A.5 Carbon Cycle Science

Notice: Proposals to this program will be taken via a two-step proposal process. This means that the Notice of Intent is replaced by a required Step-1 proposal and the Title and Principal Investigator are binding and cannot be changed in the Step-2 proposal. The required Step-1 proposal must be submitted by an authorized institutional official at the Principal Investigator's organization. The two-page Step-1 proposal will be used to conduct a preliminary evaluation, which will result in full proposals being either encouraged or discouraged. See Section 4 for details.

1. Scope of Program

This announcement offers opportunities for Carbon Cycle Science investigations within the NASA Earth Science Program, the U.S. Department of Agriculture (USDA) National Institute of Food and Agriculture (NIFA) Agriculture and Food Research Initiative Competitive Grants Program (AFRI), the U.S. Department of Energy (DOE) Terrestrial Ecosystem Science Program, and the Atmospheric Chemistry, Carbon Cycle, and Climate (AC4) Program within NOAA's Climate Program Office. NASA, USDA, DOE, and National Oceanic and Atmospheric Administration (NOAA) seek proposals to improve understanding of changes in the distribution and cycling of carbon among the active land, ocean, and atmospheric reservoirs and how that understanding can be used to establish a scientific foundation for societal responses to global environmental change.

2. Background

Priorities for new carbon cycle science research continue to derive from the research agenda of the U.S. Global Change Research Program (USGCRP) (http://www.globalchange.gov/), and, specifically, its U.S. Carbon Cycle Science Program (http://www.carboncyclescience.gov/), as well as the goals and objectives of the individual agencies supporting the research.

In 2011, the U.S. carbon cycle science community completed a new plan for carbon cycle research. This reassessment of U.S. carbon cycle science priorities was conducted by the USGCRP Carbon Cycle Interagency Working Group's (CCIWG) Carbon Cycle Science Steering Group (CCSSG). The planning process culminated in the publication of *A U.S. Carbon Cycle Science Plan* (http://www.carboncyclescience.gov/USCarbonCycleSciencePlan-August2011.pdf). This community plan informs U.S. research efforts on the global carbon cycle for the next decade. It is organized around three overarching questions:

- How do natural processes and human actions affect the carbon cycle on land, in the atmosphere, and in the ocean?
- How do policy and management decisions affect the levels of the primary carbon-containing gases, carbon dioxide and methane, in the atmosphere?
- How are ecosystems, species, and natural resources impacted by increasing greenhouse gas concentrations, the associated changes in climate, and by carbon management decisions?

2.1 NASA Carbon Cycle Science

The overall goals for NASA's Earth Science program are documented in NASA's Strategic Plan (http://nasascience.nasa.gov/about-us/science-strategy). The goals of the NASA Earth Science Program for carbon cycle science are to improve understanding of the global carbon cycle and to quantify changes in atmospheric CO_2 and CH_4 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 USGCRP activities, including the Carbon Cycle Science Program's U.S. North American Carbon Program (NACP) and the Ocean Carbon and Climate Change Program (OCCC) (http://www.globalchange.gov/, http://www.carboncyclescience.gov/, http://www.nacarbon.org/nacp/, and http://www.us-ocb.org/about/projects.html). NASA carbon cycle research also contributes toward the goals of the National Ocean Council's National Ocean Policy planning documents (http://www.whitehouse.gov/administration/eop/oceans/policy).

2.2 USDA Carbon Cycle Science

The USDA-NIFA mission is to advance knowledge for agriculture, the environment, human health and well-being, and communities. The purpose of the AFRI 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, including carbon consequences of adaptation strategies within these systems, and to identify agricultural and forestry activities that can contribute toward reducing atmospheric concentrations of greenhouse gases. This carbon cycle science program falls within the USDA-NIFA'S Agriculture and Natural Resources Science for Climate Variability and Change program which seeks both fundamental and applied interdisciplinary research on impacts and feedbacks to global change and potential adaptation and mitigation strategies, as well as discovery and demonstration of decision support tools for land, ecosystem and water resource managers to mitigate carbon and greenhouse gas emissions (i.e., increase carbon sequestration and storage) while maintaining or enhancing productivity and associated ecosystem products, services, and structure; identify vulnerable ecosystems (including production and management systems) and their thresholds; and adapt to global change and its drivers. USDA carbon cycle research contributes toward the goals of major USGCRP activities, including the Carbon Cycle Science Program's U.S. NACP. In addition, USDA-NIFA encourages international coordination in the area of agricultural greenhouse gases via the Global Research Alliance (http://www.globalresearchalliance.org/).

The objectives of this program address the USDA Strategic Plan for 2010-2015 under Strategic Goal 2, Objective 2.2: Lead Efforts to Mitigate and Adapt to Climate Change, in particular the

strategy to “Develop models, national observing and monitoring systems, decision support tools, and new technology and adaptation strategies for communities, agriculture producers, and natural resource managers;” and “Encourage the adoption of reasonable, transparent, and science-based programs to adapt to, or mitigate the effects of, climate change on agriculture and forestry.” They also support the USDA Research, Education, and Economics (REE) Action Plan (http://www.ree.usda.gov/ree/news/USDA_REE_Action_Plan_02-2012_2.pdf) Goal 2: Responding to Climate and Energy Needs, Subgoal 2A: Responding to Climate Variability, with direct reference to the identified REE role to “develop and deliver science-based knowledge that empowers farmers, foresters, ranchers, land owners, resource managers, policymakers, and Federal agencies to manage the risks, challenges, and opportunities of climate variability, and position decision makers to reduce emissions of atmospheric greenhouse gases and enhance carbon sequestration.”

2.3 DOE Carbon Cycle Science

Within DOE's Office of Science, the Climate and Environmental Sciences Division (CESD) seeks to advance a robust predictive understanding of Earth’s climate and environmental systems and to inform the development of sustainable solutions to the nation’s energy and environmental challenges. Among CESD's goals, the following three pertain to the Terrestrial Ecosystems Science (TES) program and to this solicitation:

- Develop, test, and simulate process-level understanding of terrestrial ecosystems.
- Advance fundamental understanding of coupled biogeochemical processes in complex subsurface environments to enable systems-level environmental prediction and decision support.
- Synthesize new process knowledge to advance next-generation, integrated models of the human-Earth system.

TES seeks to improve the representation of terrestrial ecosystem processes in Earth system models, thereby improving the quality of climate model projections and providing the scientific foundation needed to inform DOE’s energy decisions. TES seeks to focus its research on ecosystems that are globally important, climatically sensitive, and comparatively understudied or underrepresented in Earth system models.

