National Aeronautics and
Space Administration **September 27, 2002**

CAN-02-OES-01

A COOPERATIVE AGREEMENT NOTICE

Earth Science *REASoN* – Research, Education and Applications Solutions Network
A Distributed Network of Data and Information Providers
For Earth Science Enterprise
Science, Applications and Education

A Cooperative Agreement Notice for the Science and Applications Divisions

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Letters of Intent Due November 1, 2002
Proposals Due November 26, 2002 by 4:30 p.m. (EST)

NASA Vision

To improve life here,

To extend life to there,

To find life beyond.

NASA Mission

To understand and protect our home planet

To explore the universe and search for life

To inspire the next generation of explorers

…as only NASA can.

Preface

The Office of Earth Science of the National Aeronautics and Space Administration uses NASA's unique capabilities in space to study the fundamental Earth processes that power climate, weather, and natural hazards, and the impact of those processes on the quality of life. The Office has the responsibility to assure that the data, technology and attendant capabilities acquired and developed by NASA to meet the scientific mission of the agency are exploited to the maximum extent possible for the benefit of society and the economy of the nation, i.e., to understand and protect the planet.

In pursuit of its objectives in Earth science research, applications and education, NASA is generating Earth system data of unprecedented quality and quantity and developing data processing and modeling capabilities to transform these data into products, information, and, ultimately, new knowledge of our planet. The information products support science findings and applications directed toward understanding and predicting the future of the Earth, resource policy and management decision support systems, and education tools to inspire and train current and future generations of scientists. NASA Earth science data, data products and data processing algorithms are stored in archives at centers across the United States and linked by the Internet for data access and distribution.

Capabilities developed by NASA are emerging concurrently with capabilities in the commercial sector to acquire Earth observation data and information products and the use of the Internet and telecommunications technologies as the medium of choice by public and private sector organizations and the general public for access and delivery of digital data.

This Cooperative Agreement Notice (CAN) solicits proposals that will afford *solutions* for utilization of NASA assets and capabilities by:

- providing data products and/or information systems and services capabilities in support of the goals and objectives of the research, applications, and education strategies of NASA's Earth Science Enterprise (ESE);
- developing, where necessary, advanced data systems technologies integrated into a project (solution) that addresses the above objectives;
- applying principles from the Strategy for the Evolution of ESE Data Systems (SEEDS) regarding community involvement, product life cycle planning, and standards and interfaces for interoperability and exchange of data and information;
- supporting ongoing SEEDS efforts through Working Groups for Standards and Interfaces, Technology Infusion Working Group, Architecture and Reuse, and Metrics Planning and Reporting; and,
- contributing to benchmarking solutions that serve society through integration of Earth science measurements, models and decision support systems.

The projects funded under this CAN will join on-going NASA data and information projects to form the NASA Earth Science *Research, Education and Applications Solutions Network* (Earth Science *REASoN).* The research, applications and education elements of the NASA Earth science community share interests and requirements that can best be met through cooperative

efforts that generate, access and distribute data, information and knowledge. REASoN projects will focus on national priorities in e-government solutions and education. These projects will unite previously disparate activities and programs under a unified management approach, taking full advantage of public and private resources and partnerships to derive maximum benefit for the public good, and consistent with the President's initiative on competitive sourcing.

The CAN provides the strategy for evolution of ESE data systems, the goals and objectives of these projects, and the requirements for submitting proposals. Background information for REASoN projects, and the conceptual framework for research, applications and education in the Office of Earth Science are appended. Proposals are due November 26, 2002. Selection of awards is expected by the end of February, 2003. Potential respondents are encouraged to review the CAN and direct questions to the points of contact indicated in Section IV.N. of the CAN text.

Potential respondents are strongly encouraged to review the NASA Research Announcement NRA-02-OES-04, "Advanced Information Systems Technology (AIST) Program," published concurrently with this announcement (http://research.hq.nasa.gov/code_y/open.cfm). The AIST NRA is intended for development of new technology for space-based mission and super-computing data systems for analysis and utilization of space-based Earth observations in conjunction with computer models. This CAN leverages or develops technologies that are applicable to, and that will be incorporated within, solutions that address known science and applications information requirements and Earth science education needs. Review of both announcements will provide guidance on which opportunity best suits the respondent's interests. Present and former partners with the NASA Office of Earth Science on projects to develop and distribute data products for research, applications and education are especially encouraged to consider the CAN as the mechanism to continue and expand such efforts.

Dr. Ghassem R. Asrar
Associate Administrator for Earth Science

Earth Science *REASoN* – Research, Education and Applications Solutions Network
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I. Introduction

A. Project Types

The National Aeronautics and Space Administration (NASA) through this Cooperative Agreement Notice (CAN) solicits proposals, from all sources, to provide data products and information systems and services capabilities to forward the goals and objectives of the research, applications, and education strategies of NASA's Earth Science Enterprise (ESE).

This CAN is a mechanism to continue development and implementation of information systems and services for research, applications and education product generation and distribution, and extend efforts for such activities initiated by NASA, e.g., Earth Science Information Partnerships (ESIPs) and Applications Research Centers (ARCs,) and Congress through the Regional Earth Science Applications Centers (RESACs) and the Synergy Project. Projects supported by this CAN will provide data products and/or information systems and services capabilities to:

- (*Research*) Improve accessibility by the NASA science community to, and accuracy of: a) data and data products, including selected geophysical parameters of Earth observations constructed from multiple sources; and, b) efforts that more effectively integrate and fuse sources for geophysical parameters that may not be directly observed;
- (*Applications*) Provide data products and tools for resource management and policy decision support in applications of national importance, and provide decision makers with interactive access to dynamically updated knowledge of the Earth system; and,
- (*Education*) Address needs of the educational community particularly with respect to timely and ready access to Earth and environmental data to promote math, science and geography in K-12 education, and earth system science in graduate and post graduate education.

The CAN focuses on "solutions" that exploit the capabilities of the Internet for data delivery, access to information, dynamic updating of databases and educational use of data and information. Projects funded by the CAN will participate in the NASA Earth Science *REASoN* – Research, Education and Applications Solutions Network – and in a Federation, comprised of similar projects and other NASA and non-NASA sponsored activities, to share results, facilitate partnerships, and assure that data, data products and technology for research, applications and education conform with national standards and are integrated into national systems for on-line data distribution and decision support systems.

