

A.3 CARBON CYCLE SCIENCE

1. Scope of Program

This announcement offers opportunities for new and successor Carbon Cycle Science investigations within the NASA Earth Science Program and the U.S. Department of Agriculture (USDA) Cooperative State Research, Education, and Extension Services (CSREES) National Research Initiative Competitive Grants Program (NRI). NASA and USDA-CSREES seek proposals to improve understanding of changes in the distribution and cycling of carbon among the active land, ocean, and atmospheric reservoirs. Of special interest are the factors that affect changes in the sources and sinks for atmospheric carbon dioxide (CO₂) and methane (CH₄) and carbon management to slow increases of these greenhouse gases.

NASA Earth Science Research Program goals in carbon cycle science are to improve understanding of the global carbon cycle and to quantify changes in atmospheric CO₂ and CH₄ concentrations as well as terrestrial and aquatic carbon storage in response to fossil fuel combustion, land use and land cover change, and other human activities and natural events. NASA carbon cycle research encompasses multiple temporal and spatial scales and addresses atmospheric, terrestrial, and aquatic carbon reservoirs, their coupling within the global carbon cycle, and interactions with climate and other aspects of the Earth system. A focus on observations from space pervades carbon cycle research by NASA and is a basis for partnerships with other U.S. Government agencies and institutions. NASA carbon cycle research contributes toward the goals of major U.S. Climate Change Science Program (CCSP) activities, including the U.S. North American Carbon Program (NACP) and the Ocean Carbon and Climate Change Program (OCCC).

NASA Applied Sciences projects extend the products of Earth science research and the tools associated with that research, including observations, measurements, predictive models, and systems engineering, to meet societal needs beyond NASA Earth Science Research Program objectives. Carbon management is one of 12 applications of national priority addressed by the NASA Applied Sciences Program. Projects exploit NASA carbon cycle research results and related capabilities to enhance decision making within operational agencies responsible for resource management and policy decisions that affect carbon emissions, sequestration, and fluxes among terrestrial, aquatic, and atmospheric environments.

The USDA-CSREES mission is to advance knowledge for agriculture, the environment, human health and well being, and communities. The purpose of CSREES's NRI is to support research, education, and extension grants that address key problems of national, regional, and multistate importance in sustaining all components of agriculture. USDA research seeks to determine the significance of agricultural systems (including farm, crop, forest, and range lands) in the global carbon cycle and to identify agricultural and forestry activities that can contribute toward reducing atmospheric concentrations of greenhouse gases.

2. Carbon Cycle Research Themes

NASA and USDA-CSREES carbon cycle research contributes toward the goals of the CCSP (<http://www.usgcrp.gov/>) and the U.S. Ocean Action Plan (<http://ocean.ceq.gov/actionplan.pdf>) by providing critical scientific information about the movement of carbon in the environment and potential near- and long-term changes in the carbon cycle, including the role of and implications for societal actions. U.S. carbon cycle research addresses two broad questions:

- How large and variable are the dynamic reservoirs and fluxes of carbon within the Earth system and how might carbon cycling change and be managed in future years, decades, and centuries?
- What are our options for managing carbon sources and sinks to achieve an appropriate balance of risk, cost, and benefit to society?

In this solicitation, NASA requests proposals to use satellite observations effectively in studies to address these questions. Proposals within four research themes are of interest to NASA:

1. Global carbon cycle modeling and analysis;
2. Regional studies that provide critical understanding of and offer to reduce major uncertainties about the global carbon cycle;
3. Studies of the carbon cycle implications of ocean acidification; and
4. Decision-support systems for carbon management.

The USDA-CSREES requests proposals to conduct regional carbon studies in North America under research themes two and four.

Additionally, NASA and USDA-CSREES will consider successor proposals to advance the results of projects selected under the 2004 Carbon Cycle Science NASA Research Announcement (NRA-04-OES-01; <http://nspires.nasaprs.com/external/>; click on "selected proposals" and search on 2004.) toward synthesis at continental, ocean basin, and global scales.

2.1 Global Carbon Cycle Modeling and Analyses Theme

The carbon cycle is an integrated global system, and a complete understanding of changes in atmospheric CO₂ and CH₄ concentrations requires study of global carbon sources and sinks and their dynamics at relevant temporal scales. Models are primary tools for integration and scaling of information and for predicting future conditions. Better global models are required to improve the portrayal of carbon cycle dynamics and the processes that control them, as well as to couple the cycling of carbon to other processes within Earth system models.

NASA requests proposals for new or improved carbon models that are more comprehensive in treating significant processes and drivers, including those involving or

stemming from human activities. These advanced carbon models should address time scales of decades to centuries and seek to realistically portray processes occurring over longer time-scales such as plant growth, mortality, and decomposition; changes in land use and vegetation type; disturbance and recovery cycles; succession; carbon export to the deep ocean; or responses to changes in the thermohaline circulation of the ocean. Models that integrate across spatial scales, and up to the global scale, are of interest. Proposals for advanced carbon models should utilize satellite remote sensing data either to drive the model or for model evaluation (i.e., calibration or validation).

