on accessing high-performance computing resources, data infrastructure, or advanced visualization resources. In addition to these widely available computing resources, proposers may also request specific allocations for high-throughput computing and/or cloud computing in tandem with their proposal submission. This is described in further detail in the Proposal Preparation Instructions of this solicitation (Section V.A).

III. AWARD INFORMATION

Estimated Number of Awards: 4 -10

The number of awards will be determined based on the results of the merit review process and availability of funds.

Anticipated Funding Amount: $5,000,000 to $10,000,000

Estimated program budget, number of awards and average award size/duration are subject to the availability of funds.

Estimated Award Size and Duration:

Track 1 projects will be 2 years in duration with a maximum budget size of $400,000. Track 2 projects will be 3 years in duration with budget size

up to about $1,600,000. Specific budgets for Track 1 and Track 2 projects are expected to be commensurate with the size and scope of the project and anticipated scientific impact.

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.
- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities.
- Other Federal Agencies and Federally Funded Research and Development Centers (FFRDCs): Contact the appropriate program before preparing a proposal for submission.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

Limit on Number of Proposals per PI or co-PI:

There are no restrictions or limits.

Additional Eligibility Info:

Proposers are encouraged to pursue partnerships between academia, industry, and others. Mechanisms to engage in such partnerships include subaward arrangements (for funded partners) and unfunded collaborations (documented via letters of collaboration).

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Full Proposal Preparation Instructions: Proposers may opt to submit proposals in response to this Program Solicitation via Research.gov or Grants.gov.

- Full Proposals submitted via Research.gov: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the *NSF Proposal and Award Policies and Procedures Guide* (PAPPG). The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg. Paper copies of the PAPPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov. The Prepare New Proposal setup will prompt you for the program solicitation number.
- Full proposals submitted via Grants.gov: Proposals submitted in response to this program solicitation via Grants.gov should be prepared and submitted in accordance with the *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov*. The complete text of the *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: (https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide). To obtain copies of the Application Guide and Application Forms Package, click on the Apply tab on the Grants.gov site, then click on the Apply Step 1: Download a Grant Application Package and Application Instructions link and enter the funding opportunity number, (the program solicitation number without the NSF prefix) and press the Download Package button. Paper copies of the Grants.gov Application Guide also may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov.

In determining which method to utilize in the electronic preparation and submission of the proposal, please note the following:

Collaborative Proposals. All collaborative proposals submitted as separate submissions from multiple organizations must be submitted via Research.gov. PAPPG Chapter II.E.3 provides additional information on collaborative proposals.

See PAPPG Chapter II.D.2 for guidance on the required sections of a full research proposal submitted to NSF. Please note that the proposal preparation instructions provided in this program solicitation may deviate from the PAPPG instructions.

The following provides additional guidance beyond that contained in the PAPPG or NSF Grants.gov Application Guide.

High-Throughput Computing Resources:

Proposals may request high-throughput computing (HTC) resources through the Partnership to Advance Throughput Computing (PATh) project supported by NSF.

Proposers should describe the request in a Supplementary Document no longer than two pages with a technical description of, and justification for, the requested HTC resources that includes (a) the expected number of self-contained tasks per ensemble – note that each task can be packaged into one or more batch job; (b) the resource requirements for each task type in the ensemble – for example, requirements for cores, memory, wall-time, and scratch space; (c) the expected number of ensembles; (d) the expected input and output data requirements for each task type; and (e) the expected number and size of shared input files within an ensemble – expected number of times each file is read per ensemble.

Proposers should include "HTCAccess" (one word without spaces) as a keyword on the Project Summary page, at the end of the Overview section (before the section on Intellectual Merit) if incorporating this request into the proposal. Proposers may visit PATh credit accounts web page (see https://path-cc.io/services/credit-accounts/) for more information on the available HTC resources which can be allocated through this program.

See below for specific instructions on how to describe the HTC/PATh request in the Project Summary and the Other Supplementary Documents.