Figure 1 illustrates the program architecture ESE uses to meet its strategic objectives and the role of the REASoN projects in the ESE strategy. ESE science and applications draw upon observations and measurements obtained from ESE instruments and predictions from models to generate products that supply decision support systems. The decision support systems serve the policy development and national applications needs of the Nation. The same observations and

models generate products for educational products and workforce development. REASoN projects facilitate the flow of data and information products (the blue arrows in Figure 1) for use by the research and applications community for modeling, decision support and educational development.

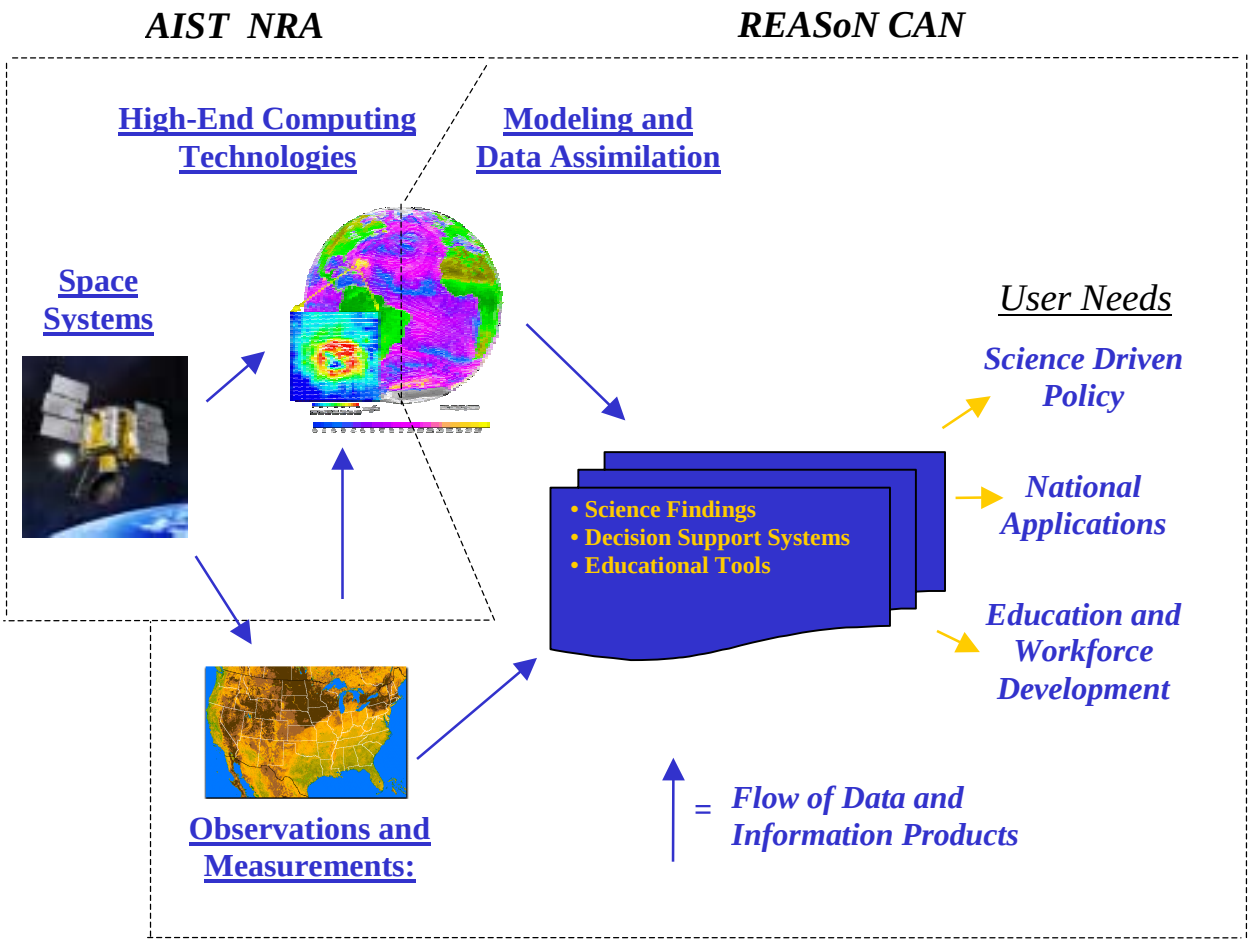

Figure 1

ESE Systems Development Flow and AIST NRA and REASoN CAN Realms

REASoN projects typically will utilize observations and/or models from ESE science drivers for the benefit of science policy, national applications and educational support. The REASoN CAN is focused on the data, products and services to support user needs for science understanding, policy and resource management and education. The AIST NRA is focused on space systems and high-end computing technologies.

B. Data Systems

NASA is planning for the evolution of the current ESE network of data systems and service providers to ensure the timely delivery of Earth Science information at an affordable cost, and to

fully engage the community on data and information management issues, objectives, and solutions. The Strategy for the Evolution of ESE Data Systems (SEEDS) activity, currently being formulated, will establish a unifying framework of standards, interfaces, and levels of service to introduce greater flexibility and responsiveness into the infrastructure used to support the generation, management and distribution of science data products from NASA science missions.

Providers of REASoN data and information products will contribute to and apply SEEDS principles in development of REASoN products and services, and adhere to the standards, interfaces and required levels of service that emerge from the SEEDS Working Groups. Projects supported by this CAN will:

1. Apply the Strategy for the Evolution of ESE Data Systems (SEEDS) principles to REASoN developed products and services and:
   - Engage the community in defining REASoN products and services;
   - Plan and cost REASoN project product life cycle spanning design, development, storage, access, distribution, and long term archival;
   - Define and use of standards and interfaces for interoperability and exchange of data and information.
2. Provide ideas, capabilities, and effort to support ongoing SEEDS efforts (described in Appendix A, Section B.2. and Appendix J) through the following SEEDS working groups:
   - Standards and Interfaces
   - Technology Infusion
   - Architecture and Reuse
   - Metrics Planning and Reporting
3. Conform to Administration and ESE Guidelines:
   - Include Internet-based data delivery systems, the capability to update databases dynamically, as required, and an Internet-based education element.
   - Provide product and service directory information to NASA's Global Change Master Directory (GCMD)[1]
   - Conform to the objectives and requirements of the National Spatial Data Infrastructure (NSDI)[2], of the Federal Geographic Data Committee (FGDC)[3] to develop and maintain on-line data and information systems consistent with the Administration's "Geo-Spatial One-Stop" (e-government) initiative[4,5].
4. Optionally, develop new ground data system technologies necessary in conjunction with proposed REASoN project objectives.