Carbon data assimilation or data fusion to ingest atmospheric measurements, satellite observations, and data from terrestrial and aquatic *in situ* networks provide formal means of integrating diverse data within carbon cycle models. The ability to understand the processes and mechanisms underlying assimilation results rests on the veracity and detail of models within assimilation or fusion systems. NASA requests proposals to extend carbon data assimilation or data fusion schemes by incorporating models of major carbon cycle components with substantially improved detail, realism, and accuracy in the representation of key processes that determine magnitudes and distributions of sources and sinks for carbon and carbon cycle dynamics affecting CO₂ or CH₄ concentrations. NASA also is interested in proposals to develop new carbon data assimilation or data fusion approaches that are truly innovative over existing schemes.

Proposals for carbon modeling and data assimilation must make substantial and critical use of NASA satellite remote sensing data.

The Orbiting Carbon Observatory (OCO), an Earth System Science Pathfinder mission expected to launch in September 2008, will provide measurements of atmospheric column CO₂ at spatial and temporal resolutions that allow more detailed estimation of sources and sinks for atmospheric CO₂ (<http://oco.jpl.nasa.gov/>). In this solicitation, NASA is interested in proposals to prepare the scientific community for analysis of OCO data. Such work might anticipate needs for improved atmospheric transport and inversion models, extended validation activities, or to develop data assimilation and data fusion approaches tailored specifically to OCO data and the estimation of atmospheric carbon sources and sinks. Proposed work might create or make use of simulated data or surrogate data products (e.g., observations from the Atmospheric InfraRed Sounder (AIRS) on Aqua, the Tropospheric Emission Spectrometer (TES) on Aura, Japan's Interferometric Monitor for Greenhouse Gases (IMG), or the European Space Agency's Scanning Imaging Absorption SpectroMeter for Atmospheric CHartography (SCIAMACHY)). Proposals should complement, not duplicate, work undertaken by instrument science teams.

2.2 Regional Studies to Reduce Major Global Carbon Cycle Uncertainties Theme

NASA requests proposals for regional carbon cycle studies where critical understanding can be achieved to reduce major uncertainties about the global carbon cycle. Proposals should focus on regions of the Earth (land, ocean, or integrated terrestrial-aquatic systems) and on carbon cycling processes that can cause significant changes in fluxes of

CO₂ or CH₄ to the atmosphere or in the size and longevity of important carbon sources and sinks. To be of interest, such studies must take advantage of unique NASA capabilities and/or make substantial use of remote sensing observations. An understanding of the errors associated with measurement and quantification must accompany these research results.

The northern high latitudes, inclusive of boreal and arctic ecosystems, are one region of specific interest. These areas are experiencing significant changes and are projected to respond strongly to future climate change. Changes in the carbon dynamics of these regions may have profound feedbacks to climate through altered productivity and decomposition rates, melting permafrost, aquatic transport and transformation of carbon, and changes in albedo and the surface energy budget. Proposals for regional studies at northern high latitudes should include appropriate linkages to and address the requirements of the NACP (<http://www.nacarbon.org/>), Northern Eurasia Earth Science Partnership Initiative (NEESPI; <http://neespi.org/>; also see Appendix A.2 of this NRA, sections 1.2.3 and 1.3, for information about requirements for NEESPI participation), or the International Polar Year (IPY; <http://www.ipy.org/>).

In this solicitation, NASA is interested only in regions that are large enough to be significant in continental- to global-scale carbon budgets either in terms of area (generally areas greater than 1,000,000 km²) or in terms of atmospheric exchanges and changes in carbon stocks.

USDA-CSREES requests proposals addressing the contributions of North American agriculture, forestry, and land-use and land-cover change to greenhouse gas fluxes; CO₂, CO, and CH₄ are of particular interest. USDA-CSREES is also interested in proposals to investigate carbon storage and exchange within North American agricultural, silvicultural, and rangeland systems. Predictive model results that inform policies regarding carbon in agricultural and forestry sectors are of interest. Projects that coordinate with observational and experimental facilities such as National Science Foundation (NSF) Long-Term Ecological Research (LTER) sites, Free-Air CO₂ Enrichment (FACE) experiments, AmeriFlux, and proposed Critical Zone sites, as well as those established by NACP field campaigns are particularly encouraged.

