A.4 SCOPING STUDIES FOR THE NEXT TERRESTRIAL ECOLOGY FIELD CAMPAIGN

NOTICE: Amended July 28, 2022. Section 6.3, describing evaluation criteria, has been corrected and updated. New text is in bold and deleted text is struck through. The due dates for this program have been delayed. Proposals NOIs are requested by October 25, 2022, and proposals are now due January 11, 2023.

Proposers must use the standard Earth Science template for level of work effort and current and pending support (see Section 5). No Data Management Plan is required.

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1. NASA's Terrestrial Ecology Program

The NASA Terrestrial Ecology Program uses surface, airborne, and space-based observations to understand how Earth's carbon cycle and terrestrial ecosystems respond to environmental change and human interventions. This improved understanding is gained by combining observations with advanced data analysis techniques and ecosystem process modeling. The goal of the Terrestrial Ecology Program is to improve our understanding of (1) the structure, function, and productivity of terrestrial ecosystems across the globe, (2) the spatial and temporal variability of ecosystem states and processes; (3) the interaction of these ecosystems with the atmosphere and hydrosphere, and (4) the role that these ecosystems play in the cycling of the major biogeochemical elements and water. This improved understanding allows

us to develop a capability to diagnose and predict the response of terrestrial ecosystems to environmental change.

The NASA Terrestrial Ecology Program seeks to strengthen the theoretical and scientific basis for measuring the properties of Earth's vegetation using reflected, emitted, and scattered electromagnetic radiation and develop the methodologies and technical approaches required to analyze and interpret such measurements. These activities will ultimately provide a foundation for the new remote sensing capabilities needed to understand and monitor terrestrial ecosystems at regional to global scales.

All investigators associated with successful proposals from this program element will become members of the NASA Terrestrial Ecology community. Membership in the NASA Terrestrial Ecology community includes the responsibility to serve on NASA Peer Review Panels.

2. Scope of Solicitation

2.1 Scoping Study Objectives

NASA's Terrestrial Ecology Program has a long and rich history of successfully mounting intensive field campaigns (see Section 3). These field campaigns have been aimed at exploiting the synergistic benefits of multidisciplinary science focused on a specific science question or set of science questions. These science questions are addressed using satellite and airborne remote sensing observations in combination with surface and near-surface measurements of smaller scale features and processes. Such field experiments use an integrative modeling framework to synthesize and scale the results across space and time. NASA Terrestrial Ecology field campaigns focus the community's attention on (a) answering big science questions targeted on important regions or biomes; (b) enabling more effective interpretation and analysis of space-based measurements; (c) fostering collaborative interactions and building new relationships within the scientific community; (d) providing valuable opportunities for training and educating the next generation of scientists; and (e) leaving a legacy data set of great value for future research.

The ideas and strategy for field campaigns have usually arisen from within the research community – often as a result of discussions among current NASA-funded researchers working on related research questions or through the committees and working groups of national and international programs.

This opportunity requests scoping studies that will (1) identify the scientific questions, (2) develop an initial study design; (3) and propose an implementation concept for a new NASA Terrestrial Ecology field campaign that could be implemented on a six- to nine-year time frame. This solicitation offers resources to facilitate such planning and provides an opportunity to design a major, yet logistically feasible, initiative that advances the Terrestrial Ecology Program's research goals and makes use of NASA's unique capabilities to mount well-coordinated projects that use satellite and airborne remote sensing as a central element. Examples of the objectives and scope of previous campaigns are provided in Section 3. An important element of any field campaign must be the synthesis of the observations into a diagnostic and predictive capability that helps us to better understand the role of terrestrial ecosystems in climate change.