Cloud Computing Resources:

Proposals may request cloud computing resources to use public clouds such as Amazon Web Services (AWS), Google Cloud Platform (GCP), IBM Cloud, and Microsoft Azure. Cloud computing resources described in proposals may be obtained through an external cloud access entity supported by NSF's Enabling Access to Cloud Computing Resources for CISE Research and Education (Cloud Access) Program.

Proposers should describe the request in a Supplementary Document no longer than two pages with (a) which public cloud provider will be used, (b) anticipated annual and total costs for accessing the desired cloud computing resources, based on pricing currently available from the public cloud computing providers; and (c) a technical description of, and justification for, the requested cloud computing resources. The NSF Budget should not include any such costs for accessing public cloud computing resources via CloudBank.org. The total cost of the project, including this cloud computing resource request from CloudBank.org, may not exceed the budget limit described in this solicitation.

For example, consider a proposal submitted to Track 1, which has a total proposal budget limit of $400,000. If a PI wishes to request $20,000 in cloud computing resources through CloudBank, then such proposal should request, as part of the proposal budget, no more than $380,000. The remaining $20,000 for cloud computing resources should be specified in the Supplementary Document. If a proposal is a collaborative project with two PIs from two different organizations, then each PI may request cloud computing resources separately through independent Supplementary Documents as long as the total budget (on the budget pages plus in the Supplementary Documents) does not exceed $400,000.

Proposers should include "CloudAccess" (one word without spaces) as a keyword on the Project Summary page, at the end of the Overview section (before the section on Intellectual Merit) if incorporating this request into the proposal. Proposers may contact CloudBank.org (see https://www.cloudbank.org/faq) for consultation on estimating the budget for using cloud computing resources.

See below for specific instructions on how to describe the CloudAccess request in the Project Summary and the Other Supplementary Documents.

Title: To assist NSF staff in sorting proposals for review, proposal titles should include "GEO OSE Track 1:" or "GEO OSE Track 2:".

Project Summary (1-page limit): If cloud computing resources are being requested from CloudBank.org, then the keyword "CloudAccess" (one word without space) should be included at the end of the Overview section (before the section on Intellectual Merit) of the Project Summary page. Similarly, if high-throughput computing (HTC) resources are being requested, then the keyword "HTCAccess" (one word without space) should be included at the end of the Overview section (before the section on Intellectual Merit) of the Project Summary page.

Project Description (15-page limit): In addition to the guidance specified in the PAPPG, including the requirement for a separate section labeled "Broader Impacts", the project description should describe how the work meets the Specific Requirements described in the Program Description for this solicitation.

Budget:

Awardees are expected to participate in annual PI meetings to be held in the Washington, DC, area with travel costs supported by the award. These travel costs must be included in the proposal budget. Collaborative projects do not need to send PIs and co-PIs for all of the lead and non-lead partners.

The total budget of the project, including any cloud computing resource request from CloudBank.org, may not exceed the budget limits for the

respective tracks described in this solicitation. The total cost of the cloud computing resources requested from CloudBank.org should not be included in the NSF budget, and should be specified only in the associated supplementary document (see below for additional instructions).

Other Supplementary Documents:

In addition to the guidance specified in the PAPPG, the following Supplementary Documents should be included as applicable. Proposals missing any of the required documents will be returned without review. Each proposal (the lead proposal for collaborative projects) must submit the following documents, as applicable:

1. **Personnel List (required):** Each proposal must submit a single unified personnel list for the entire project. For each person known at the time of proposal submission to be involved in proposed activities, provide the last name, first name, and institution/organization. Undergraduate students, graduate students, and postdoctoral researchers not yet specifically identified do not need to be included in this list. Proposals lacking the list of project personnel will be returned without review.
2. **Letters of Collaboration (if applicable):** Lettersmust be provided for any organization or individuals that are mentioned in the Project Description but are not receiving funds (i.e., mentioned in the proposal and not listed in any of the associated budgets).
3. **High-Throughput Computing Resources (if applicable):** If requesting high-throughput computing (HTC) resources, include a description of the requests (not to exceed 2 pages) as a supplementary document that includes (1) title of the proposal; (2) institution name; (3) the anticipated total HTC resources required, with yearly breakdown; and (4) a technical description and justification for the request. The latter should include information regarding (a) the expected number of self-contained tasks per ensemble – note that each task can be packaged into one or more batch job; (b) the resource requirements for each task type in the ensemble – for example, requirements for cores, memory, wall-time, and scratch space; (c) the expected number of ensembles; (d) the expected input and output data requirements for each task type; and (e) the expected number and size of shared input files within an ensemble – expected number of times each file is read per ensemble. Proposers should include "HTCAccess" (one word without space) as a keyword on the Project Summary page, at the end of the Overview section (before the section on Intellectual Merit).
4. **Cloud Computing Resources (if applicable):** If requesting cloud computing resources, include a description of the requests (not to exceed 2 pages) as a supplementary document that includes: (1) title of the proposal; (2) institution name; (3) the anticipated total cost of computing resources, with yearly breakdown; (4) which public cloud providers will be used; and (5) a technical description and justification of the request, along with how the cost was estimated. The NSF Budget should not include any such costs for accessing public cloud computing resources via CloudBank.org. The total cost of the project, including this cloud computing resource request from CloudBank.org, may not exceed the budget limits for the project track of the proposal, as described in this solicitation. Proposers should include "CloudAccess" (one word without space) as a keyword in the Project Summary page, at the end of the Overview section (before the section on Intellectual Merit).

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Budget Preparation Instructions:

Awardees are expected to participate in annual PI meetings to be held in the Washington, DC, area with travel costs supported by the award. These travel costs should be included in the proposed budget. Collaborative awards do not need to send PIs and co-PIs for all of the lead and non-lead partners.

Prospective PIs are reminded that proposals with budgets exceeding the associated limit for the project track of the proposal, as described in this solicitation, will be returned without review. For this purpose, a multi-organization collaborative project is treated as one project, for which the above limits apply.

C. Due Dates

- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

  March 16, 2023

D. Research.gov/Grants.gov Requirements

For Proposals Submitted Via Research.gov:

To prepare and submit a proposal via Research.gov, see detailed technical instructions available at: https://www.research.gov/research-portal/appmanager/base/desktop?_nfpb=true&_pageLabel=research_node_display&_nodePath=/researchGov/Service/Desktop/ProposalPreparationandSubmission.html. For Research.gov user support, call the Research.gov Help Desk at 1-800-673-6188 or e-mail rgov@nsf.gov. The Research.gov Help Desk answers general technical questions related to the use of the Research.gov system. Specific questions related to this program solicitation

should be referred to the NSF program staff contact(s) listed in Section VIII of this funding opportunity.

For Proposals Submitted Via Grants.gov:

Before using Grants.gov for the first time, each organization must register to create an institutional profile. Once registered, the applicant's organization can then apply for any federal grant on the Grants.gov website. Comprehensive information about using Grants.gov is available on the Grants.gov Applicant Resources webpage: https://www.grants.gov/web/grants/applicants.html. In addition, the NSF Grants.gov Application Guide (see link in Section V.A) provides instructions regarding the technical preparation of proposals via Grants.gov. For Grants.gov user support, contact the Grants.gov Contact Center at 1-800-518-4726 or by email: support@grants.gov. The Grants.gov Contact Center answers general technical questions related to the use of Grants.gov. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this solicitation.

Submitting the Proposal: Once all documents have been completed, the Authorized Organizational Representative (AOR) must submit the application to Grants.gov and verify the desired funding opportunity and agency to which the application is submitted. The AOR must then sign and submit the application to Grants.gov. The completed application will be transferred to Research.gov for further processing.

Proposers that submitted via Research.gov may use Research.gov to verify the status of their submission to NSF. For proposers that submitted via Grants.gov, until an application has been received and validated by NSF, the Authorized Organizational Representative may check the status of an application on Grants.gov. After proposers have received an e-mail notification from NSF, Research.gov should be used to check the status of an application.