TES uses a systems approach to understand ecosystems over multiple scales that can be represented in models (e.g., single process models, system models, and coupled Earth system models). This emphasis on the capture of advanced understanding in models has two goals. It seeks to improve the representation of these processes in coupled models, thereby increasing the sophistication of the projections from those models. It seeks to exercise those models and compares the results against observations or other data sets to inform future research directions.

2.4 NOAA Carbon Cycle Science

The focus of NOAA carbon cycle science research is to better quantify the information on atmospheric composition, its influence on the energy budget, and feedbacks that contribute to changes in Earth’s climate. Specifically, NOAA seeks to provide the understanding needed to

link emissions of climate-relevant compounds to the radiative forcing of climate change for science-based decision support (see http://www.nrc.noaa.gov/plans.html)

NOAA is providing research 1) to understand oceanic and atmospheric processes, both natural and human-related, that affect carbon dioxide (CO_2) trends, 2) to quantify the climate roles of the radiatively important trace atmospheric species such as fine particles (aerosols), ozone, and chemically active greenhouse gases, and 3) to understand and assess stratospheric ozone depletion.

Research activities 1) may be directly applied to climate projection and to policy decisions regarding carbon management that are related to limiting unwanted effects of future climate change and 2) provide timely and adequate information needed to broaden the suite of noncarbon options for addressing changes in climate forcing, especially in the next few decades.

NOAA's carbon cycle research supports both national and international assessments of the climate system, e.g., the synthesis and assessment products of the USGCRP, the assessment reports of the IPCC, and the reports to the U.N. Montreal Protocol on the ozone layer. Such science-based assessments and scenarios provide (1) tools for better management of carbon- and noncarbon-based climate-forcing emissions, (2) a suite of choices for both air quality and the alteration of climate forcing in the near term, and (3) longer-term assessments of strategies for managing climate-forcing emissions over the longer term.

3. Carbon Cycle Research Solicited

In this solicitation, NASA, USDA, DOE, and NOAA request proposals for research and/or applied science investigations aimed at addressing the three overarching U.S. carbon cycle science questions and conducting research focused on integrated scientific-societal issues. Proposals within six specific research themes are requested. Each agency participating in this solicitation will be able to support research only in a subset of these themes, and the participating agencies are noted in parentheses for each theme listed below. The six research themes solicited are:

1. Carbon research in critical regions, specifically: Arctic-boreal regions, tropics, and high latitude oceans (NASA, DOE, USDA);
2. Carbon dynamics along terrestrial-aquatic interfaces, including land-ocean, land-freshwater, and coastal ocean regions (USDA, DOE, NASA);
3. Belowground carbon processes and soil carbon (USDA, DOE);
4. Carbon dynamics within urban-suburban-forested-agricultural landscapes (NOAA, USDA, DOE, NASA);
5. The impact of rising CO_2 on aquatic ecology (NASA); and
6. Carbon cycle science synthesis research (NASA, USDA, DOE)

A further description of the types of research solicited under each of these themes is provided in the sections that follow.

3.1 Theme 1: Carbon Research in Critical Regions (NASA, DOE, USDA)

Many Earth system research programs have focused on temperate systems due to proximity and ease of access. However, many extratemperate systems are increasingly recognized for their importance in critical Earth processes, particularly biogeochemical cycles associated with carbon and macronutrients. Tropical and Arctic ecosystems sequester massive quantities of carbon and are directly responsible for important feedbacks to the global climate system. However, our understanding of these systems and their characteristics and dynamics is poor and limits our ability to adequately predict their long-term behavior. Thus, representations within Earth system models frequently ignore or greatly oversimplify these important Earth systems. Research is solicited for the following three critical regions.

3.1.1 *Carbon Dynamics in Tropical Terrestrial Ecosystems (moist forests and woodlands/savannas)*

The tropics include approximately 40% of Earth's land surface area and critically regulate many Earth system processes. Tropical terrestrial ecosystems contain great stores of biomass representing a major reservoir of terrestrial carbon. These ecosystems also cycle more carbon dioxide (CO_2) and water than other biomes and play important roles in determining Earth's energy balance, which drives global systems of temperature and precipitation. Large-scale changes in tropical terrestrial ecosystems have the potential to change global patterns of temperature and precipitation. Tropical ecosystems are under significant stress from a changing climate and from anthropogenic land use changes. While generally accepted as a critical global system, tropical ecosystems are poorly understood, causing corresponding limitations to their representation in ecosystem and global-scale carbon cycle and climate system models. Important questions from microscale (microbial processes, biogeochemical processes) to macroscale (plants and plant systems, watersheds) to landscape scale remain unanswered regarding carbon dynamics in tropical systems.

Proposals should address improved understanding of widespread, critical tropical ecosystems. Particular emphasis is placed on research that combines measurements and/or experiments with modeling to provide improved quantitative and predictive understanding of the coupled biological, chemical, and physical interactions that represent potentially strong carbon cycle feedbacks from tropical terrestrial ecosystems in a changing climate. Processes of particular interest include the impacts of drought, temperature, and changes in hydrology, as well as improved understanding of soil biogeochemistry and methane dynamics. Preference will be given to projects that demonstrate strong potential feedbacks and wide geographic applicability.

3.1.2 *Carbon Dynamics in Arctic/Boreal Terrestrial Ecosystems*

Arctic tundra, boreal systems, and the transitions in between represent a vast expanse of northern land mass and contain one of the largest volumes of carbon stored in the biosphere. As a consequence of a warming climate, the region may be approaching a potential tipping point with regard to the release of this stored carbon. Climate warming could trigger large-scale releases of CO_2 and CH_4 from thawing Arctic/boreal soils into the atmosphere. However, warming and drying of land surfaces could increase plant production and either decrease methane production

or increase methane consumption, and thus potentially reduce carbon emissions to the atmosphere. Although it is widely accepted that this region is critically important to our understanding and modeling of climate change, our understanding of key processes, impacts, and feedbacks are far from robust. There are currently large uncertainties in the direction and strength of the positive and negative feedbacks and what is likely to occur in the region in response to continued climate change. These ecosystems are remote and measurements and observations that are widespread and common in temperate ecosystems are rare or absent in many of these northern ecosystems.

Therefore, this theme solicits fundamental research to advance our understanding of the function of widespread, critical northern terrestrial ecosystems, particularly in ways that influence carbon cycle feedbacks to the climate system. Particular emphasis is placed on research that combines measurements and/or experiments with modeling to provide improved quantitative and predictive understanding of the coupled biological, chemical, and physical interactions that represent potentially strong carbon cycle feedbacks to climate from northern terrestrial ecosystems in a changing climate. Preference will be given to projects that focus on strong potential feedbacks and have wide geographic applicability.