Figure 2 illustrates the cycle from recognition of user requirements through data acquisition, product generation, data distribution and decision support that addresses the initial user requirement. The intention of the CAN is to maximize data distribution by providing an efficient interface between existing ESE data systems and decision support systems that are the province of federal agencies and other national organizations.

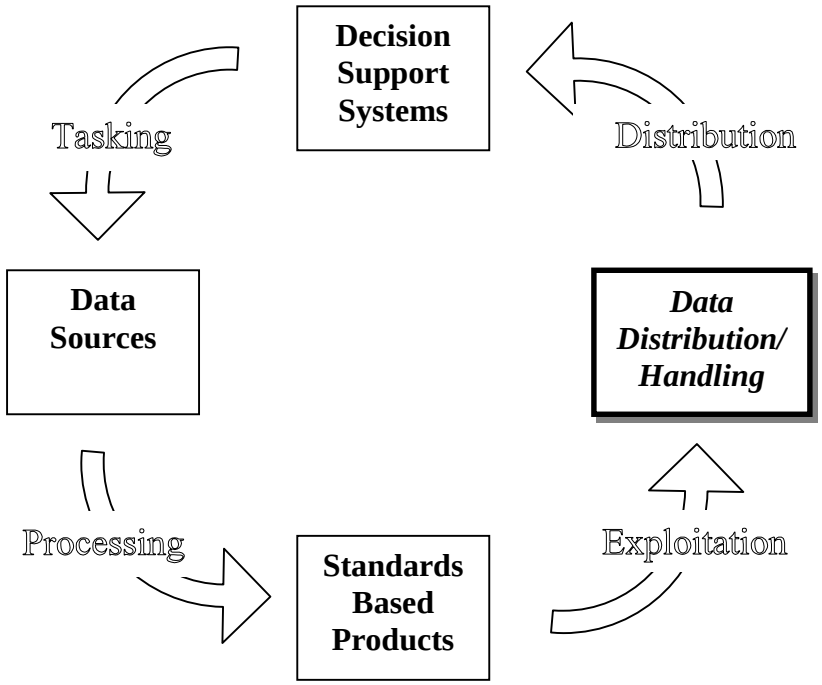

Figure 2

ESE Information Cycle

Typical development cycle for information from user requirement (at the top of the figure) through decision support system. The CAN emphasizes facilitating data distribution to assure that data and products stored in NASA archives are readily exploited and made available to the Nation.

C. Concurrent Solicitations

The REASoN CAN is one of two current solicitations ESE has issued to develop and augment its information technology capabilities and infrastructure. The other solicitation is a NASA Research Announcement (NRA), "Advanced Information Systems Technology (AIST) Program," (NRA-02-OES-04). The relationship between the two solicitations is also illustrated in Figure 1.

The REASoN CAN solicits projects to develop and demonstrate, or benchmark, the use of data products and/or information systems and services capabilities in support of the ESE research, applications, and education goals, and leverage or develop applicable advanced ground data systems technologies. REASoN projects will embody SEEDS principles to promote the evolution of the ESE network of data systems and services providers and to ensure the timely and affordable delivery of ESE data to the user community. In parallel, the AIST NRA solicits proposals for technology development in support of ESE information system needs in space-

based processing, and high-end computing models. The AIST NRA projects will support or enable on-board processing, space-based communication networks and more autonomous and distributed mission operations. The AIST NRA also solicits tools to assist modelers in attaining high throughput and model efficiencies for high volume Earth science data models.

Investigators are strongly encouraged to review both solicitations and identify the appropriate mechanism before responding. Information on the AIST NRA is available on-line at http://research.hq.nasa.gov/code_y/open.cfm . Questions regarding the AIST NRA should be directed to the point of contact at NASA HQ listed in the NRA.

Present and former partners with the NASA Office of Earth Science on grants and cooperative agreements to develop and distribute data products and services for research, applications and education – e.g., RESACs, ARCs, ESIPs and Synergy – are especially encouraged to consider the CAN as the mechanism to continue and expand such efforts. The REASoN CAN will likely be the only solicitation on this subject from the Office of Earth Science through the end of fiscal year 2003.

II. REASoN Opportunities

This Cooperative Agreement Notice (CAN) solicits proposals from all sources to:

- provide data products and/or information systems and services capabilities in support of the goals and objectives of the research, applications, and education strategies of NASA's Earth Science Enterprise (ESE);
- apply principles from the Strategy for the Evolution of ESE Data Systems (SEEDS, formerly NewDISS), regarding community involvement, product life cycle planning; and standards and interfaces for interoperability and exchange of data and information;
- support ongoing SEEDS efforts through Working Groups for Standards and Interfaces, Technology Development and Infusion, Architecture and Reuse, and Metrics Planning and Reporting;
- where needed, develop applicable advanced data systems technologies integrated into a project that addresses the above objectives.
- contribute to benchmarking solutions that serve society through integration of Earth science measurements, models and decision support systems.

All proposed solutions must address a research, applications or education element of the Earth Science Enterprise. More that one element may be addressed. Proposals should present a balance of research, applications or education solutions with appropriate technology and promote innovative adoption and/or development of data and information tools and technologies.

A. Research

NASA's Office of Earth Science uses NASA's unique capabilities in space to study the fundamental Earth processes that power climate, weather, and natural hazards, and the impact of

those processes on the quality of life. The Office has the responsibility to assure that the data, technology and attendant capabilities acquired and developed by NASA to meet the scientific mission of the agency are exploited to the maximum extent possible for the benefit of society and the economy of the nation, i.e., to understand and protect the planet.

NASA/ESE has defined its Research Strategy around a hierarchy of scientific questions. At the highest level, the Enterprise is attempting to provide an answer to the one overarching question, "How is the Earth changing and what are the consequences for life on Earth?" The next tier of questions provides the conceptual approach ESE is taking to improve our knowledge of the Earth system.

- How is the global Earth system changing?
- What are the primary forcings of the Earth system?
- How does the Earth system respond to natural and human-induced changes?
- What are the consequences of changes in the Earth system for human civilization?
- How well can we predict future changes in the Earth system?

NASA conducts and sponsors Earth science research projects that assist the research community in addressing and answering the hierarchy of questions posed.

NASA solicits research REASoN projects that will work in concert with NASA's existing and emerging data systems to help the community answer the science questions outlined in the ESE Research Strategy. Generally, two classes of science questions and priority for system designs can be distinguished in concept: Systematic Measurements and Process Product Suites.