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

Proposals received by NSF are assigned to the appropriate NSF program for acknowledgement and, if they meet NSF requirements, for review. All proposals are carefully reviewed by a scientist, engineer, or educator serving as an NSF Program Officer, and usually by three to ten other persons outside NSF either as *ad hoc* reviewers, panelists, or both, who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with oversight of the review process. Proposers are invited to suggest names of persons they believe are especially well qualified to review the proposal and/or persons they would prefer not review the proposal. These suggestions may serve as one source in the reviewer selection process at the Program Officer's discretion. Submission of such names, however, is optional. Care is taken to ensure that reviewers have no conflicts of interest with the proposal. In addition, Program Officers may obtain comments from site visits before recommending final action on proposals. Senior NSF staff further review recommendations for awards. A flowchart that depicts the entire NSF proposal and award process (and associated timeline) is included in PAPPG Exhibit III-1.

A comprehensive description of the Foundation's merit review process is available on the NSF website at: https://www.nsf.gov/bfa/dias/policy/merit_review/.

Proposers should also be aware of core strategies that are essential to the fulfillment of NSF's mission, as articulated in *Leading the World in Discovery and Innovation, STEM Talent Development and the Delivery of Benefits from Research - NSF Strategic Plan for Fiscal Years (FY) 2022 - 2026*. These strategies are integrated in the program planning and implementation process, of which proposal review is one part. NSF's mission is particularly well-implemented through the integration of research and education and broadening participation in NSF programs, projects, and activities.

One of the strategic objectives in support of NSF's mission is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions must recruit, train, and prepare a diverse STEM workforce to advance the frontiers of science and participate in the U.S. technology-based economy. NSF's contribution to the national innovation ecosystem is to provide cutting-edge research under the guidance of the Nation's most creative scientists and engineers. NSF also supports development of a strong science, technology, engineering, and mathematics (STEM) workforce by investing in building the knowledge that informs improvements in STEM teaching and learning.

NSF's mission calls for the broadening of opportunities and expanding participation of groups, institutions, and geographic regions that are underrepresented in STEM disciplines, which is essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports.

A. Merit Review Principles and Criteria

The National Science Foundation strives to invest in a robust and diverse portfolio of projects that creates new knowledge and enables breakthroughs in understanding across all areas of science and engineering research and education. To identify which projects to support, NSF relies on a merit review process that incorporates consideration of both the technical aspects of a proposed project and its potential to contribute more broadly to advancing NSF's mission "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes." NSF makes every effort to conduct a fair, competitive, transparent merit review process for the selection of projects.

1. Merit Review Principles

These principles are to be given due diligence by PIs and organizations when preparing proposals and managing projects, by reviewers when reading and evaluating proposals, and by NSF program staff when determining whether or not to recommend proposals for funding and while overseeing awards. Given that NSF is the primary federal agency charged with nurturing and supporting excellence in basic research and education, the following three principles apply:

- All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of knowledge.
- NSF projects, in the aggregate, should contribute more broadly to achieving societal goals. These "Broader Impacts" may be accomplished through the research itself, through activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. The project activities may be based on previously established and/or innovative methods and approaches, but in either case must be well justified.
- Meaningful assessment and evaluation of NSF funded projects should be based on appropriate metrics, keeping in mind the likely correlation between the effect of broader impacts and the resources provided to implement projects. If the size of the activity is limited, evaluation of that activity in isolation is not likely to be meaningful. Thus, assessing the effectiveness of these activities may best be done at a higher, more aggregated, level than the individual project.

With respect to the third principle, even if assessment of Broader Impacts outcomes for particular projects is done at an aggregated level, PIs are expected to be accountable for carrying out the activities described in the funded project. Thus, individual projects should include clearly stated goals, specific descriptions of the activities that the PI intends to do, and a plan in place to document the outputs of those activities.

These three merit review principles provide the basis for the merit review criteria, as well as a context within which the users of the criteria can better understand their intent.