The proposed scoping studies should build on the NASA Terrestrial Ecology Program's history of conducting intensive, multidisciplinary, large-scale field campaigns. This solicitation is open to scientists with or without past experience in the NASA Terrestrial Ecology Program. Indeed, a productive mix of early career, mid-career, and senior scientists has been, and will continue to be, an important characteristic of NASA Terrestrial Ecology field campaigns. Proposals can identify new ecosystems, biomes or regions that merit intensive investigation or expand on and/or revisit previous efforts. This solicitation also welcomes proposals that leverage alternative models for conducting field campaigns such as studying long gradients that integrate multiple ecosystems, or a network of smaller campaigns that are distributed or targeted to answering overarching high impact science questions.

Regardless of the field campaign approach, proposals should identify high impact scientific questions that require a major investment in time and resources to advance terrestrial ecology, biogeochemistry, and related sciences. The scoping studies should focus on critical biomes and/or regions that are of importance to understanding the potential feedbacks between terrestrial and aquatic ecosystems with the atmosphere in the context of global change. Such field campaigns also aim to better prepare the science community to make use of NASA's future satellite data, such as that from the upcoming NASA Earth System Observatory constellation to advance the scientific objectives of the Terrestrial Ecology Program. The future field experiment is not intended for technology demonstrations. However, the use of innovative remote sensing to answer key scientific questions is strongly encouraged. The timeline for the implementation of the field campaign will depend on the availability of resources and therefore, proposals should be flexible regarding the implementation schedule. Nevertheless, proposals should contain a notional schedule, e.g., Year 1, Year 2, etc.

2.2 Proposals Requested

We seek proposals to conduct scoping studies over a period of 12 months. The main deliverable will be a scoping report that lays out the scientific issues at stake, the logistical framework, and one or more paths forward toward implementation. Scoping studies will be required to address the following elements:

1. The science questions and issues;
2. The current state-of-the-science;
3. The potential for a major, significant scientific advancement;
4. The central, critical role of NASA remote sensing;
5. The essential scientific components of the study and why coordinated teamwork is required in their implementation.
6. An overall study design identifying the required observational (e.g., spaceborne, airborne, and/or supporting in situ observations) and analytical (e.g., models, data, and information system) infrastructure;
7. The feasibility of the proposed project, both technical and logistical;
8. The engagement of the broader research community to seek feedback on the ideas, to assess interest, and to foster diversity and inclusion;
9. The disciplinary skills needed to conduct the study and engage potential partners in their planning activities.

10. Potential use of results for applications and decision support.

Proposals should make an initial attempt to address the above issues so that NASA can evaluate the promise and potential of the proposed scoping studies.

Proposals submitted in response to this solicitation should explain how data management considerations will be addressed during the scoping study. NASA Terrestrial Ecology field campaigns must be committed to NASA's Earth Data and Information Policy, NASA Open Science Philosophy, and NASA's Open Data, Services, and Software Policy.

While the focus should be on Terrestrial Ecology Program goals and objectives, it is clear that past successful field campaigns and related projects have involved interdisciplinary research questions and scientists trained in a number of different disciplines. Past campaigns have also involved interagency and/or international partnerships. Thus, scoping studies should identify the disciplinary skills needed to conduct the study and engage potential partners in their planning activities.

While proposers will be free to develop their own work plan, it is anticipated that a typical scoping study might support the activities of a small planning/writing group and one or more community workshops. The scoping studies funded through this solicitation are expected to be team efforts. The planning team (PI and co-investigators) need not be large, e.g., 2 to 6 people would be reasonable. The budget for workshop(s) should be separately explained and justified in the budget section of the proposal and may include travel costs for attendees.

Scoping studies must produce a written report that provides the scientific rationale and an initial study design concept for a new field campaign or related team project. While this report need not be lengthy, it must include a thorough presentation of science questions, goals, and objectives; the underlying rationale in terms of state-of-the-art, relevance, and expected advances; implementation concepts; and other information to enable NASA to fully evaluate the project. Examples of two previous scoping studies are provided here (click on final reports).