First, as explained in Appendix A, NASA intends to ensure that scientists studying Earth system variability and change will have an accurate, uninterrupted series of key geophysical observation records (i.e., systematic measurements) stretching from early satellites through NASA's Earth Observing System (EOS)-era satellites, and including follow-on satellites. The concept of systematic measurements transcends stand-alone missions.

For these measurements, the focus is on contributing to the construction of consistent data sets from multi-instrument, multi-platform, and, typically, multi-year observations with careful attention to calibration and validation over the lifetime of the measurement. By the end of this decade, an increasing fraction of these measurements may be obtained from operational satellites or platforms, as the quality, calibration, and availability of such systems are improved to meet scientific research needs.

Second, there are science questions that by their nature pose needs for concerted gathering of "bundles" of data, information, and services, especially for getting at derived parameters that are not directly observed. Exploratory mission observations, field experiment data, analyzed information and model output to be brought to bear to help answer a key scientific question can sometimes be an large activity, including removal of temporal and spatial differences, data fusion and integration.

The key need is for an informed and interactive service to the community. REASoN projects will not work alone but on behalf of the community involved in the enterprise of areal research in answering key science questions concerning particular Earth variability and/or forcing. Research REASoN projects must demonstrate a process of broad community input into the requirements

for products and services, and feedback on what is provided. Evaluation criterion 2R is keyed to this important community process (see Appendix C.)

1. Projects Contributing to Systematic Measurements

NASA intends to ensure that scientists studying Earth system variability and change will have an accurate, uninterrupted series of key geophysical observation records (i.e., systematic measurements) stretching from early sources, including NASA satellites and NOAA and DoD operational satellites, through current EOS-era NASA satellites to NASA's next-generation systematic measurement satellite series, including both NASA missions and our partnerships with operational agencies for measurement continuation, and beyond.

The systematic data sets solicited through this CAN will typically involve the synthesis of data from multiple instruments and/or platforms, and will exhibit consistent calibration and common validation throughout the entire measurement time series. The systematic data sets to be prepared in response to this section of the CAN should be highly useful to a significant segment of the Earth science research community in its efforts to help provide answers to the questions in the ESE Research Strategy. The data sets produced may also be useful to a broader range of scientists and policy-makers in the context of assessment and support for environmental and policy decisions.

Where there are different ideas in the research community about how to synthesize data sets or choose among alternative algorithms for the data sets, the proposers should demonstrate that they will work with the scientific community to try to resolve these different ideas and reach a consensus that will maximize the broad acceptance and use of the systematic data set. The role of the research community in the validation of the data set, and the mechanism by which the proposers will respond to community feedback about its quality and limitations should also be addressed by proposers.

This CAN welcomes development and demonstration proposals that may contribute toward a Systematic Measurement capability, as generally outlined in the ESE Research Strategy. Systematic Measurements are primarily those involved in the Variability and Forcing sections of the ESE Research Strategy. ESE current and planned Systematic Measurements are summarized in Appendix M.

Early NASA models for these Systematic Measurements systems are the Pathfinder datasets and the ocean color Sensor Intercomparison and Merger for Biological and Interdisciplinary Oceanic Studies (SIMBIOS) program. ESE understands the need to use lessons from the early research success of Pathfinder Datasets and SIMBIOS to focus on thematically producing a key set of systematic measurements supported by mission-based instrument calibration/validation and the community intellectual capital of multi-instrument heritage product generation and analysis.

2. Projects Contributing to Interdisciplinary or Process Studies

Some science questions by their nature pose needs for concerted gathering of "bundles" of data, information, and services. For example, large regional scientific problems, interdisciplinary scientific questions, cycling questions, or large impact processes may best be answered by the community if there is a community-based attempt at aggregation of data, information, tools, and

services dedicated to providing the inputs needed. Information may need to be derived from disparate or multiple-source data, with data usage barriers, such as temporal and spatial differences, removed. This CAN welcomes proposals that provide, or contribute to provision of, comprehensive information to answer the high priority science questions posed in the ESE Research Strategy[6] regarding specific Earth system components or processes.

3. Examples

The following section contains examples of community support solicited for research REASoN project goals and objectives described in Appendix A, Section 1. The scope of this CAN is not limited to the areas contained in these examples. This announcement presents an opportunity to participate in any area of the ESE research and development activity through provision of data, information, and service support for the Earth science community in answering strategic science questions delineated in the ESE Research Strategy.

a. Precipitation

One of the questions posed in the ESE Research Strategy is: "*How are global precipitation, evaporation, and the cycling of water changing?* **"** Global Precipitation is the principal indicator of the rate of change of the global water cycle, and can also be used effectively as an input for numerical weather forecasting.

Space-based global observations have been significantly improved by the on-going Tropical Rainfall Measuring Mission (TRMM.) Successful experience with the tropical precipitation data has led NASA to embark on an Integrated Precipitation Data System, as a SEEDS prototype for this systematic measurement. Clearly the existence of a global trend can only be established on the basis of global rainfall observations. To this end, NASA is establishing a Global Precipitation Science Team. The transition from mission-oriented measurements to systematic precipitation measurements will occur throughout the transfer from the TRMM mission to the Global Precipitation Mission being planned for 2008 timeframe, and be done in consultation with members of the soon-to-be-solicited Precipitation Science Team.

NASA would like to begin fusing data from multiple sources into the data streams, increasing the spatial and temporal coverage. The concept is not to build a system as a single-point mission system, but instead to incorporate a rolling-wave of capabilities, scalable to handle satellites/instruments' data added, deleted, replaced as required, and associated tools for their management. Partners are a key part of the concept. Ability of other existing and/or future precipitation sites to tie into data and services is envisioned.

NASA encourages proposals for innovative solutions focused on creation, use and manipulation of global precipitation data. Proposals are encouraged in a number of areas not only related to precipitation data transformation and combination but also for data and information tools that can assist the Earth System science community in using existing and anticipated precipitation products in new and flexible ways.

Also encouraged are proposals to help NASA hone down the concepts of thematic and systematic-parameter-oriented research systems in support of current and future precipitation missions. Such systems are assumed to be offered by providers demonstrating the capability to

offer services or products that are specialized and go beyond the normal standard data products offered traditionally by a satellite mission. These services and products provide additional information for addressing global precipitation than standard products that any mission can offer.