2. Merit Review Criteria

All NSF proposals are evaluated through use of the two National Science Board approved merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two merit review criteria are listed below. **Both** criteria are to be given **full consideration** during the review and decision-making processes; each criterion is necessary but neither, by itself, is sufficient. Therefore, proposers must fully address both criteria. (PAPPG Chapter II.D.2.d(i). contains additional information for use by proposers in development of the Project Description section of the proposal). Reviewers are strongly encouraged to review the criteria, including PAPPG Chapter II.D.2.d(i), prior to the review of a proposal.

When evaluating NSF proposals, reviewers will be asked to consider what the proposers want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful. These issues apply both to the technical aspects of the proposal and the way in which the project may make broader contributions. To that end, reviewers will be asked to evaluate all proposals against two criteria:

- **Intellectual Merit:** The Intellectual Merit criterion encompasses the potential to advance knowledge; and
- **Broader Impacts:** The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.

The following elements should be considered in the review for both criteria:

1. What is the potential for the proposed activity to
    a. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
    b. Benefit society or advance desired societal outcomes (Broader Impacts)?
2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
4. How well qualified is the individual, team, or organization to conduct the proposed activities?
5. Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?

Broader impacts may be accomplished through the research itself, through the activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. NSF values the advancement of scientific knowledge and activities that contribute to achievement of societally relevant outcomes. Such outcomes include, but are not limited to: full participation of women, persons with disabilities, and other underrepresented groups in science, technology, engineering, and mathematics (STEM); improved STEM education and educator development at any level; increased public scientific literacy and public engagement with science and technology; improved well-being of individuals in society; development of a diverse, globally competitive STEM workforce; increased partnerships between academia, industry, and others; improved national security; increased economic competitiveness of the United States; and enhanced infrastructure for research and education.

Proposers are reminded that reviewers will also be asked to review the Data Management Plan and the Postdoctoral Researcher Mentoring Plan, as appropriate.

Additional Solicitation Specific Review Criteria

Proposals will be evaluated on how successfully they meet the Specific Requirements of the Program Description:

1. **Geosciences Advancement:** How well do proposed activities contribute to demonstrated needs for advancing geosciences research and/or education? Do proposed activities include broad participation of geoscientists throughout the project?
2. **Open Science Alignment:** How effective and feasible is the vision for open science? How well do the proposed activities help the project move towards this vision?

B. Review and Selection Process

Proposals submitted in response to this program solicitation will be reviewed by Ad hoc Review and/or Panel Review.

Reviewers will be asked to evaluate proposals using two National Science Board approved merit review criteria and, if applicable, additional program specific criteria. A summary rating and accompanying narrative will generally be completed and submitted by each reviewer and/or panel. The Program Officer assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation.

After scientific, technical and programmatic review and consideration of appropriate factors, the NSF Program Officer recommends to the cognizant Division Director whether the proposal should be declined or recommended for award. NSF strives to be able to tell applicants whether their proposals have been declined or recommended for funding within six months. Large or particularly complex proposals or proposals from new awardees may require additional review and processing time. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director acts upon the Program Officer's recommendation.

After programmatic approval has been obtained, the proposals recommended for funding will be forwarded to the Division of Grants and Agreements or the Division of Acquisition and Cooperative Support for review of business, financial, and policy implications. After an administrative review has occurred, Grants and Agreements Officers perform the processing and issuance of a grant or other agreement. Proposers are cautioned that only a Grants and Agreements Officer may make commitments, obligations or awards on behalf of NSF or authorize the expenditure of funds. No commitment on the part of NSF should be inferred from technical or budgetary discussions with a NSF Program Officer. A Principal Investigator or organization that makes financial or personnel commitments in the absence of a grant or cooperative agreement signed by the NSF Grants and Agreements Officer does so at their own risk.

Once an award or declination decision has been made, Principal Investigators are provided feedback about their proposals. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers or any reviewer-identifying information, are sent to the Principal Investigator/Project Director by the Program Officer. In addition, the proposer will receive an explanation of the decision to award or decline funding.