2.3 Stakeholder Engagement and Decision Support

A description of stakeholders and the approach to stakeholder engagement should be a part of the scoping study. Consequently, proposals should succinctly describe how researchers will interact with and/or develop partnerships with stakeholders pertinent to their investigation. Stakeholders may include the people and/or institutions where the field campaign will take place as well as other interested parties. Stakeholders may include Indigenous/aboriginal peoples on whose land the research might take place, as well as others with land ownership/usage rights; local communities; local, regional, and national government organizations; and partner organizations with specific decision support needs.

While the NASA Terrestrial Ecology Program focuses on advancing the fundamental science necessary to understand how ecosystems function on regional to global scales and how they might change in the future, we are also interested in applications of the knowledge gained to provide decision support for policy and other applications that could be useful to entities involved with the management of natural resources.

Proposals should describe the applications potential of the proposed scientific activities. If there is no potential for applications, proposals should state as such.

2.4 Diversity and Inclusion

NASA recognizes and supports the benefits of having diverse and inclusive scientific, engineering, and technology communities and expects that such values will be reflected in the composition of field campaigns. Discrimination and harassment are not tolerated at NASA. Having a diverse, inclusive, and safe workplace is essential to achieving the excellence for which NASA strives. In support of NASA's core value of Inclusion, proposals must describe how the scoping study and the subsequent field campaign will create and maintain a diverse and inclusive team. Proposals should briefly describe any planned surveys or evaluations, training to be offered or required, codes of conduct to be developed and followed, mentoring or professional development activities offered, and planned management practices. The proposal should also describe any plans to broaden participation with unrepresented or under-represented groups. Engagement of minority serving institutions in workshops and planning is strongly encouraged.

Proposers seeking to enjoy the benefits of a more diverse team may consider, for example, referring to the NASA Minority Serving Institution (MSI) Exchange at https://msiexchange.nasa.gov/ as place for proposers to find participants on their proposals.

3. Previous Large-Scale Terrestrial Ecology Field Campaigns

Below are a few examples of major field campaigns that have been supported and/or led by the NASA Terrestrial Ecology Program.

3.1 Boreal Ecosystem-Atmosphere Study

The Boreal Ecosystem-Atmosphere Study (BOREAS) (1992-1999) was a large-scale interdisciplinary field experiment in the boreal forests of Canada. Its goal was to improve our understanding of boreal forests -- how they interact with the atmosphere, how much CO_2 they can store, and how climate change will affect them. BOREAS used satellite data to monitor forests and to improve computer simulation and weather models. BOREAS helped the NASA Terrestrial Ecology community prepare for the application of Earth Observing System data, particularly MODIS data, to boreal forests. The large-scale study area for BOREAS was a 1000 x 1000 km area covering most of Saskatchewan and Manitoba, Canada. Within that region were two specific study areas -- the Northern Study Area (NSA) in Thompson Manitoba, and the Southern Study Area (SSA) in Prince Albert, Saskatchewan. BOREAS involved Intensive Field Campaigns in 1994 and 1997 during which multi-scale surface, tower, aircraft, and satellite observations were made. BOREAS was the first time that multiple eddy covariance flux towers were deployed in a coordinated manner. Some BOREAS results are available here and here.

3.2 Large-Scale Biosphere-Atmosphere Experiment in Amazonia

The Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) (1998-2011) was an intensive scientific investigation of the tropical rainforest of Brazil and portions of adjacent countries. LBA used remote-sensing techniques and ground-based

experiments to investigate the atmosphere-biosphere-hydrosphere dynamics of this large tropical region. The overarching science questions for LBA were: (1) How does Amazonia currently function as a regional entity? (2) How will changes in land use and climate affect the biological, chemical and physical functions of Amazonia, including the sustainability of development in the region and the influence of Amazonia on global climate?