3.1.3 *Carbon Cycling and Ecosystem Dynamics in High Latitude Oceans*

The polar seas are areas of the world's ocean where the impacts of an altered climate are becoming ecologically dramatic. However, access to these regions has been historically limited, resulting in large unknowns in carbon cycle dynamics. For example, the waters of the Southern Ocean are known to be rich in macronutrients, although the interaction of macronutrients, micronutrients, and carbon dynamics and evolving impacts and feedbacks of carbon dynamics on Antarctic aquatic ecology are not well understood. In the Arctic, recent findings have shown nutrient-based changes occurring in Arctic biogeochemistry and ecology due to changes in sea ice cover. As a result of these unknowns and potential local and global impacts of climate change in high latitude waters, the elucidation of carbon cycle and ecosystem dynamics of the Antarctic and Arctic are major research priorities for many Federal, state, and regional agencies and institutions, including the USGCRP.

The biological pump is a significant driver of CO_2 cycling in the oceans; however, uncertainties still exist in our understanding of the role of the biological pump in high latitude carbon dynamics. There is a range of ideas as to what drives the biogeochemical and ecological dynamics of the Southern and Arctic Oceans. For example, it has been suggested that the interplay of micronutrients, light, and the biological pump drive biodiversity within these high latitude ecosystems. Micronutrients can impact the coupling between different biogeochemical cycles, with feedbacks on climate or on productivity of adjacent ocean basins, possibly affecting both the local ecology and the global carbon cycle. Resolving this complex, multifaceted story requires multiscale approaches in observations, analysis, and modeling. Research is needed to resolve different aspects of Arctic and Southern Ocean carbon cycle and ecosystem dynamics, including supplies of micro- and macronutrients, carbon sequestration and atmospheric CO_2 drawdown; the interaction between nutrient availability and the structure, biodiversity, and functioning of coastal and pelagic ecosystems; and the identification of carbon sources, sinks,

and fluxes within these waters and through the ecosystems. Proposals are invited that seek to address carbon cycling and ecosystem dynamics in Arctic and Antarctic waters.

Large changes in carbon cycle and ecosystem dynamics in response to shifts in climate are anticipated for Arctic and Antarctic aquatic ecosystems; consequently, proposals should seek to characterize ecosystem impacts of climate change in these regions and the ways in which they affect the carbon cycle. Proposals are encouraged that include interactions between human activities and aquatic ecosystems as these activities have the potential to profoundly alter aquatic ecosystems.

3.2 Theme 2: Carbon Dynamics along Terrestrial-Aquatic Interfaces (USDA, DOE, NASA)

Rivers, canal systems, lakes, wetlands, estuaries, and coastal oceans have complex linkages to terrestrial, atmospheric, and open ocean processes affecting carbon fluxes. Estuaries, mangroves, peatlands and swamps are areas of high accumulation of organic carbon, often dependent on influxes of nutrients from watersheds and/or coastal oceans. Coastal ocean carbon fluxes, through both biotic and abiotic processes across various temporal and spatial scales, are not well characterized and quantitative estimates of carbon fluxes in these regions are not well constrained. This topic addresses issues of carbon balance and fluxes affecting and as affected by processes at continental margins and other terrestrial-aquatic interfaces. In particular, research projects are sought in two topic areas to provide new or improved understanding of: 1) critical carbon processes, transformations and transport at terrestrial-aquatic-atmospheric interfaces and/or from watersheds to coastal areas, and 2) carbon fluxes at the interfaces among the land, coastal areas, atmosphere, and/or ocean.

Watersheds connect upland landscapes to coastal marine or ocean margin waters, linking fundamentally different terrestrial and aquatic carbon systems with land/ocean interfaces subject to dynamic processes that impact carbon sources, sinks, and fluxes. The terrestrial runoff and river discharge that connect these regions can vary over spatial and temporal scales, and in response to climatic and environmental variability and change. With that in mind, research on this first topic (i.e., critical carbon processes, transformations, and transport at terrestrial-aquatic-atmospheric interfaces and/or from watersheds to coastal areas) must focus on carbon cycling (e.g., transformation, transport, deposition) of terrestrial runoff and associated materials along the pathway to and/or within waters at the margins of the ocean or other large water bodies.

Research on carbon fluxes at the interfaces among the land, coastal areas, atmosphere, and/or ocean should emphasize understanding potential feedbacks to the climate system and key carbon cycle processes (e.g., soil carbon transformation, methane biogeochemistry, interactions with the nitrogen cycle) or management options to minimize release of carbon-containing greenhouse gases in regions of terrestrial-aquatic interfaces, and/or maximize carbon storage at the ends of or along terrestrial-aquatic pathways. Since human actions and socioeconomic drivers profoundly affect these areas in particular, a focus on or inclusion of these aspects into the proposed research is encouraged. Research may focus on terrestrial ecosystems and their interfaces with watersheds, wetlands, estuaries, coastal oceans (including fjords, bays, and sounds),

and/or the atmosphere; or on open ocean, atmospheric, and coastal ocean processes, and their interfaces with estuarine and/or coastal wetlands. Where appropriate, projects that integrate process research with modeling or that span different spatial and temporal scales are of strong interest.

3.3 Theme 3: Belowground Carbon Processes and Soil Carbon (USDA, DOE)

Belowground ecosystems play a critical role in the global carbon cycle and in the Earth's climate system. A variety of physical and chemical processes interact with plants, microbes, and the soil to regulate incorporation, stabilization, and release of carbon between the land and atmosphere. These belowground processes are not generally understood as a functional system. As a result, they often are ignored or oversimplified in modeling efforts. This gap in understanding or "black box" representation lacks adequate mechanistic resolution and, therefore, limits our ability to understand and project the source/sink relationship of terrestrial ecosystems at various temporal and spatial scales. Since belowground ecosystems cycle and store a significant fraction of carbon, improved understanding of belowground carbon accumulation, stabilization, vulnerability, and release is necessary. These topics could include soil carbon incorporation through root processes or stabilization/release through microbial/geochemical processes. This is particularly true of efforts to model and project the responses to and feedbacks from a changing climate. Proposed research should seek to advance our understanding and model representation of belowground processes and their feedbacks in the global carbon cycle.