REASoN projects selected to contribute to the Integrated Precipitation Data System are required to participate in Precipitation Program meetings. See Appendix K for specific information regarding the Integrated Precipitation Data System.

b. Data Assimilation Products Consistent for Climate Study

Perhaps the single greatest roadblock to fundamental advances in our understanding of climate variability and climate change is the lack of robust and unbiased long-term global observations of the climate system. Such observations are critical for the identification and diagnosis of climate variations, and provide the constraints necessary for developing and validating climate models. Without such long-term observations, we are in danger of "over-fitting" our models to the available recent observations, making them potentially unsuitable for understanding or predicting future climate variations. There is, in fact, mounting evidence that climate processes are fundamentally non-stationary and episodic. Examples are the apparent long-term changes in the Indian monsoon/ENSO (El Niño Southern Oscillation) relationship, other decadal and longer-term changes in ENSO and its links to the middle latitudes, and the episodic nature of long-term devastating droughts in such places as the African Sahel and the Great Plains of the United States.

New observations can only tell us something about the climate if they can be put in the context of past observations. Are the observations indicating something unusual is happening? Are similar or related changes occurring in other parts of the globe, and/or in other quantities? Are they part of a trend? If so, what is forcing that trend, and will it continue? Does the change have a diurnal component (e.g., is it primarily the nights that are getting warmer)? Are the observations during the course of a season indicating more or fewer extreme weather events compared with "normal"? The answers to such questions require systematic climate data sets that are consistent over time and space. Four-dimensional climate data assimilation, in which new observations are integrated with our historical record and with model fields, provides an integrated approach to understanding such climate variability and ensuring that climate models are consistent with the full range of observed climate variations. Four-dimensional data assimilation in fact provides information, not only about the quality of the models, but also about the quality of the observations.

Current techniques of four-dimensional data assimilation have been largely developed for numerical weather prediction, and are not well suited for dealing with model and observational bias and inhomogeneities in the evolving observing system. Addressing the problem of a changing observing system within a data assimilation framework is intimately linked to the issue of model quality and the compatibility of the model with the observations. Data assimilation, by injecting observations into the system at effectively every time step, acts to constrain climate models at the process level. Systematic mismatches between the observations and the model are a critical factor in exacerbating the sensitivity of the assimilated climate to changes in the observing system. At the same time, the mismatches between model and observations provide important diagnostic information for assessing the veracity of physical parameterizations and evaluating the changing character of the observing system. One of the key challenges of climate

data assimilation will be to develop new tools and methodologies that take advantage of the wealth of information provided by long-term climate data assimilations to eliminate model bias, reduce observational bias, and reduce the sensitivity of the assimilated climate to changes in the observing system.

NASA encourages REASoN project proposals to integrate the current and past satellite and conventional observations to produce temporally and spatially consistent long-term systematic data sets of the Earth System suitable for climate variability and climate change studies. Proposals are solicited to develop and test methods for minimizing discontinuities in the climate record resulting from changes in the observing system, to develop and test analysis techniques that are optimized for estimating low frequency climate signals, to carry out demonstrations of data assimilation in a coupled atmosphere/ocean/land model to assess potential benefits and problems of assimilating observations in a fully coupled framework, to apply the infrastructure being developed as part of the multi-agency Earth System Modeling Framework (ESMF) to assess and improve the performance of climate models within a data assimilation framework, with emphasis on model bias, the quality of regional climates, and the development of improved physical parameterizations, to develop a test-bed facility based on ESMF that would facilitate research and education on data assimilation and model development issues related to the production of long-term climate datasets.

4. Cryospheric Products

This section provides a special opportunity, and could be provided in the context of either the systematic measurements or the process type of community support solicited for research REASoN goals and objectives described earlier in this section.

In the past, NASA has made available certain higher-level Synthetic Aperture Radar (SAR) products through Alaska SAR Facility (ASF) and an associated web site at the Jet Propulsion Laboratory (JPL)[7]. NASA recognizes that open peer-review is often the best methodology for developing and making available value-added cryospheric products in order to effectively address questions from the ESE Research Strategy that pertain to ice on the land and the seas and their interaction with the surrounding oceans and atmosphere. Consequently, NASA is soliciting proposals for efforts that will develop and provide the Earth science research community with data sets that will advance our understanding of the cryosphere and its relationship with the rest of the Earth system as explicated in the *Oceans and Ice in the Earth System* and the *Global Water and Energy Cycle* sections of the ESE Research Strategy. SAR data are especially valuable for cryospheric research because of their all-weather capability, high resolution, and interactions with snow and ice surfaces. Their volume and complexity, however sometimes limit the extent to which the community utilizes them. The conversion of complex and voluminous data into value-added data products that facilitate analysis of geophysical processes is desirable. These types of products could be derived from individual sensors, multiple sensors through data fusion, and a combination of remote sensing, modeling, and *in situ* data.

B. Applications

The goal of the ESE Applications Program is to *expand and accelerate the realization of economic and societal benefits from Earth science, information, and technology*. The Application Program works with partners to employ ESE results to demonstrate practical solutions to high priority, national issues. The ultimate objective of NASA/ESE-sponsored applications projects is the integration of NASA data and capabilities into decision support systems employed by user organizations to guide environmental and resource management and policy decisions (see Figure 1). Toward that objective, the Applications Division solicits REASoN projects that:

1. Generate and/or provide data and data products, from NASA/ESE systems, that are used in decision support systems for national priorities (Type 1); or,

2. Develop "cross cutting solutions," i.e., solutions that address issues common to multiple national applications, through improvements in information technology (Type 2).

REASoN applications projects should identify a user organization that will ultimately benefit from the decision support system (DSS), and an existing or proposed DSS involved in the national application as illustrated in Figure 1. These projects should draw upon, and contribute to, E-government solutions, with an emphasis on delivering data and information over the Internet. Project implementations that include dynamic updates to databases of NASA measurements and derivative Earth science data products are preferred. A REASoN applications project may operate independently or in partnership with other REASoN projects and/or other organizations with related solutions.

Applications REASoN projects are expected to perform one or more of the following functions:

- Improve access to, and expand the immediate relevancy of, ESE data, science results and technology to the broad user community by enabling these data and capabilities to be utilized to serve policy and management decision support.
- Expedite the realization of social and economic benefits of ESE data beyond the science community through involvement of resources and capabilities outside of NASA, particularly in enabling solutions integrated into the U.S. industrial base .
- Transform ESE science products into innovative, applications-oriented information products/ solutions designed to meet the needs of specific national purposes and lead to measurable enhancements to resource management, economic growth, and overall quality of life
- Leverage non-NASA capabilities in remote sensing, environmental monitoring and information systems to extend the social and economic benefits of ESE research to a broad user community and enhance the relevance of NASA's scientific research for societal benefits.
- Fuse, integrate and assimilate ESE generated data with GISs and other technologies presently in use by other Federal agencies, state and local governments, value-added companies, private sector users, and various non-governmental organizations (NGO's).

