

A.7 CARBON MONITORING SYSTEM: CONTINUING PROTOTYPE PRODUCT DEVELOPMENT, RESEARCH, AND SCOPING

NOTICE: This amendment adds a new opportunity for the Carbon Monitoring System program element, which had previously been designated as not solicited this year. Notices of Intent to propose are requested by January 29, 2016, and proposals are due March 29, 2016. Proposers to this program do not need to submit a data management plan via the NSPIRES cover pages, because the data management plan is part of the evaluation of Merit, see Sections 2.2.7 and 3.2.

1. Scope of Program

The NASA Carbon Monitoring System (CMS) is a forward-looking initiative designed to make significant contributions to characterizing, quantifying, understanding, and predicting the evolution of global carbon sources and sinks through improved monitoring of carbon stocks and fluxes. Initially implemented in response to language in NASA's 2010 Congressional Appropriation, this program is now included in NASA's multiyear budget; as presently implemented, the program conducts pre-Phase A and pilot initiatives for the development of a carbon monitoring system.

NASA's approach toward a carbon monitoring system emphasizes exploitation of current and future satellite remote sensing resources, computational capabilities, scientific knowledge, airborne science capabilities, and end-to-end system expertise that are major strengths of the NASA Earth Science program. Significant effort is being devoted to rigorous evaluation of the carbon monitoring products being produced, as well as to the characterization and quantification of errors and uncertainties in those products. The emphasis has been on regional, national, and global satellite-based carbon monitoring products relevant to national needs for completely transparent carbon and biomass inventory processes that provide statistical precision and accuracy with geospatially explicit associated attribute data.

NASA's approach takes into account data and expertise that are the domain of other U.S. Government agencies and anticipates continuing close communications and/or partnerships with those agencies and their scientific and technical experts as U.S. national efforts toward integrated carbon monitoring mature, especially as coordinated through the Carbon Cycle Interagency Working Group of the U.S. Global Change Research Program (<http://www.carboncyclescience.us>).

NASA also recognizes a need for complementary local-scale (airborne and *in situ*) information to demonstrate quantitative remote sensing methods; to aid in scaling up from project, county, and/or state levels; and for essential evaluation of regional-, national-, and global-scale products. Such work is critically important for advancing Monitoring Reporting and Verification (MRV) system capabilities in support of Reducing Emissions from Deforestation and Forest Degradation (REDD) in developing nations. Additionally, the current approach lays the groundwork for CMS-related applications of future NASA satellite sensors now in operation and development (i.e., Orbiting Carbon Observatory-2 (OCO-2); Ice, Cloud, and Land Elevation Satellite-2

(ICESat-2); Global Ecosystem Dynamics Investigation (GEDI), Pre-Aerosol; Clouds; and ocean Ecosystem (PACE), and the NISAR (NASA-Indian Space Research Organization L- and S-band synthetic aperture radars)) or in preformulation, i.e., Active Sensing of CO₂ Emissions Over Nights, Days, and Seasons (ASCENDS) and Hyperspectral Infrared Imager (HyspIRI).

In a first phase of activities, NASA initiated two CMS pilot studies and several scoping efforts focused on the utilization of satellite data:

- A Biomass and Carbon Storage Pilot Product
- An Integrated Emission/Uptake ("Flux") Pilot Product
- Scoping studies and research to understand the needs of end users and scope potential new carbon monitoring products

A second phase of activities focused on:

- Building upon the foundation established and lessons learned in the initial pilot studies and scoping efforts and to further integrate NASA products and capabilities with those of other U.S. agencies and international entities (solicited in ROSES-2011)
- Acquisition, field sampling, quantification, and development of prototype Monitoring Reporting and Verification (MRV) system capabilities, with an emphasis on use of commercial off-the-shelf technologies and support of Reducing Emissions from Deforestation and Forest Degradation (REDD and REDD+; see <http://www.un-redd.org/aboutredd/tabid/102614/default.aspx>) projects in developing nations and, in particular, U.S. SilvaCarbon (<http://www.silvacarbon.org/>) activities (solicited in ROSES-2013).