Proposals should address improved understanding of belowground processes in the context of natural (i.e., unmanaged) terrestrial ecosystems in a changing climate or managed terrestrial ecosystems (agricultural, urban interfaces, etc) in a changing climate. Proposals that address managed and unmanaged systems together, or their interfaces, are also of interest. Particular emphasis is placed on research that combines measurements and/or experiments with modeling to provide improved quantitative and predictive understanding of coupled biological, chemical, and physical interactions controlling 1) carbon cycling in the rhizosphere, or 2) fluxes and transformations with high potential impact on soil carbon stabilization/destabilization and long-term storage potential. Successful applications will seek to provide a refined understanding of critical belowground processes (e.g., root dynamics, mycorrhizal interactions, plant mediated root exudation/priming, hydraulic redistribution, and microbial biogeochemical transformations) that mediate carbon cycling and feedbacks in terrestrial ecosystems. Additionally, the role of management practices on the carbon cycle (storage, release, transport, and vulnerability) in the soils of managed and transitional (e.g., riparian corridors and conservation reserves/buffers) areas will be considered.

3.4 Theme 4: Carbon Dynamics within Urban-Suburban-Forested-Agricultural Landscapes (NOAA, USDA, DOE, NASA)

Land use and resource management decisions generate complex patterns of native vegetation, managed forests, agricultural systems, and urban and suburban landscapes. This mosaic of land-use and land-cover (LULC) has significant spatial and temporal variation in terrestrial carbon stocks, rates of carbon exchange, and potentials for carbon sequestration. Urban, suburban, and surrounding agricultural and forest regions are becoming increasingly important in the global

carbon cycle. For example, as of the 2010 Census, more than 80% of the population of the U.S. now lives in cities and their suburbs. More than 90% of global anthropogenic greenhouse gas emissions are attributable (directly or indirectly) to cities. In recognition of their contributions to global greenhouse gas emissions, a number of cities, regions, and nations have issued bold goals for greenhouse gas emission reductions. Effective actions to quantify the effects of such actions will depend, however, on understanding the processes controlling the uptake, storage, and release of greenhouse gases along urban to rural gradients and the social, behavioral, and economic drivers and influences on these processes.

Development choices play a central role in determining local, regional, and global carbon emissions through such factors as energy consumption, transportation, and construction, as well as management for terrestrial carbon sinks via vegetation carbon uptake and storage. However, there are very few data available to systematically evaluate how alternative patterns of urban and regional development and LULC change interact with ecosystem processes and atmospheric carbon dynamics. Studies of the processes and mechanisms controlling carbon cycling in urban and surrounding regions can provide a useful test-bed for developing carbon cycle information that can provide a sound basis for carbon management at local and regional scales.

Land use changes of interest across the range of urban-suburban-forested-agricultural systems include, for example, deforestation, reforestation, and afforestation; urban encroachment; land conversions to and from agricultural and forestry uses; changes related to renewable energy production; changes in crop, range, pasture, or forest management systems; and fragmentation of land cover types. Also of importance are the interactions at the intersections of different land-uses/land-cover -- how does one land use affect the adjacent land-use or land-cover and what is the resulting net impact on carbon fluxes and stores. This could also include consideration of the tradeoffs between carbon sequestrations or greenhouse gas reductions and other goods and services needed by society and of the natural and socioeconomic drivers of these land changes and decisions. Changes and disturbances of interest include, for example, changing precipitation patterns; altered fire regimes; increasing temperatures and/or concentrations of CO_2, CH_4, and other greenhouse gases; extreme events; nitrogen deposition; and biotic or socioeconomic disruptions.

To better guide and strengthen the development of models of the processes dominating terrestrial and atmospheric carbon dynamics, effective use of advanced measurement and observational capabilities is needed. Integration of a broader range of data and information will also, in time, lead to improved predictive model capabilities. Carbon cycle research under this theme is, therefore, expected to help quantify the carbon signatures (spatial and temporal changes in fluxes) of ecosystems across a range of human influence and control, requiring measurements, modeling, and analysis. Research that aims to put observational constraints on the atmospheric signature of emission estimates is also encouraged, as are projects that attempt to characterize and quantify important atmospheric processes via modeling and analysis. Priority will be given to projects that most effectively apply advanced measurement approaches and integrate observations (both *in situ* and remotely sensed) and analysis to aid in understanding and/or predictive modeling of carbon dynamics across urban to rural gradients. Priority will also be given to those efforts that capitalize on ongoing activities and/or projects investigating systems of high potential carbon flux or climate feedback.

Additionally, projects that integrate research with outreach and/or education for various types of decision makers may be proposed under this theme. Such integrated projects should involve stakeholders from the beginning and throughout the project. Research may include assessing sustainable land use methodologies and technologies that can be implemented by stakeholders, to provide information that is essential for efficient markets and effective programs and oversight, or the development of decision support tools, educational materials or programs, and outreach strategies related to carbon management and policies.

3.5 Theme 5: The Impact of Rising CO_2 on Aquatic Ecology (NASA)

Recent planning documents for carbon cycle science, including the 2011 *A U.S. Carbon Cycle Science Plan*, point to large unknowns in global carbon dynamics, including a need to determine the synergistic effects of rising CO_2 on ecosystems in the presence of altered patterns of climate and associated changes in weather, hydrology, sea level, and ocean circulation. Concurrently, the United States Ocean Carbon and Biogeochemistry program (www.us-ocb.org) points to two overarching research priorities: oceanic uptake and release of atmospheric CO_2 and other greenhouse gases and environmental sensitivities of biogeochemical cycles, marine ecosystems, and interactions between the two. With these overarching goals in mind, this program element solicits proposals that seek to address one aspect of these scientific issues: to delineate, understand, and quantify the impact of rising atmospheric CO_2 on aquatic ecology. Proposals must include substantive use of NASA (ocean color) satellite data.

New research is needed to understand the impacts of rising atmospheric CO_2 on aquatic ecosystems, including, but by no means limited to, ocean acidification and the resulting impacts of aquatic uptake or release of carbon dioxide on aquatic organisms and ecosystems. Higher atmospheric CO_2 levels are likely to change the competitive balance among ecosystem dynamics, functional groups, and biodiversity (e.g., dramatic shifts in species). Efforts will be needed to determine the combined effects of rising CO_2 and altered patterns of climate on ecosystem structure and function in aquatic habitats. Additionally, linkages between land and ocean ecosystems represent an area that is sensitive to changes in carbon cycling, particularly the rise in CO_2 concentrations resulting from environmental change, and that has important significance for functional groups, ecosystems, and for society. These land-ocean linkages are only beginning to be examined in the context of carbon export to the coastal oceans and the impact of this export on diverse end points such as coastal ocean acidification and fisheries.

3.6 Theme 6: Carbon Cycle Science Synthesis Research (NASA, USDA, DOE)

Recent research investments in synthesis research under the North American Carbon Program (NACP) have been highly productive, producing, in addition to their scientific findings, new and valuable information regarding how carbon measurements can be used, the capabilities of carbon cycle models, and uncertainties and errors in these measurements and models. However, it seems clear that there is still more that could be learned and, at least in the case of the NACP midcontinent study, more data to be analyzed. Therefore, focused, follow-on research that extends and/or completes NACP synthesis research is solicited.