2.3 Ocean Acidification Theme

The oceans play a critical role in the global carbon cycle and in Earth's climate. A variety of processes interact among land, ocean, and atmosphere (the Earth System), and the interplay of these processes' impacts and feedbacks on ocean chemistry. Changes in ocean chemistry, as a result of both natural and anthropogenic factors, translate to ocean biology and ocean ecosystems. One poorly understood area in need of study is ocean acidification, particularly as may result from environmental change. NASA welcomes proposals for studies that address our understanding of ocean acidification and the impacts and feedbacks on ocean chemistry and biology, including the impact of increasing or high CO₂ concentrations on ocean chemistry and ecology, such as the oceans' ability to take up CO₂. Other interests include the biotic partitioning of carbon

and how ocean processes affect and constrain where in the ocean CO₂ may be sequestered. To the extent possible, predictions of changes and quantification of ocean acidification on the broad ocean system, especially carbon dynamics, with the associated errors, are encouraged.

All studies proposed in response to this solicitation should make substantial use of NASA suborbital or satellite remote sensing data. An understanding of the errors associated with measurement and quantification must accompany these research results.

2.4 Carbon Management Theme

NASA requests proposals to address decision support for carbon management in North America, especially projects that link science results from projects related to the NACP with decision-support tools of operational users. Projects must include one or more of the following programmatic elements:

1. A review of science results from carbon cycle research to identify outcomes with potential impact on specific decision-making processes;
2. Development and evaluation of prototypes that demonstrate the potential of observations from NASA space-based systems, output from NASA predictive models, or models that use observations from NASA space-based systems to improve the performance of decision-support processes or tools; or
3. Incorporation of NASA observations from space-based systems or output from predictive models in decision-support tools of partner agencies or organizations and benchmarking the performance of the decision-making process with the NASA enhancements.

Proposals are also sought for carbon cycle science research if the need for the research is demonstrated to address a specific decision-making process. The research should include the use of NASA space-based observations and conclude with a demonstration of a prototype.

The key characteristic of the Applied Sciences Program is the identification of a decision-support tool or process used by the operational partner. When developed to its fullest extent, an Applied Sciences project documents the performance of a decision-making process before and after the integration of enhancements based on NASA research results and associated tools. In response to the recognized difficulty of finding partner agencies and candidate decision-support tools or processes, the Program also supports projects that systematically review NASA Earth science research results to identify outcomes with potential impact on decision-making processes and projects that develop and evaluate prototype solutions.

USDA-CSREES will also consider carbon management projects that integrate research activities and results with decision support tools and extension activities. Proposed

extension activities should lead to measurable behavior change or adoption of technology in an identified audience or stakeholder group.

3. Programmatic Information

3.1 Evaluation and Selection of Proposals

3.1.1 NASA and USDA-CSREES Cooperation

All proposals will be submitted to a NASA-led peer review process in accordance with the guidelines provided in this solicitation and the *NASA Guidebook for Proposers*. NASA and USDA-CSREES will collaborate in the planning and conduct of the peer review. This peer review will be followed by a programmatic review in which NASA and USDA-CSREES program officers will assess program balance across the highly-rated proposals and evaluate any logistical, implementation, cost, or management concerns. The NASA and USDA-CSREES program officers will recommend for selection the proposals that best address the objectives of this solicitation within resource constraints. The NASA and USDA-CSREES program officers will also recommend the division of funding responsibilities between the two agencies consistent with each agency's mission (see section 3.1.2 on evaluation criteria below). Co-funding is possible, and NASA and USDA-CSREES reserve the option of funding co-investigator institutions either as a subaward of the principal investigator institution's award or as a separate award directly to the co-investigator institution.

The funding recommendations will be forwarded to each participating agency's Selecting Official for confirmation. The Selecting Official for USDA-CSREES will be the Research Director, Competitive Programs. The Selecting Official for NASA will be the Director, Earth Science Division. NASA will announce the official selection of proposals for award, recognizing the agency or agencies that have agreed to be responsible for funding.

Proposals that USDA-CSREES has agreed to be responsible for will be forwarded to that agency for final negotiations and implementation of awards. Respondents selected for funding by USDA-CSREES may be asked to submit additional documentation to satisfy USDA-CSREES funding compliance and certification requirements.

3.1.2 Evaluation Criteria

Proposals will be evaluated according to the criteria specified in section C.2 of the *NASA Guidebook for Proposers*. In addition, the evaluation of intrinsic merit for a proposal that addresses the theme on decision-support systems for carbon management (Section 2.4) shall consider the soundness of the systems engineering proposed to extend NASA observations, measurements, and models to enhance existing decision support tools.

Evaluation of a proposal's relevance also will consider the potential contribution to the mission of USDA-CSREES (see Section 1) in addition to its contribution to the NASA mission.