VII. AWARD ADMINISTRATION INFORMATION

A. Notification of the Award

Notification of the award is made to *the submitting organization* by an NSF Grants and Agreements Officer. Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program administering the program. Verbatim copies of reviews, not including the identity of the reviewer, will be provided automatically to the Principal Investigator. (See Section VI.B. for additional information on the review process.)

B. Award Conditions

An NSF award consists of: (1) the award notice, which includes any special provisions applicable to the award and any numbered amendments thereto; (2) the budget, which indicates the amounts, by categories of expense, on which NSF has based its support (or otherwise communicates any specific approvals or disapprovals of proposed expenditures); (3) the proposal referenced in the award notice; (4) the applicable award conditions, such as Grant General Conditions (GC-1)*; or Research Terms and Conditions* and (5) any announcement or other NSF issuance that may be incorporated by reference in the award notice. Cooperative agreements also are administered in accordance with NSF Cooperative Agreement Financial and Administrative Terms and Conditions (CA-FATC) and the applicable Programmatic Terms and Conditions. NSF awards are electronically signed by an NSF Grants and Agreements Officer and transmitted electronically to the organization via e-mail.

*These documents may be accessed electronically on NSF's Website at https://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov.

More comprehensive information on NSF Award Conditions and other important information on the administration of NSF awards is contained in the NSF *Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

Administrative and National Policy Requirements

Build America, Buy America

As expressed in Executive Order 14005, Ensuring the Future is Made in All of America by All of America's Workers (86 FR 7475), it is the policy of the executive branch to use terms and conditions of Federal financial assistance awards to maximize, consistent with law, the use of goods, products, and materials produced in, and services offered in, the United States.

Consistent with the requirements of the Build America, Buy America Act (Pub. L. 117-58, Division G, Title IX, Subtitle A, November 15, 2021), no funding made available through this funding opportunity may be obligated for an award unless all iron, steel, manufactured products, and construction materials used in the project are produced in the United States. For additional information, visit NSF's Build America, Buy America webpage.

Special Award Conditions:

Awardees are expected to participate in annual PI meetings to be held in the Washington, DC, area with travel costs supported by the award.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the Principal Investigator must submit an annual project report to the cognizant Program Officer no later than 90 days prior to the end of the current budget period. (Some programs or awards require submission of more frequent project reports). No later than 120 days following expiration of a grant, the PI also is required to submit a final project report, and a project outcomes report for the general public.

Failure to provide the required annual or final project reports, or the project outcomes report, will delay NSF review and processing of any future funding increments as well as any pending proposals for all identified PIs and co-PIs on a given award. PIs should examine the formats of the required reports in advance to assure availability of required data.

PIs are required to use NSF's electronic project-reporting system, available through Research.gov, for preparation and submission of annual and final project reports. Such reports provide information on accomplishments, project participants (individual and organizational), publications, and other specific products and impacts of the project. Submission of the report via Research.gov constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report also must be prepared and submitted using Research.gov. This report serves as a brief summary, prepared specifically for the public, of the nature and outcomes of the project. This report will be posted on the NSF website exactly as it is submitted by the PI.

More comprehensive information on NSF Reporting Requirements and other important information on the administration of NSF awards is contained in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

VIII. AGENCY CONTACTS

Please note that the program contact information is current at the time of publishing. See program website for any updates to the points of contact.

General inquiries regarding this program should be made to:

- Raleigh L. Martin, telephone: (703) 292-7199, email: ramartin@nsf.gov
- Maria P. Womack, telephone: (703) 292-2620, email: mwomack@nsf.gov
- Sean C. Kennan, telephone: (703) 292-7575, email: skennan@nsf.gov
- Alejandro Suarez, telephone: (703) 292-7092, email: alsuarez@nsf.gov
- Eva E. Zanzerkia, telephone: (703) 292-4734, email: ezanzerk@nsf.gov
- Marc Stieglitz, telephone: (703) 292-4354, email: mstiegli@nsf.gov
- Eric DeWeaver, telephone: (703) 292-8527, email: edeweave@nsf.gov
- Joseph Carlin, telephone: (703) 292-8562, email: jcarlin@nsf.gov