A following phase of activities (ROSES14) focused on:

- Studies using commercial off-the-shelf technologies to produce and evaluate prototype monitoring, reporting and verification system approaches, and/or calibration and validation data sets for future NASA missions, including, but not limited to, monitoring reporting and verification work in support of REDD, REDD+, or SilvaCarbon projects;
- Studies that address research needs to advance remote sensing-based approaches to monitoring, reporting, and verification (e.g., quantification of forest degradation; independent assessment of the accuracy of airborne remote sensing observations of biomass and carbon stocks; use of airborne flux observations and satellite remote sensing, as alternative methods for quantifying net carbon emissions/storage).
- Studies that advance upon, extend, and/or improve the existing CMS products for biomass and flux resulting from NASA's first phases of CMS pilot studies; such studies may include, for example, product improvements, refined characterization and quantification of errors and uncertainties, and/or preparation and delivery of a mature product for long-term archive at an established NASA Distributed Active Archive Center, or equivalent data center.

Studies to improve the characterization and quantification of errors and uncertainties and to understand and engage the user community for carbon monitoring products have been emphasized throughout.

A NASA Carbon Monitoring System Science Team (CMS ST) has been established to include members from all NASA CMS investigations. The CMS ST is responsible for providing broad research community involvement in the development and evaluation of NASA CMS products; coordinating their NASA-funded CMS activities to ensure maximum returns for science, management, and policy; and providing scientific, technical, and policy-relevant inputs to help set priorities and directions for future NASA CMS activities. As current proposals are completed, their Principal Investigators (PIs) will rotate off the CMS ST and be replaced by those of the newly-selected investigators.

Additional information on these initial activities, progress reports, the CMS ST, and links to available data and data products are provided at <http://carbon.nasa.gov>. The work conducted in this prototyping effort to date has leveraged the much larger investment currently made by NASA in remote sensing observations of carbon-related properties of the Earth, as well as in carbon cycle science and carbon management research.

2. Research Solicited

NASA requests proposals for investigations to advance the development of a carbon monitoring system. Emphasis is to be directed towards continued development of the established CMS pilot studies, acquisition, field sampling, quantification and development of prototype MRV see: <http://www.un-redd.org/UNREDDProgramme/InternationalSupport/MeasurementReportingandVerification/tabid/1050/language/en-US/Default.aspx>) system capabilities which can provide transparent data products achieving levels of precision and accuracy required by current carbon trading protocols. NASA is also looking for advancements from past CMS activities that will substantially contribute to the above activity. Successful applicants will become members of the NASA CMS ST.

2.1 Research Topics

NASA is interested in receiving proposals for the following types of prototyping, research, and scoping activities for carbon monitoring:

- Studies using remote sensing data products to produce and evaluate prototype MRV system approaches and/or calibration and validation data sets for future NASA missions;
- Studies that conduct MRV-related work in support of international REDD or REDD+ projects;
- Studies that address research needs to advance remote sensing-based approaches to MRV (e.g., quantification of forest degradation; independent assessment of the accuracy of airborne remote sensing observations of biomass and carbon stocks; use of airborne flux observations as an alternative method for quantifying net carbon emissions/storage).
- Studies to improve the characterization and quantification of errors and uncertainties in existing and/or proposed NASA CMS products, including errors and uncertainties in the algorithms, models, and associated methodologies utilized in creating them; and
- Studies of stakeholder interests and requirements that offer to 1) understand and engage the user community for carbon monitoring products and/or 2) evaluate current and planned NASA CMS products with regard to their value for decision making by these users and to

assist in having existing products used for stake-holder activities. Priority will be given to proposals where potential stakeholders have in-kind contributions to ensure transfer of CMS activities into their own ongoing or future activity.

Data from airborne or spaceborne remote sensing must be an essential element in all proposed carbon monitoring investigations. All sources of remotely sensed data to be used must be well justified in terms of their importance and appropriateness for the work to be conducted, as well as their overall utility and priority for monitoring carbon for science, management, and policy.

The NASA CMS program continues to emphasize the importance of characterizing and quantifying uncertainties and errors in all CMS products and analyses, and such work must be included in all investigations proposed (see also section 2.2.7).

Proposals must explain the societal relevance of the carbon monitoring activities proposed and provide justification regarding the importance of this work to U.S. national interests in current or potential carbon monitoring for science, management, and policy. Proposers are strongly encouraged to address stakeholder interests in their studies and to contribute to CMS ST activities to understand and engage the user community for carbon monitoring products.