Also, the agencies believe that additional relevant carbon cycle science programs, projects, and topic areas would benefit from new synthesis studies addressing the important science questions of this solicitation. Candidate programs, projects, and topics include, but are not limited to Free Air Carbon Dioxide Enrichment (FACE), Greenhouse Gas Reduction through Agricultural Carbon Enhancement Network (GRACENet), AmeriFlux, Consortium for Agricultural Soils Mitigation of Greenhouse Gases (CASMGS), Rapid Soil Carbon Assessment, International Soil Carbon Network, disturbance, mortality, and ecosystem fluxes. New synthesis studies must be directed toward addressing the scientific topics outlined in Themes 1-5 in Sections 3.1-3.5 above.

Model intercomparison approaches with focused scientific objectives are of interest for synthesis research. Activities and infrastructure essential to the support of synthesis research, including data preparation, management, and distribution may be proposed as part of a scientific synthesis study. Proposers are encouraged to make use of existing infrastructure and/or partner with established data centers whenever possible. Proposals offering support infrastructure only, with no scientific synthesis research, will be considered nonresponsive to this program element.

3.7 Cross-cutting research activities

3.7.1 *Human Activities*

The agencies participating in this solicitation strongly encourage all proposers to consider offering research investigations that address human activities, including impacts on coupled human-biogeophysical systems and societal responses involving adaptation, mitigation, and/or integrated, adaptive management of carbon in the environment. Preference will be given to such proposals. Social science research approaches are encouraged when appropriate to the carbon cycle science activities proposed.

3.7.2 *Space-based Atmospheric Carbon Observations*

Past solicitations for interagency carbon cycle science research called for studies using space-based atmospheric carbon observations to be better prepared for upcoming observations from the Orbiting Carbon Observatory-2 (OCO-2) and Greenhouse Gases Observing Satellite (GOSAT) missions. Because other solicitations from NASA have called for similar studies, and because the GOSAT data are now becoming mature and used, this solicitation is not calling explicitly for such studies. Instead, studies are encouraged that use and/or combine existing space-based CO_2 and/or CH_4 observations (with or without other types of observations) to concentrate on the topics covered within sections 3.1 through 3.6 of this solicitation. In particular, sections 3.1, 3.2, and 3.4 are all quite relevant for the use of these atmospheric carbon observations. Also, validation of satellite atmospheric carbon data products remains a strong interest in support of the use of these observations and research to support surface remote sensing observations and infrastructure to evaluate current CO_2 and CH_4 data products would be welcome.

3.7.3 *Research Approaches and Analysis Tools*

The agencies value certain research approaches and analysis tools and believe they have much to offer in advancing current understanding of the global carbon cycle. Proposers are strongly

encouraged to consider including one or more of the approaches described below in this section in their research plans.

3.7.3.1 *Improved Observations*

Scientific understanding of the carbon cycle can be limited by the amount and quality of relevant observations and studies that offer improvements in observations are of interest when they focus on improving the observations necessary to achieve a particular carbon cycle science goal during the course of the study. However, proposers should note that this solicitation is not an appropriate vehicle for proposing technology development or instrument development work; any such proposals will be considered nonresponsive.

3.7.3.2 *Modeling*

Modeling approaches are of great interest and essential for developing predictive capacity for carbon cycling. The agencies are interested in all types of models that address carbon cycle dynamics (budgets and/or fluxes), including: data assimilation modeling, atmospheric transport and inversion modeling, ecosystem component modeling, socioeconomic modeling, model improvement through incorporation of new/better data and process information, analysis of model outputs, modeling at global and regional scales, models at the scale of key processes, and model intercomparison studies (including the data preparation and management activities necessary to support them). Utilization of, or explicit links to, widely used, open source models is encouraged, where appropriate.

3.7.3.3 *Coordination with other Federal Research Projects*

The U.S. Carbon Cycle Science Program coordinates the carbon cycle research of ten Federal agencies. Some of these agencies direct or compete their carbon cycle research in ways not compatible with an interagency solicitation of this nature at this time. Thus, it is imperative that efforts be made to coordinate and encourage synergies across all contributions to the U.S. Carbon Cycle Science Program. Proposers to this solicitation are, therefore, strongly encouraged to offer studies that collaborate with, leverage, complement, or build upon existing carbon cycle science or related projects of other U.S. agencies (e.g., NSF, USGS, other elements of USDA, etc.).

3.8 Additional Requirements for All Proposals

Proposers are advised to take great care to match their proposed activities to the research themes solicited (see Section 3) and the scientific goals (see Section 2) and programmatic considerations (see Sections 3.7.5 and 4.3-4.6) of each agency. Proposers are encouraged to contact the relevant agency point of contact listed in Section 5 if they have any questions regarding the appropriateness of or requirements for a particular type of study.

In addition to the requirements specified under each research theme in Sections 3.1-3.6 and the cross-cutting activities in Section 3.7 above, all proposals must adhere to the requirements detailed below.

3.8.1 *Error and Uncertainty*

All proposals must address how error and uncertainty will be dealt with in the study and describe how an understanding of the errors associated with measurement, quantification, and/or interpretation will be conveyed along with the research results.

3.8.2 *Project Management Plan*

Proposals must include a project management plan that presents a management structure describing roles and responsibilities for all Co-Investigators and Collaborators and how the research activities will be coordinated and integrated. The proposal budget section and proposal cover page must include budgetary information for all funded Co-Investigators. Involvement of students and postdoctoral scientists, where possible, is encouraged. The project management plan section should be inserted after the science and technical section of the proposal and does not have a page limit.

3.8.3 *Data Management Plan*

Research data obtained through public funding are a public trust. These data must be publicly accessible to be in compliance with the data policy of the U.S. Global Change Research Program of full and open access to global change research data (see http://www.gcrio.org/USGCRP/DataPolicy.html). Proposals submitted in response to this solicitation must include a data management plan describing the researcher's data sharing plan if the proposed research involves the acquisition of data. This includes data from measurements, observations, and experiments and from model simulations that would be costly to duplicate. The description must include plans for sharing and disseminating the data that are to be acquired in the course of the proposed research, particularly how the acquired data will be preserved, documented, quality assured, and archived for access by others. It is not necessary to identify the archive in the proposal, but a process for determining the archive should be described. The data management plan must include, when relevant to the type of study being proposed, the types of data and data products or other materials to be produced in the course of the project and the standards to be used for data and metadata formats. The data sharing plan called for in section 2.3.5 of the NASA *Guidebook for Proposers* should be included in the data management plan. The data management plan section should be inserted after the Project Management Plan section of the proposal and does not have a page limit.