- Develop and utilize processes to make Earth science data easy to preserve, locate, access, and use for practical applications within the context of the existing Federation.
- Provide "cross-cutting solutions," i.e., new technology that solves problems common to multiple applications.

C. Education

The ESE Education Program supports and aligns with the NASA core mission in "*inspiring the next generation of explorers … as only NASA can*". The priorities for NASA's educational mission are:

- Motivate K-16+ students to pursue careers in science, math, and engineering…as only NASA can
- Provide educators with unique teaching tools and compelling teaching experiences…as only NASA can
- Optimize the integration of NASA results into education venues
- Engage minority and underrepresented students, educators, and researchers in NASA's education programs

The ESE Education Program participates in Agency-wide educational initiatives (e.g., telepresence technology) and collaborates with educational organizations outside of NASA that contribute to quality teaching and learning of Earth system science and related fields (including geography and Earth science) for all Americans using NASA's unique content. Particularly relevant to this CAN are the telepresence and digital library technologies for educational or learning purposes.

The working definition for telepresence is "the experience of being in an environment by means of communication technology." NASA telepresence program elements include research, content, context, technology tools, and building strategic partners. Regarding content, NASA wishes to establish meta-tagged materials (context, themed) repositories of text, images, datasets, video and audio clips for digital library collections, as well as provide technologies that effectively engage the learner such as 3-D and 4-D visualization. The robust data and scientific knowledge resulting from NASA's Earth remote sensing satellites offer a unique opportunity for applying telepresence technology to enable students to experience knowledge of the workings of the dynamic Earth system.

One of the great promises of the National Science Digital Library (NSDL) instantiated by the NSF is the ability to make it easy for students (or learners) to explore data to answer their own questions. The ESE Education Program collaborates with the Digital Library for Earth System Education (DLESE, a member of NSDL)[8.] The mission of DLESE is to improve the quality, quantity, and efficiency of teaching and learning about the Earth system by developing, managing, and providing access to high-quality education resources and supporting services through a community-based, distributed digital library.

Existing Earth Science Information Partnerships (ESIPs) have assisted in improving the usability (including packaging, manipulation, rendering, etc.) and accessibility of NASA data for use in the education community in both formal and informal learning. Through this CAN, NASA/ESE seeks new solutions that can serve the national agenda and address NASA's mission in education, with a particular focus on the Internet for delivery of data and information for use by the educational community. NASA recognizes data-enhanced learning experiences, including activities in which students (or learners) explore research databases to answer questions, are an important pedagogical tool. In particular, data-enhanced learning experiences can

- Prepare students (or learners) to address complex real-world problems,
- Develop their ability to use scientific methods,
- Provide interfaces to dynamically-updated knowledge, models, education modules, and Earth science data,
- Teach students how to critically evaluate the robustness of data (or other forms of evidence) for their consequent interpretations or conclusions, and
- Provide training in technical and communication skills and the values and ethics of working with data.

NASA recognizes the importance of timely access of "usable" Earth remote sensing data and information for teaching and learning in the classroom and in informal settings (informal learning centers, youth groups, community groups, libraries, natural and cultural history sites, etc.). This type of demand is on the increase and the information systems requirements are just as rigorous as those for scientific research and national applications purposes. The synergistic combination of expertise representing education/interpretation, content, and data/information delivery and inter-operability is particularly valuable to the Earth Science Enterprise in accomplishing our mission to "inspire the next generation of explorers".

There are excellent examples of how students (learners) can be engaged in using data to answer questions from all of the scientific disciplines and engineering. Through REASoN education projects, NASA seeks to help disseminate existing examples of effective practice and develop data access infrastructure and services that support data-enhanced learning experiences. The Education Program seeks solutions that perform one or more of the following:

- Develop tools, techniques or methodologies for finding and accessing data relevant to the topic under investigation, for evaluating the quality of this data, and for contribution of data to larger data sets;
- Develop tools and interfaces to manipulate and render (visualize and represent) data to enable students interactive access to dynamically updated databases to be used in answering questions, and/or to combine multiple and diverse data sets to solve a complex problem;
- Develop tools or methodologies that enable simple and ready translation of a wide range of scientific data products into ones that are appropriate for classroom use at K-12 grade and college levels;
- Develop or enhance data or data products that fulfills current voids and supports quality learning with a scalable, sustainable and systemic approach.

- Develop interfaces to enable existing (and developing) education modules to be linked to solutions that deliver interactive access to dynamically updated database and models of Earth system.

D. Technology Development in REASoN Projects

This CAN is a vehicle to evolve the current ESE network of data systems and service providers over the next decade through selection of REASoN projects that will provide solutions for Earth science research, applications, and education communities. New technologies for ESE data systems, developed within the context of specific topical and user needs and that utilize and conform to community-accepted standards and guidelines (established through the SEEDS processes), may be included as part of a REASoN CAN.

Technology development is NOT a requirement for REASoN proposals. It is expected that proposals will demonstrate effective, innovative use of technology. Proposals that include technology development must do so within the well articulated balance of a research, applications or education solution or solutions. Proposals for technology development *only* are NOT solicited and will be considered non-responsive to the CAN.

1. REASoN Technologies

New technology components of CAN proposals must demonstrate that the proposed technology has been theoretically proven but has not been demonstrated in a relevant Earth science environment (i.e., demonstrate an entry technology readiness level (TRL) of 3 or higher, and a concluding TRL of 7 or higher). Furthermore, proposals must show how the technology development, if successful, will be integrated and demonstrated in the proposer's final data system. Finally, the technology component of the proposal should identify benefits to the evolution of ESE data systems beyond its initial use. Technology components of CAN awards will be monitored by the Earth Science Technology Office (ESTO: See Appendix A, Section A.2.) through quarterly status reports and regular reviews. In addition, technology development awardees will also be required to participate at a level of up to 0.25 FTE in the SEEDS Technology Infusion Working Group to help in defining technology needs and infusion processes.