Many of the studies funded through the ROSES-2013 CMS solicitation (A.7; see [PDF document with titles and abstracts of ROSES-2013 awards](#)) will be expiring, while all the investigations funded in the ROSES-2014 solicitation (A.7; see [PDF document with titles and abstracts of ROSES 2014 awards](#)) have two more years until completion. Proposals to further develop or expand upon the funded ROSES-2014 activities are, therefore, not as high a priority this year as the research topics listed in this solicitation. It is anticipated that activities selected in ROSES-2014 will be given higher priority in future CMS-related solicitations.

2.2 Additional Proposal Requirements

2.2.1 *Requirements Regarding the Duration of Award*

The scientific tasks of the ST members will be of no more than three years duration and proposers may not propose for a longer period of performance. If the proposed research can be conducted in less than three years, a shorter period of performance is encouraged.

2.2.2 *Carbon Monitoring System Science Team Membership*

All proposals must request CMS ST membership for one or more key investigators and include 1-2 paragraphs describing the contributions they anticipate making to the activities of the CMS ST. This section should address one or more of the following:

- Representing concerns of the broad carbon monitoring community with respect to the nature, quality, and utility of NASA CMS products;
- Coordinating their CMS activities to ensure maximum returns and enhance or create complementarity, integration, and synergy;
- Providing important perspectives on product development, implementation, and evaluation;
- Providing insights on the relative merits of alternative approaches and products;

- Making connections to ongoing and newly developing activities with similar and/or complementary objectives being undertaken by other entities, especially other U.S. agencies; and/or
- Providing scientific, technical, and policy-relevant inputs to help set priorities and directions for future NASA CMS activities, including the participation with the existing working groups within CMS.

The CMS ST will conduct its business through periodic meetings with more frequent interactions through teleconference calls and E-mail. Proposals are not being solicited here for the Science Team leader, as one was selected in the ROSES-2014 CMS solicitation. It is anticipated that proposals for this role will be solicited in a future ROSES call.

2.2.3 Requirements for the Cost Plan

Given the differing types of investigations solicited, NASA expects to fund a range of investigation sizes. It is expected that proposals requiring acquisition of new airborne or commercial satellite data will have budget profiles that have a significant peak during the year of data purchase/acquisition, but for the other years of such studies and for all other investigation types, NASA would not expect the per year budget, even for the most ambitious of investigations, **to exceed \$500,000.**

All proposals must include in their cost plans resources for activities to be undertaken as a CMS ST member, including funds for travel to ST meetings. The proposed budget should include funds to participate in two CMS-related meetings per year lasting three days each. For planning purposes, proposers should budget each year for one meeting in the western U.S. and one meeting in the Washington, DC area.

2.2.4 Requirements for Proposals Requesting Acquisition of New Airborne Data

New proposals requiring data from airborne sensors must detail in their cost plan all costs for acquiring the new data sets, including costs for aircraft hours, deployment costs, mission peculiar costs, data processing costs, and other costs associated with deploying the sensors, aircraft, and personnel (this provision applies to all sensors and platforms, including any NASA sensors and platforms, as well as non-NASA sensors and platforms). If the instrument or aircraft platform are not NASA assets, proposers must take responsibility for making all arrangements to secure the availability of the needed sensors and aircraft and explain these plans in the proposal.

All proposers must submit a Flight Request to the NASA Airborne Science Flight Request system at <http://airbornescience.nasa.gov> (and then click on "FLIGHT REQUEST"). This is required whether the request involves NASA sensors, platforms, and personnel or not because the flight request is used to help NASA to understand and track all of the airborne science it supports. Questions regarding the flight request system or process should be addressed to Marilyn Vasques, Flight Request Manager (Marilyn.Vasques@nasa.gov or 650-604-6120).

Given that this solicitation allows the use of commercial off-the-shelf technologies, which includes commercial airborne sensors and platforms, it is important to note that all such activities must be conducted according to required NASA policies and procedures. All aircraft operations,

including operations of commercially acquired aircraft, will be reviewed in accordance with NPR 7900.3 (<http://nodis3.gsfc.nasa.gov/displayDir.cfm?t=NPR&c=7900&s=3C>). At a minimum, this will include meeting NASA safety requirements.

2.2.5 Requirements for International Agreements, Permissions, and Flight Clearances

CMS activities proposing airborne and *in situ* data acquisitions outside the U.S. (e.g., for REDD, REDD+, or SilvaCarbon projects) and/or cooperation with foreign institutions may require international agreements, permissions (e.g., research/data collection permits), overflight clearances, or other formal arrangements. Proposals must detail plans for meeting such requirements.