Selected investigations also will be expected to comply with the data policy of the agency funding their study. The relevant agency data policies and archive descriptions that are now available online can be found at the following Web links:

NASA: http://science.nasa.gov/earth-science/earth-science-data/data-information-policy/ and http://earthdata.nasa.gov/data/data-centers
USDA: nothing available online at this time
DOE: http://cdiac.ornl.gov/, http://www-pcmdi.llnl.gov/ipcc/about_ipcc.php and http://public.ornl.gov/ameriflux/data-guidelines.shtml
NOAA: https://www.nosc.noaa.gov/EDMC/PD.DSP.php

3.8.4 *Principal Investigator Meeting Attendance Required*

All lead Principal Investigators (PI) of proposals funded under this solicitation will be required to attend the PI meetings of the agency funding their project or another PI meeting designated by that agency. Travel funds should be budgeted to allow at least the lead PI to attend one PI meeting during each year of the project.

3.8.5 *Agency-Specific Requirements and Opportunities*

3.8.5.1 *NASA Requirements and Opportunities*

To be eligible for NASA funding, the proposed research must make substantial use of remotely sensed data from satellites or airborne platforms.

3.8.5.2 *USDA Requirements and Opportunities*

3.8.5.2.1 USDA International Partnerships

To be eligible for USDA-NIFA funding, projects must show relevance to U.S. agriculture and forestry. However, to attain USDA's goals for agriculture and forestry, applicants may include international partnerships and activities, as long as they clearly describe how the international activities proposed contribute to and support advances in the viability and sustainability of U.S. agriculture and forestry.

3.8.5.2.2 USDA Restrictions on Indirect Costs

In addition, budgets for all USDA-NIFA funded projects must comply with USDA-NIFA restrictions on indirect costs and allowable expenses (see Section 4.3.3) or be willing to adjust budgets to comply with these restrictions upon being recommended for an award. Proposals funded by USDA-NIFA must show relevance to U.S. agriculture, including rangelands, forestry, food systems, or rural communities. Subcontracts to foreign institutions are allowed by USDA-NIFA, but cannot include salaries for regular employees of non-U.S. institutions.

3.8.5.2.3 USDA Opportunities for Enhancement Funding to Quantify and Mitigate Greenhouse Gases from Agriculture

USDA-NIFA intends to provide opportunities for successful proposals from this solicitation to seek additional funding for work to more accurately quantify and mitigate greenhouse gases from agriculture. These projects will have the opportunity to apply for enhancement funding to allow for international coordination, collaboration, and synthesis through a multinational solicitation. The agricultural sector has many opportunities to contribute to emissions reductions and carbon sequestration while still helping meet food security objectives. Most initiatives on agriculture and climate change have been taken at national levels to date, but a joint multilateral approach can maximize the effectiveness of national efforts, develop the much needed expertise on mitigation for agricultural systems, and spread the knowledge gained and improved technologies resulting from international research cooperation and investment in mitigation

practices and technologies. Moreover, there are several national projects on GHG emissions that, without a pan-national scale synthesis of existing and emerging knowledge, cannot provide the critical mass of new evidence to perform systematic data analysis and improve models. The purpose of the enhancement funds will be to bring together expertise, data, and models from, as yet, disparate communities (e.g. animal science, soil science, grassland, paddy rice and crop science, socioeconomics) in a balanced way, as well as to bring together a variety of tools and approaches (e.g. driver data, experiments, long-term observatories and experimental infrastructures, modeling, socioeconomics) for improved agricultural productivity with reduced greenhouse gas emissions and increased carbon sequestration. Applicants who are interested in this opportunity should contact the USDA-NIFA program contact.

3.8.5.2.4 USDA Requirements for Responsible and Ethical Conduct of Research

The responsible and ethical conduct of research (RCR) is critical for excellence, as well as public trust, in science and engineering. Consequently, education in RCR is considered essential in the preparation of future scientists. In accordance with sections 2, 3, and 8 of 7 CFR Part 3022, institutions that conduct extramural research funded by USDA must foster an atmosphere conducive to research integrity, bear primary responsibility for prevention and detection of research misconduct and are to maintain and effectively communicate and train their staff regarding policies and procedures. In the event an application to NIFA results in an award, the AOR assures, through acceptance of the award that the institution will comply with the above requirements. Per award terms and conditions, grant recipients shall, upon request, make available to NIFA the policies and procedures, as well as documentation, to support the conduct of the training.

Note that the training referred to herein shall be either on-campus or the Collaborative Institutional Training Initiative (CITI) program for RCR (www.citiprogram.org/rcrpage.asp). The general content of the ethics training, at a minimum, will emphasize three key areas of research ethics: authorship and plagiarism, data and research integration and reporting misconduct. Each institution will be responsible for developing its own training system, as schools will need flexibility to develop training tailored to their specific student needs. Typically RCR education addresses the topics of: Data Acquisition and Management - collection, accuracy, security, access; Authorship and Publication; Peer Review; Mentor/Trainee Responsibilities; Collaboration; Conflict of Interest; Research Misconduct; Human Subject Research; and Use of Animals in Research.

3.8.5.2.5 USDA Reporting Requirements

Grantees are to submit initial project information and annual summary reports to NIFA's electronic, Web-based inventory system that facilitates both grantee submissions of project outcomes and public access to information on Federally funded projects. The details of these reporting requirements are included in the award terms and conditions.

3.8.5.3 *DOE Requirements and Opportunities*

Proposers should be aware that DOE is looking for proposals that pose their research goals, objectives, and approach in the context of representing terrestrial ecosystem processes in Earth system models. The emphasis on applicability to models can be accomplished through process research that specifies mechanisms for the incorporation of results into state-of-the-art process, ecosystem or Earth system models, by proposing direct improvements to such models or through synthesis activities that draw on existing data sets. This is not necessarily guidance to include modeling in every application, but rather to pose the questions in the context of identified (or previously unrecognized) needs for Earth system models and to propose a clear mechanism whereby the results of the proposed research would be made available to the modeling community.

3.8.5.4 *NOAA Requirements and Opportunities*

Projects in collaboration with NOAA scientists are highly encouraged.

NOAA seeks to fund studies only focused on U.S. landscapes.