For questions related to the use of NSF systems contact:

- NSF Help Desk: 1-800-673-6188
- Research.gov Help Desk e-mail: rgov@nsf.gov

For questions relating to Grants.gov contact:

- Grants.gov Contact Center: If the Authorized Organizational Representatives (AOR) has not received a confirmation message from Grants.gov within 48 hours of submission of application, please contact via telephone: 1-800-518-4726; e-mail: support@grants.gov.

IX. OTHER INFORMATION

The NSF website provides the most comprehensive source of information on NSF Directorates (including contact information), programs and funding opportunities. Use of this website by potential proposers is strongly encouraged. In addition, "NSF Update" is an information-delivery system designed to keep potential proposers and other interested parties apprised of new NSF funding opportunities and publications, important changes in proposal and award policies and procedures, and upcoming NSF Grants Conferences. Subscribers are informed through e-mail or the user's Web browser each time new publications are issued that match their identified interests. "NSF Update" also is available on NSF's website.

Grants.gov provides an additional electronic capability to search for Federal government-wide grant opportunities. NSF funding opportunities may be accessed via this mechanism. Further information on Grants.gov may be obtained at https://www.grants.gov.

ABOUT THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation (NSF) is an independent Federal agency created by the National Science Foundation Act of 1950, as amended (42 USC 1861-75). The Act states the purpose of the NSF is "to promote the progress of science; [and] to advance the national health, prosperity, and welfare by supporting research and education in all fields of science and engineering."

NSF funds research and education in most fields of science and engineering. It does this through grants and cooperative agreements to more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations and other research organizations throughout the US. The Foundation accounts for about one-fourth of Federal support to academic institutions for basic research.

NSF receives approximately 55,000 proposals each year for research, education and training projects, of which approximately 11,000 are funded. In addition, the Foundation receives several thousand applications for graduate and postdoctoral fellowships. The agency operates no laboratories itself but does support National Research Centers, user facilities, certain oceanographic vessels and Arctic and Antarctic research stations. The Foundation also supports cooperative research between universities and industry, US participation in international scientific and engineering efforts, and educational activities at every academic level.

Facilitation Awards for Scientists and Engineers with Disabilities (FASED) provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See the *NSF Proposal & Award Policies & Procedures Guide* Chapter II.F.7 for instructions regarding preparation of these types of proposals.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation about NSF programs, employment or general information. TDD may be accessed at (703) 292-5090 and (800) 281-8749, FIRS at (800) 877-8339.

The National Science Foundation Information Center may be reached at (703) 292-5111.

The National Science Foundation promotes and advances scientific progress in the United States by competitively awarding grants and cooperative agreements for research and education in the sciences, mathematics, and engineering.

To get the latest information about program deadlines, to download copies of NSF publications, and to access abstracts of awards, visit the NSF Website at https://www.nsf.gov

- **Location:** 2415 Eisenhower Avenue, Alexandria, VA 22314
- **For General Information** (NSF Information Center)**:** (703) 292-5111
- **TDD (for the hearing-impaired):** (703) 292-5090
- **To Order Publications or Forms:**

  Send an e-mail to: nsfpubs@nsf.gov

  or telephone: (703) 292-8134
- **To Locate NSF Employees:** (703) 292-5111

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; and project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the proposal review process; to proposer institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies or other entities needing information regarding applicants or nominees as part of a joint application review process, or in order to coordinate programs or policy; and to another Federal agency, court, or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See System of Record Notices, NSF-50, "Principal Investigator/Proposal File and Associated Records," and NSF-51, "Reviewer/Proposal File and Associated Records." Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

An agency may not conduct or sponsor, and a person is not required to respond to, an information collection unless it displays a valid Office of Management and Budget (OMB) control number. The OMB control number for this collection is 3145-0058. Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding the burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to:

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