Proposals requesting use of NASA aircraft or NASA sensors and/or involving NASA personnel in international work will be required to follow all NASA policies and procedures regarding such activities. In some cases, it may either be required or preferable that NASA take the lead in securing all or certain ones of the required agreements, permissions, or clearances. In most cases where the use of NASA aircraft or sensors is not requested and NASA personnel are not involved, proposers will be fully responsible for securing their own arrangements.

Research involving participants at foreign organizations must be proposed and performed on a no-exchange-of-funds basis, whether on a proposal from a foreign or a U.S. organization. For more information see <http://science.nasa.gov/researchers/sara/faqs/#14>.

2.2.6 Requirements to Address Errors, Uncertainties, and Instrument Calibration

Given the importance of MRV data and information for decision-making, it is essential that the research supported under NASA's CMS program characterize uncertainties and quantify errors associated with data and derived information products, as well as with analytical approaches, model results, and/or scientific interpretations. When new data are acquired as part of the proposed activities, it is equally important that instrument calibration be documented and traceable so that different types of data and data products can be intercompared with a high degree of confidence. Therefore, all proposals submitted in response to this solicitation must describe how errors and uncertainties will be addressed within their research project, including, if relevant to their study, errors and uncertainties associated with instrument calibration. The characterization of errors and uncertainties must be described in a separate subsection of the Scientific/Technical/Management section of the proposal. If new observations are to be made in the study, then this subsection should also describe their calibration, accuracy, and traceability.

2.2.7 Data Policy and Data Management Plan Requirements

All data and information acquired and data products produced under the NASA CMS program must be made publicly available, with no period of exclusive use, in compliance with NASA's Earth Science data policy (<http://science.nasa.gov/earth-science/earth-science-data/data-information-policy/>). Proposals must include a data management plan of no more than two pages that addresses the dissemination and sharing of research results, how data and information will be provided, and the proposer's compliance with the NASA Earth Science data policy. The data management plan should include the types of data and data products, algorithms, models and model outputs, or other materials to be produced in the course of the project; the standards to be used for data and metadata formats; the types of errors and uncertainties to be quantified and

how they will be reported; and plans for providing access to and/or archiving the data and other research products. The data sharing plan called for in Section 2.3.5 of the *Guidebook for Proposers* may be included in the data management plan. For any proposed new data products, the data management plan must include provisions for quality assessment, timely public release consistent with NASA policies, and long-term archive of the data product(s). The data management plan must be included within the 15-page limit for the Scientific/Technical/Management section of the proposal.

3. Programmatic Information

3.1 Funding Allocations

Of the \$10M of Fiscal Year 2016 funding provided for continuing CMS efforts, \$5.5M is committed to ongoing competitive research commitments from prior years. Therefore, \$4.5M in FY 2016 funding is available to support new research under this solicitation.

3.2 Evaluation Criteria

Proposals will be evaluated according to the criteria specified in Section C.2 of the *NASA Guidebook for Proposers*, with additional factors noted in this section.

In addition to the factors given in the *Guidebook for Proposers*, the determination of a proposal's intrinsic merit shall take into account the following additional considerations:

- The quality and appropriateness of the proposed approach to product prototyping, product evaluation, and/or characterization of uncertainties and quantification of errors, including those associated with instrument calibration, and
- The quality and completeness of the data management plan.

In addition to the factors given in Section 2.1, the determination of a proposal's relevance shall take into account the relative priority of the activities proposed for support of carbon monitoring-related decision making.

4. Summary of Key Information

Expected program budget for first year of new awards	\$4.5M
Number of new awards pending adequate proposals of merit	~8-15
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	January 29, 2016. See also Tables 2 and 3 in the <i>ROSES Summary of Solicitation</i>
Due date for Proposals	March 29, 2016. See also Tables 2 and 3 in the <i>ROSES Summary of Solicitation</i>
Planning date for start of investigation	September 2016

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>
Relevance to NASA	This program is relevant to the Earth Science questions and goals in the NASA Science Plan; see Table 1 of ROSES and the reference therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the <i>ROSES Summary of Solicitation</i> .
Detailed instructions for the preparation and submission of proposals	See the <i>NASA Guidebook for Proposers</i> 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 <i>ROSES Summary of Solicitation</i> 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	NNH15ZDA001N-CMS
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