4. Programmatic Information

4.1 The Two-Step Submission Process

To diminish the workload on authors and reviewers of proposals, the Carbon Cycle Science program is using a two-step proposal submission process in 2013 (see also Section IV(b)(vii) of the *ROSES Summary of Solicitation*). In the two-step process, two-page Step-1 proposals replace the Notice of Intent. A Step-1 proposal is required in order to later submit a normal (i.e., full, 15-page) proposal, which is called the Step-2 proposal. The Step-1 Proposal Title and Principal Investigator are binding and cannot be adjusted in the full (Step-2) proposal. Step-1 Proposals must be submitted electronically by the Step-1 due date (see Tables 2 and 3 in the *ROSES Summary of Solicitation*). Because of the way the NSPIRES web interface works, the required Step-1 proposal must be submitted by an authorized institutional official at the Principal Investigator's organization. The Step 1 review recommendation of either encourage or discourage will be nonbinding. Also, submission of a Step-1 proposal does not obligate the offerors to submit a full, Step-2 proposal later.

NSPIRES will be open for the submission of Step-1 proposals starting ~30 days in advance of the Step-1 proposal due date. NASA, USDA, DOE, and NOAA program officers will review each Step-1 proposal to determine whether submission of a full Step-2 proposal will be encouraged or discouraged. NASA’s response to the Step-1 proposals will only indicate whether a full proposal is encouraged or discouraged; no additional feedback will be provided to the proposers. Responses to the Step-1 proposals will be provided to proposers at least 45 days in advance of the deadline for full, Step-2 proposals.

4.1.1 *Proposal Content and Submission: Step 1 Proposals*

The NSPIRES system will guide proposers through submission of all required proposal information. The Scientific/Technical section of Step-1 proposals may be at most two pages in length. Please note that the Proposal Summary, Business Data, Program Specific Data, and Proposal Team are required Cover Page Elements for a Step-1 Proposal. A detailed budget is not required for Step-1 proposals.

The Scientific/Technical section of Step-1 proposals should be provided as a PDF document upload not to exceed two pages. It should focus on providing the following:

- A brief description of *what* research is proposed, including identification of what is new, different, and/or a scientific advancement.
- Clear statements as to *why* the work proposed is 1) scientifically and societally important, 2) responsive to this Carbon Cycle Science program element, and 3) relevant to the goals and objectives of one or more of the participating agencies (i.e., NASA, USDA, DOE, and NOAA).
- A brief description of *how* the research will be conducted; it should address the overall approach and, as appropriate, data sources, methods, analytical tools, and anticipated scientific outcomes and/or products.

4.1.2 *Proposal Content and Submission: Step-2 Proposals*

Step-2 proposals should follow the guidance for full proposals provided in Section 2.3 the *NASA Guidebook for Proposers* and Section 3 of this solicitation. Step-2 Proposals must be submitted electronically by the proposal due date (see Tables 2 and 3 in this NRA's *Summary of Solicitation*) in full compliance with the requirements specified in this NRA's *Summary of Solicitation* and the *NASA Guidebook for Proposers.*

4.2 Evaluation and Selection of Proposals

4.2.1 *Interagency 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, USDA, DOE, and NOAA will collaborate in the planning and conduct of the peer review. This peer review will be followed by a programmatic review in which NASA, USDA, DOE, and NOAA program officers will assess program balance across the highly rated proposals and evaluate any logistical, implementation, cost, or management concerns. The NASA, USDA, DOE, and NOAA program officers will recommend for selection the proposals that best address the objectives of this solicitation within resource constraints. The program officers will also recommend the division of funding responsibilities between the agencies consistent with each agency's mission (see Section 2 and the evaluation criteria in Section 4.2.2 below). Co-funding is possible, and NASA, USDA, DOE, and NOAA reserve the option of funding co-investigator institutions either as subawards of the principal investigator institution's award or as separate awards directly to the co-investigator institutions. The funding recommendations will be forwarded to each participating agency's Selection Official for confirmation. The Selection Official for NASA will

be the Director, Earth Science Division. The Selection Official for USDA will be the Assistant Director, Institute of Bioenergy Climate and Environment at the National Institute of Food and Agriculture. The Selection Official for DOE will be the Director, Climate and Environmental Sciences Division. The Selection Official for NOAA will be the Chief, Research Programs 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, DOE, or NOAA have agreed to be responsible for will be forwarded to the appropriate agency for final negotiations and implementation of awards. Respondents selected for funding by USDA, DOE, or NOAA will be required to submit additional documentation. Further information will be provided to applicants selected for funding by those agencies.

4.2.2 *Evaluation Criteria*

Proposals will be evaluated according to the criteria specified below in this section. They replace in their entirety the evaluation criteria in Section C.2 of the *NASA Guidebook for Proposers*.

The evaluation criteria (of approximately equal weight) that will be considered in evaluating a proposal are its relevance to NASA's, USDA's, DOE's or NOAA's objectives; intrinsic merit; and cost. *The failure of a proposal to be rated highly in any one of these elements is sufficient cause for the proposal to not be selected*.

(1) Evaluation of a proposal's relevance includes the consideration of all of the following factors:
(i) The potential contribution of the effort to NASA's, USDA's, DOE's or NOAA's mission as expressed in their most recent strategy documents and Section 2 of this solicitation.
(ii) The specific objectives and goals given in Section 3 of this solicitation.
(iii) The quality and completeness of the project management plan.
(iv) The quality and completeness of the data management plan.

(2) Evaluation of intrinsic merit includes consideration of all of the following factors:
(i) Overall scientific or technical merit of the proposal. This includes the unique and innovative methods, approaches, or concepts, demonstrated by the proposal; the appropriateness and feasibility of the proposed methods or approaches; the clarity and delineation of objectives; the probability of success and risk-reward balance for the project; and the quality and appropriateness of the approach to characterizing uncertainties and quantifying errors.
(ii) Offeror's (i.e., proposing institutions's) capabilities, related experience, facilities, techniques, or unique combination of these which are integral factors for achieving the proposal's objectives.
(iii) The qualifications, capabilities, and experience of the proposed principal investigator, team leader, or key personnel critical in achieving the proposal objectives.
(iv) Evaluation against the state-of-the-art. (Review panels are instructed not to compare proposals to each other; all comparative evaluations are conducted by agency program personnel.)

(3) Evaluation of the cost of a proposed effort shall include the realism and reasonableness of the proposed cost, and the comparison of that proposed cost to available funds. Low cost, while desirable, does not offset the importance of realism and reasonableness of the proposed budget. Review panels evaluate cost realism and reasonableness; however, comparison of the proposed cost to available funds is performed by agency program personnel.

4.3 Programmatic Information Specific to NASA

Those investigators whose research requires high-performance computing should refer to the *ROSES 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.

NASA encourages use of the new NASA Earth Exchange (NEX) collaboration facility for large-scale global high resolution carbon cycle data analysis and modeling projects. Proposers should refer to Appendix A.1, Section 4.4, for additional information about NEX and the resources it offers. Proposals should include a section that justifies the need for using NEX, specifies the data storage and processing needs, and includes NEX in its data management plan. NEX resource availability will be considered during the proposal review and selection process. Additional constraints and requirements for proposals to use NEX are available at https://c3.nasa.gov/nex/resource_updates.