The LBA Project, led by Brazil, encompassed several components. The NASA-sponsored LBA-ECO component focused on specific questions regarding the role of terrestrial ecosystems in the Amazon and was the primary focus of NASA's Terrestrial Ecology Program. The science questions included the following: How do tropical forest conversion, regrowth, and selective logging influence carbon storage, nutrient dynamics, trace gas fluxes, and the prospect for sustainable land use in Amazonia? What is the role of old growth tropical forests in the regional and global carbon cycle? What are the potential effects of Amazon deforestation on the water and energy budget of the region? LBA-ECO involved measurements by eddy covariance flux towers, forest sampling plots, atmospheric sampling, experimental manipulations, and satellite remote sensing. Some results from LBA and LBA-ECO are summarized here and here.

3.3 Arctic-Boreal Vulnerability Experiment

The Arctic-Boreal Vulnerability Experiment (ABoVE) (2015-2024) is a NASA Terrestrial Ecology Program field campaign that is being conducted in Alaska and western Canada (see Study Domain). ABoVE is a large-scale study of environmental change and its implications for social-ecological systems. ABoVE's science objectives are broadly focused on (1) gaining a better understanding of the vulnerability and resilience of Arctic and boreal ecosystems to environmental change in western North America, and (2) providing the scientific basis for informed decision-making to guide societal responses at local to international levels. ABoVE research links field-based, process-level studies with geospatial data products derived from airborne and satellite sensors, providing a foundation for improving the analysis and modeling capabilities needed to understand and predict ecosystem responses and their societal implications.

ABoVE resulted from a 2008 solicitation by the NASA Terrestrial Ecology Program for scoping studies (white papers) for a new field campaign. The final report of the scoping study can be found here. Subsequently, a workshop was held, a Science Definition Team was formed, and the ABoVE Concise Experiment Plan was produced. Solicitations for pre-ABoVE data product creation were released in 2012 and 2013. The Solicitation for Phase 1 was released in 2014; for the Airborne Campaign in 2016; for Phase 2 in 2018; and for Phase 3 in 2021. The ABoVE Implementation Plan is a living document that describes the implementation of the ABoVE research projects. Some results from ABoVE are described here and here. The detailed timeline for the development of ABoVE can be found here.

4. Relevance to NASA Earth Science Research Priorities

The overall goals of NASA's Earth Science program are documented in the NASA Science Mission Directorate 2020-2024 Science Plan and *NASA 2018 Strategic Plan*. NASA Earth Science research focuses on using space-based observations to safeguard and improve life on Earth. These space-based observations are often supplemented

with other types of observations (e.g., aircraft and/or surface measurements) and then combined and synthesized in models. Coordinated large-scale Terrestrial Ecology field campaigns make significant contributions to understanding the role of terrestrial ecosystems in climate change and thus make a significant contribution to NASA Earth Science.

Large-scale field campaigns contribute toward the goals of the U.S. Global Change Research Program (USGCRP) for improved understanding of the changing Earth system through observations, modeling, and process studies, as well as changing patterns of extreme events and potential tipping points in the natural and human systems. Large-scale field campaigns can also contribute to USGCRP's goals to expand research into inter-connected natural and managed systems to inform decision-making about adaptation, mitigation, and environmental justice issues related to global change.

The Marine and Terrestrial Ecosystems and Natural Resources Management Panel of the 2017 Decadal Survey for Earth Science and Applications from Space (ESAS) of the National Academies of Sciences, Engineering, and Medicine (NASEM) *Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space* identified several science and application questions essential to understanding how environmental change impacts ecosystems and how this may affect the services they provide, and how the structure of these ecosystems affects the fluxes of carbon, nutrients, and energy between and across the components of the Earth system. NASA expects future field campaigns to contribute to advancing the goals of the current and future Earth Science Decadal Surveys by conducting research that helps prepare for the new observation capabilities expected to become available. A future NASA Terrestrial Ecology field campaign should help NASA use the future Earth System Observatory, particularly the NISAR and SBG missions, to answer important scientific questions regarding the role of terrestrial ecosystems in climate change, sustainable development, and biodiversity conservation.