The identified technology drivers noted below come from understanding that the study of the Earth as an integrated system requires the capture, processing and analysis of tremendous volumes of diverse scientific data. Currently, Earth scientists spend significant amounts of time writing specialized software to perform a variety of data analysis functions such as accessing relevant data sources, translating from/to specific data formats, manipulating data in a variety of science algorithms, doing projections and overlays for visualization and analysis, and formatting and archiving the data analysis results as new data products. There are three areas where technology development is needed to enable the Earth science community to more efficiently access, analyze and manage NASA remote sensing data.

a. Access and Delivery

An open system approach is needed to enable discovery, access and delivery of Earth science data and services. Intelligent system techniques are needed to facilitate users' independent search and access to the specific information or data they require. Examples include, but are not limited to:

- Data and service locator technologies leveraging the web and commercial approaches that are tailored to the unique demands of the geo-spatial Earth science data sets; and
- Techniques addressing seamless, automated access to data residing in distributed multi-petabyte archives.

b. Interoperability Framework

The long-term goal is to create an infrastructure such that individuals can contribute reusable components of a modular (Earth science software) solution that can be reused by others in the community as part of a whole system implementation. Such an infrastructure accommodates new components (evolvable) and the upgrade or replacement of existing components (maintainable). The open systems approach is intended to create a marketplace for data services, enabling 'plug and play' components contributing to tailored Earth science analysis tools. Examples include, but are not limited to:

- Reference architecture descriptions, proof-of-concept prototypes, middleware components, and 'use scenarios' demonstrating end user benefits;
- Data and Service representation methods, languages and metadata techniques enabling Earth science community-centric services and open tools sets; and
- Technologies managing data integrity, authentication, and heritage, among others.

c. Knowledge Management

Knowledge management technologies manage information capture, storage, cataloging, access, and dissemination to improve communications (e.g., assisting users in finding data) or share information within the science community (e.g., assisting providers in describing data products and services they have to share). NASA is interested in methods and tools to facilitate the creation, capture, sharing, and leveraging of information about Earth science data and services from internal and external sources. Examples include, but are not limited to

- Knowledge representation and categorization;
- Improved support for navigation and discovery across disciplines; and tools for automatic generation of documentation about data and services.

2. Participation in ESE Data System Evolution

As described in Section II, the community will be actively involved in shaping the evolution of the ESE data systems and services via active involvement in the SEEDS ongoing efforts. This CAN is intended to promote such involvement by directing the REASoN project proposers to

develop and cost plans to contribute to one or more of the four SEEDS ongoing efforts described below.

a. Standards and Interfaces Activities

This group will initiate a coordinated set of activities that will support the ESE and its projects and user community in the definition and effective use of standards and standard interfaces for data and information systems.

- Define a process or set of processes whereby the ESE can evaluate and make decisions on establishing requirements or recommendations on data systems standards. It will be required that representatives of the ESE community of users and stakeholders be participants in the processes.
- Work with ESE management to define responsibilities and empanel a Standards and Interfaces Working Group to give direction to the respective activities.
- Document requirements and guidelines as determined and develop and maintain the tools developed to conform to and use the standards.
- Provide consulting services to ESE projects and users on the use of the standards and interfaces and associated tools.
- Provide the interface to external standards organizations and other federal and international agencies and institutions to track their activities and to represent ESE initiatives in these areas.

It is anticipated that the CAN awardees will play a major role in the performance of all of the SEEDS standards and interfaces activities. Each team will be expected to provide an individual to serve on the Standards and Interfaces Working Group (SIWG) at a level of up to 0.25 FTE. In addition, the teams will be candidates to perform the activities associated with standards and standard interfaces as defined by the ESE and SEEDS management and the SIWG.

b. Technology Infusion Working Group

The Technology Infusion Working Group's purpose is to define processes to infuse new technologies into the evolving ESE data systems, and to define and conduct community-based processes to identify needed capabilities and technologies. REASoN project proposers with expertise in technology development, leveraging, and infusion are encouraged to participate at a level of up to 0.25 FTE in the Technology Infusion Working Group to help in defining technology needs and infusion processes. Participation in the Technology Infusion Working Group is mandatory for all REASoN projects receiving additional funds for technology development (Section II.D).

c. Architecture and Reuse

NASA's ESE intends to explore, via prototyping, whether open source software development efforts sharing ESE custom code could enable greater re-use across ESE's science data systems. The intent of this effort would be to contribute to the following overall ESE goals:

- Reduction of the cost of supporting future missions, science, and applications;

- Increase flexibility and responsiveness to new missions, science and applications; and
- Increased effective, accountable community participation in system development and operations.

d. Software

CAN winners are encouraged to participate in a software re-use working group that will be examining open source re-use issues. Participation can be at several levels, high degrees of participation will be on the level of 0.25 FTE/year of participation.

First year efforts will examine the following topics:

- Selecting standards for architecture expression to enable communication about available resources,
- Mining existing assets to determine common functions,
- Addressing intellectual property issues, and
- Advising on policies linking reuse to technology infusion.

Future years efforts are expected to include:

- Defining the needed infrastructure to enable reuse,
- Developing notional architectures,
- Participating in open-source efforts, etc.

It is anticipated that travel once a year will be required, with bi-monthly working group meetings, and fulfillment of assignments between meetings.

3. Open-source Prototype Demonstration (Mission Success)

This CAN seeks to award two or more open source "testbeds"/prototypes in the range of $150K-$300K to demonstrate reusable asset deployment. A prototypes/testbed may be proposed as an option on a proposal for a research, applications, or education REASoN project. The costs for developing the prototype should be highlighted in the cost proposal. A Proposer for an open-source testbed should be cognizant of ESE-related software and have identified potential users, outside his/her organization, with need for the software. In addition, he/she should be familiar with existing open source project support like SourceForge (http://sourceforge.net/). Funding under this element of the CAN will be provided to mine the proposer's current assets, make the software ready (e.g., document and formalize interfaces) and available to existing open source projects, and work collaboratively with potential users to re-use the software via an existing open source effort. The effort should focus the first year on planning only, the second year should ready the software and work cooperatively with an open source effort, and the third and subsequent years should demonstrate integration of the software by the potential users.