4.4 Programmatic Information Specific to USDA

4.4.1 *Legislative Authority and Background*

Section 7406 of the Food, Conservation, and Energy Act of 2008 (FCEA) (Pub. L. 110-246) amends section 2(b) of the Competitive, Special, and Facilities Research Grant Act (7 U.S.C. 450i(b)) to authorize the Secretary of Agriculture to establish the Agriculture and Food Research Initiative (AFRI); a competitive grant program to provide funding for fundamental and applied research, education, and extension to address food and agricultural sciences. Grants shall be awarded to address priorities in United States agriculture in the following areas:

1. Plant health and production and plant products;
2. Animal health and production and animal products;
3. Food safety, nutrition, and health;
4. Renewable energy, natural resources, and environment;
5. Agriculture systems and technology; and
6. Agriculture economics and rural communities.

To the maximum extent practicable, the National Institute of Food and Agriculture (NIFA), in coordination with the Under Secretary for Research, Education, and Economics (REE), will make grants for high priority research, education, and extension, taking into consideration, when available, the determinations made by the National Agricultural Research, Extension, Education,

and Economics Advisory Board (NAREEEAB) pursuant to section 2(b)(10) of the Competitive, Special, and Facilities Research Grant Act (7 U.S.C. 450i(b)(10)), as amended. The authority to carry out this program has been delegated to NIFA through the Under Secretary for REE.

AFRI encourages projects that develop content and programs suitable for delivery through the Cooperative Extension System's eXtension Initiative. Funds may be used to contribute to existing Communities of Practice (CoP) such as the Climate Forests and Woodlands Community of Practice, or to form a new CoP focused on content relevant to sustainable bioenergy systems and water resource management. Projects that choose to include the delivery of products through eXtension must align with the eXtension vision, mission, and values, and a letter of acknowledgement from eXtension is required. In addition, a letter of support may be required from one or more of the Communities of Practice. For detailed guidance on how to partner with eXtension, go to http://create.extension.org/node/2057.

4.4.2 *Eligible Applicants for USDA-NIFA Awards*

Eligible applicants for the program implemented under this subpart include: 1) State Agricultural Experiment Stations; 2) colleges and universities (including junior colleges offering associate degrees or higher); 3) university research foundations; 4) other research institutions and organizations; 5) Federal agencies, 6) national laboratories; 7) private organizations or corporations; 8) individuals who are U.S. citizens, nationals, or permanent residents; and (9) any group consisting of 2 or more entities identified in 1) through 8). Eligible institutions do not include foreign and international organizations. For questions regarding USDA eligibility, please contact the USDA-NIFA point of contact listed in Part 5.

4.4.3 *Funding Restrictions for USDA-NIFA Awards*

Allowable indirect costs are not to exceed 30% of Federal Funds awarded, equivalent to a maximum of 42.86% of total direct costs. For FY 2013 and 2014 appropriated funds, see Section 720 of the Agriculture, Rural Development, Food and Drug Administration, and Related Agencies Appropriations Act, 2012 (Division A of Pub. L. 112-55).

Funds made available for grants under the AFRI program shall not be used for the construction of a new building or facility or the acquisition, expansion, remodeling, or alteration of an existing building or facility (including site grading and improvement, and architect fees).

4.5 Programmatic Information Specific to DOE

4.5.1 *Eligibility*

All types of entities are eligible to apply for funding from DOE, except Federally Funded Research and Development Center (FFRDC) Contractors, and nonprofit organizations described in section 501(c)(4) of the Internal Revenue Code of 1986 that engaged in lobbying activities after December 31, 1995.

4.5.2 *Collaborations*

Multidisciplinary and interinstitutional collaborations are strongly encouraged to enhance and strengthen research capabilities as needed. Collaboration could include institutions such as universities, industry, nonprofit organizations, Federal agencies, and Federally Funded Research and Development Centers (FFRDCs), which include the DOE National Laboratories. Collaborations involving the DOE National Laboratories are permitted; however, the efforts must reflect specific and unique capabilities/expertise at the collaborating DOE National Laboratory. These financial collaborations should show clear scientific leadership from the submitting institution and reflect an appropriate level of effort from the DOE National Laboratory and should not exceed 10% of the budget except for pay-for-use situations (i.e., sample analysis).

4.6 Programmatic Information Specific to NOAA

There is no programmatic information specific to NOAA.

5. Summary of Key Information

Expected program budget for first year of new awards	NASA: $6.5 M; USDA: $1.67 M; DOE: $3 M; NOAA: $1 M
Number of new awards pending adequate proposals of merit	NASA: ~15-45 ; USDA: ~6-8; DOE: ~8-15; NOAA: ~5-7
Maximum duration of awards	3 years
Due date for Step-1 proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Due date for Step-2 Proposals	See Tables 2 and 3 in the *ROSES Summary of Solicitation*.
Planning date for start of investigation	January 1, 2014
Page limit for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA, USDA, DOE, and/or NOAA	This program is relevant to the Earth science strategic goals and subgoals in NASA's *Strategic Plan*; see Table 1 of ROSES and the reference therein. Proposals that are relevant to this program are, by definition, relevant to NASA. Proposals for other agency funding must address one or more of the agency-specific objectives listed in Section 2 of this Appendix.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.

Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of Step 1 and Step 2 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 (Step-1 only)	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Web site for submission of Step 2 proposal via Grants.gov	Option not available
Funding opportunity number for downloading an application package from Grants.gov	NNH13ZDA001N-CARBON
NASA point of contact concerning this program	Diane E. Wickland Earth Science Division Science Mission Directorate National Aeronautics and Space Administration Washington, DC 20546-0001 Telephone: (202) 358-0245 E-mail: Diane.E.Wickland@nasa.gov
USDA point of contact concerning this program	Nancy Cavallaro Global Climate Change Program National Institute of Food and Agriculture U.S. Department of Agriculture Washington, DC 20250-2241 Telephone: (202) 401-5176 E-mail: ncavallaro@nifa.usda.gov
DOE point of contact concerning this program	Mike Kuperberg Terrestrial Ecosystem Sciences Office of Science/Biological and Environmental Sciences U.S. Department of Energy Washington, DC Telephone: (301-903-3511) E-mail: michael.kuperberg@science.doe.gov
NOAA point of contact concerning this program	Kenneth Mooney Climate Program Office (R/CP) National Oceanic and Atmospheric Administration 1315 East-West Highway, Suite 12824 Silver Spring, MD 20910 Telephone: (301) 734-1242 E-mail: kenneth.mooney@noaa.gov