Evaluation of the relevance of a proposal that addresses the theme on decision-support systems for carbon management (Section 2.4) shall include the following additional factors:

- the alignment with the objectives and approach of the NASA Applied Sciences Program and its carbon management program element or the alignment with the objectives and approach of the USDA-CSREES NRI Integrated Authority (see the 2007 NRI Request for Applications at http://www.csrees.usda.gov/funding/rfas/pdfs/07_nri.pdf; Part II,C,3. Integrated Projects); and
- the potential to transfer successful enhancements of decision support tools into the operational procedures of a user organization.

3.2 Programmatic Information Specific to NASA:

3.2.1 High-End Computing Resources

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

3.3 Programmatic Information Specific to USDA-CSREES

3.3.1 Eligibility

For *research projects*, the eligibility requirements for the NRI are as follows: except where otherwise prohibited by law, State agricultural experiment stations, all colleges and universities, other research institutions and organizations, Federal agencies, national laboratories, private organizations or corporations, and individuals are eligible to apply for and to receive a competitive grant.

For *integrated projects*, the eligibility requirements for the NRI are as follows: except where otherwise prohibited by law, State agricultural experiment stations, all colleges and universities, research foundations maintained by colleges or universities, private research organizations with established and demonstrated capacities to perform research or technology transfer, Federal research agencies, and national laboratories are eligible to apply for and receive a competitive grant.

3.3.2 Level of Funding Available

USDA-CSREES plans to provide \$1.6 million over three years with the typical budget for a project not to exceed \$600,000 over three years.

3.3.3 Legislative Authority

The authority to support research projects through the USDA-CSREES program is contained in 7 U.S.C. 450i(b). Under this authority, subject to the availability of funds, the Secretary may award competitive research grants, for periods not to exceed five years, for the support of research projects to further the programs of the USDA.

Section 401 of the Agricultural Research, Extension and Education Reform Act of 1998 (AREERA) authorizes the Secretary of Agriculture to establish a research, extension, and education competitive grants program to address critical emerging U.S. agricultural and rural issues related to future food production; environmental quality and natural resource management; farm income; or rural, economic and business and community development policy. In addition, the Secretary of Agriculture is authorized to make grants that address priority mission areas related to: (1) agricultural genomics, (2) food safety, food technology, and human nutrition, (3) new and alternative uses and production of agricultural commodities and products, (4) agricultural biotechnology, (5) natural resource management, including precision agriculture, and (6) farm efficiency and profitability, including the viability and competitiveness of small and medium-sized dairy, livestock, crop, and other commodity operations.

This program is listed in the Catalog of Federal Domestic Assistance under 10.206, National Research Initiative Competitive Grants Program, Carbon Cycle Science.

3.3.4 Current and Pending Support

For proposals funded by USDA-CSREES, the agency requires that the Current and Pending Support information be submitted for all Project Directors (PDs) and Senior/Key Persons regardless of percentage of effort.

3.3.5 Limit on Indirect Costs for USDA-CSREES Awards

Section 709 of the FY 2006 Consolidated Agricultural Appropriations Act (Public Law 109-97) limited indirect costs to 20 percent of the total Federal funds provided under each award. CSREES anticipates that the FY 2007 Agricultural Appropriations Act will include a similar limitation. Therefore, when preparing budgets, applicants should limit their requests for recovery of indirect costs to the lesser of their institution's official negotiated indirect cost rate or the equivalent of 20 percent of total Federal funds awarded. Another method of calculating the maximum allowable is 25 percent of the total direct costs. Please note that if the 2007 Agricultural Appropriations Act contains a different indirect cost limitation, CSREES will contact each successful applicant to apply the correct rate prior to the award of a grant.

3.4 Summary of Key Information

Expected annual program budget for new awards	~ \$7–9M
Number of new awards pending adequate proposals of merit	~30–40
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	See Tables 2 and 3 in the <i>Summary of Solicitation</i> of this NRA.
Due date for proposals	See Tables 2 and 3 in the <i>Summary of Solicitation</i> of this NRA.
NASA or USDA-CSREES strategic objective(s) which proposals must state and demonstrate relevance to	Proposals for NASA funding must address one or more strategic goals or strategic outcomes from Table 1. See also Sections I(a) and IV(e) in the <i>Summary of Solicitation</i> of this NRA. Proposals for USDA-CSREES funding must address one or more of the USDA-CSREES objectives listed in section 1 of this Appendix (A.3).
General information and overview of this solicitation	See the <i>Summary of Solicitation</i> of this NRA.
Detailed instructions for the preparation and submission of proposals	See the <i>NASA Guidebook for Proposers Responding to a NASA Research Announcement – 2007</i> at http://www.hq.nasa.gov/office/procurement/nraguidebook/ .
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the <i>NASA Guidebook for Proposers</i>
Submission medium	Electronic proposal submission is required; no hard copy is required. See also Section IV in the <i>Summary of Solicitation</i> of this NRA and Chapter 3 of the <i>NASA Guidebook for Proposers</i> .
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	NNH07ZDA001N-CARBON

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