5. Table of Work Effort and Current and Pending

Proposers must use the standard Earth Science templates to detail project participants' levels of work effort in the scoping studies and current and pending support. The Work Effort table must be placed immediately following the Biographical Sketches (Curriculum Vitae). Co-investigators should include only those people expected to play a significant role in the scoping study beyond simple attendance at a workshop.

6. Programmatic Information

6.1 Eligibility

This program element is open to all categories of institutions. Proposals from non-U.S. organizations may propose to participate on a no-exchange-of-funds basis. Collaborations between researchers at U.S. and non-U.S. organizations are welcome, but the portion of work to be conducted by the non-U.S. institution must be funded through other sources to comply with NASA's no-exchange-of-funds policy. For more information see the ROSES FAQ on this topic.

6.2 Available Funds, Budget Profiles, and Periods of Performance

Funding available for this entire program element is approximately $400K to $500K/year over a maximum 12-month period. NASA expects to support up to two scoping studies ($200K to $250K/each).

6.3 Evaluation Criteria **[Amended July 28, 2022]**

Proposals are evaluated according to the **three default** criteria **(Merit, Relevance, and Cost)** defined in **Appendix D** the *2022 NASA Guidebook to Proposers* and applied as described in Section V(a) of the *ROSES-2022 Summary of Solicitation*. **Clarifications of those criteria, as they apply to this particular program element, appear below.**

Intrinsic scientific merit addresses the overall scientific merit of the proposal**, including the quality of both the idea and its implementation**. It accounts for the extent and quality to which the proposal addresses the ten elements described in Section 2.2 of this program element, as well as the compelling nature of the scientific questions **and the feasibility of the proposed field experiment**. Relevance accounts for the extent to which the proposed scoping study will advance the goals of the NASA Terrestrial Ecology Program and NASA Earth Science. ~~It also evaluates the feasibility of the proposed field experiment.~~ Cost reasonableness evaluates whether the proposed level of effort (i.e., labor FTEs) and the other proposed direct costs (i.e., supplies, equipment, travel) are commensurate with those required to accomplish the goals of the proposal.

In addition to responsiveness to the goals, objectives, and requirements described in this program element, the assessment of a proposal's relevance shall take into account the degree to which the investigation will contribute to an understanding of large-scale responses of social-ecological systems to environmental change.

7. Summary of Key Information

Expected program budget for first year of all new awards	~$200K to $250K/year for 12 months
Expected number of new awards	1 to 2
Maximum duration of awards	12 months
Due date for notice of intent (NOI) to propose	See Tables 2 and 3 of this ROSES NRA
Due date for proposals	See Tables 2 and 3 of this ROSES NRA
Planning date for start of the investigations	~ 9 to 12 months after proposal due date
Science/Technical/Management section page limit	15 pages maximum.
Relevance	This program element is relevant to the Earth Science questions and goals in the NASA Science Plan. Proposals relevant to this program element are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES-2022 Summary of Solicitation*.

General requirements for content of proposals	See A.1 the Earth Science Research Program Overview, and Section IV and Table 1 of *ROSES-2022*.
Detailed instructions for the submission of proposals	See NSPIRES Online Help, Sections 3.22-4.4 of the *NASA Guidebook for Proposers* and Section IV(b) of *the ROSES Summary of Solicitation*.
Submission medium	Electronic proposal submission is required; no hard copy is permitted
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (Help Desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov/ (help desk available at support@grants.gov or (800) 518-4726)
Funding Opportunity Number for downloading an application package from Grants.gov	NNH22ZDA001N-TE
Points of Contact, both of whom share this address: Earth Science Division Science Mission Directorate NASA Headquarters Washington, DC 20546-0001	Hank Margolis (202) 295-7075 hank.a.margolis@nasa.gov Michael Falkowski (202) 826-7498 michael.falkowski@nasa.gov