4. Metrics Planning and Reporting

The purpose of this activity is to define performance metrics to be collected and reported by the data systems and services providers funded by ESE. In addition, this activity will include defining/refining processes needed for metrics collection and reporting. There are several purposes for collecting and reporting on performance metrics:

- Reporting on metrics is a requirement placed on ESE by the Government Performance Results Act (GPRA)[9]. Performance metrics must be defined and annual goals established. Annual reports must be provided to the Office of Management and Budget on the actual achievement of these predefined metrics.
- Appropriate metrics assist ESE in making decisions on continued funding of activities
- Metrics will assist in ensuring interface requirements between different entities funded by ESE are being met, and that ESE can meet its overall goals
- Success measures help the data systems and services providers track their own performance and their users' satisfaction to help with internal management decisions

Each of these purposes may involve definition and collection of metrics at different levels of detail, even though there may be some overlap among the sets of metrics needed for the different purposes. The collection and reporting frequencies for the metrics also vary depending on the purpose. It is difficult, if not impossible, to define a set of metrics that will remain static over a long period of time. Therefore, an on-going process is required to define and refine metrics with the participation by the funded data systems and services providers. Also, it is useful for the ESE-funded entities to collaborate in defining common sets of metrics and tools that will assist in collecting them in order to reduce the effort needed in collection and reporting. In the case of metrics needed for ESE's reports under the GPRA, it is essential that the metrics be collected in a manner suitable for integration and aggregation. Hence, in this case, common formats and standards need to be adopted.

The Earth Science Enterprise reports metrics to OMB per the annual performance plan for the GPRA. The metrics to be reported are proposed by ESE each autumn as part of the fiscal year program submission. This year (FY2002) ESE is proposing GPRA metrics for FY04. At the inception of the EOS era, the GPRA metrics defined for EOSDIS were primarily output metrics. The Enterprise wishes to move to outcome metrics, and has begun to do so by adding user satisfaction indicators. The current (FY02) set of GPRA metrics indicators for data and information system sciences includes:

- Make available data on seasonal or climate prediction, and land surface changes to users within 5 days of their acquisition.
- Increase by 50% the volume of data acquired and archived by NASA for its research programs compared to FY01.
- Increase the number of distinct NASA Earth Observing System Data and Information System (EOSDIS) customers by 20% compared to FY01.
- Increase scientific and applications data products delivered from the Earth Science Enterprise data systems by 10% compared to FY01.

- User satisfaction: increase the number of favorable comments from DAAC and Earth Science Information Partner (ESIP) users as recorded in the customer contact logs over FY01; decrease total percentage of order errors by 5% over FY01.

GPRA metrics are reported by DAACs and ESIPs on a monthly basis. REASoN projects will be required to report their GPRA metrics each month through the Federation metrics working group process. In addition, the projects are expected to assist ESE in setting new GPRA metric indicators and targets each year.

It is anticipated that the CAN awardees will play a role in the performance of all of the SEEDS metrics planning and reporting activities at up to a 0.25 FTE level of effort. Each team may propose to participate in the Metrics Planning and Reporting Working Group (MPARWG) at one of two levels of effort: representation at working group meetings, or providing ideas and inputs to active representatives and reviewing results from the working group.

Each team will be required to propose appropriate metrics for their performance (as indicated in Appendix B, Section 3.7). After the selections, the MPARWG will review the metrics to identify commonality among them and establish requirements for tools to assist in reporting that may be made available to individual CAN awardees. Proposers may also offer their off-the-shelf tools or development of tools as part of their proposals.

E. Summary of Opportunities

This CAN solicits projects to provide data products and/or information systems and services capabilities in support of the goals and objectives of the research, applications, and education strategies of NASA's ESE. The CAN leverages or develops technologies that are applicable to, and that will be incorporated within, projects to address known science and applications information requirements and Earth science education needs. REASoN projects will be fully engaged in the SEEDS effort by contributing to and applying SEEDS principles in development of REASoN projects and services, and by adhering to SEEDS standards, interfaces, and required levels of service that emerge from the SEEDS Working Groups' processes. Table 1 provides a summary of the CAN opportunities solicited.

Table 1

REASoN Project Topics and Approach Options

Examples (*not comprehensive*) of topics for research, applications and education solutions and technologies (not comprehensive) that may be proposed and used In REASoN projects.

REASoN PROJECT TOPICS:

Research

- Earth Processes Areas
  - *Climate*
  - *Weather*
  - *Natural Hazards*
- Types of Measurement Suites
  - *Systematic Measurements Contribution*
  - *Interdisciplinary/Process Studies*
- Examples
  - *Precipitation*
  - *Data Assimilation Products for Climate*
- *Cryospheric Products*

Applications

- Application Specific (Type 1)
  - *Agricultural Competitiveness*
  - *Air Quality Management*
  - *Aviation Safety*
  - *Carbon Management*
  - *Coastal Management*
  - *Community Growth*
  - *Community Disaster Management*
  - *Early Warning for Homeland Security*
  - *Energy Forecasting*
  - *Invasive Species Management*
  - *Public Health*
  - *Water Management*
- Cross cutting solutions (Type 2)

Education

- Development/dissemination of learning materials
  - *K-16+ classrooms*
  - *Informal learning centers*
  - *Workplace learning for applications professionals*
- Students as pioneers and investigators
  - *Science*
  - *Math*
  - *Engineering*
  - *Technology*
  - *Geography*
- Professional development
  - *Educators from formal education*
  - *Staff from informal learning centers*
  - *Providers of continuing education*

APPROACH OPTIONS:

New Technology (Optional)

- Analysis tools and methods
- Beta and information management schemes, tools and methods
- Multi-satellite and sensor data merging, analysis/synthesis
- Search and query tools and methods for large data sets
- New data /information products for research and applications
- Integrate data and information with decision support systems for applications
- Standards and protocols for data exchange and distribution
- Generating long-term consistently cross-calibrated data sets.

SEEDS

- Standards and Interfaces
- Technology infusion
- Architecture and Reuse
- Metrics Planning and Reporting

III. Participation

NASA encourages original and innovative proposals from all sources for effective applications of NASA's Earth science databases for educational, governmental, non-profit, and commercial

purposes and to benefit broad and diverse segments of society. The fusion and integration of NASA Earth science data with data of other federal agencies, state and local governments, non-government organizations and private sources, including scientific quality data assembled by students, worldwide, is encouraged. It is anticipated that this type of data fusion will bring significant innovations concerning beneficial use and applications of these data to make progress on scientific understanding of the Earth system and/or application of knowledge gained in policy and economic decision support systems. Appendix A (Section A.2) describes the applications strategy, which drives the priorities for selection of a portfolio of applications projects, and identifies national needs lists candidate areas where applications projects can contribute to the needed research, validation and verification, and demonstration.

Respondents are also encouraged to capitalize on existing or emerging technologies, tools, and capabilities that are commercially available or within the public domain. Library and information science technology development, as required by applications, is anticipated.

Funding for selected REASoN projects will extend for no more than five years. For Applications REASoN projects, the levels of NASA support must decrease in each performance year after the second as the project advances toward the goal of self-sufficiency. Successful Applications proposals under this CAN are not eligible for renewal or time extension through subsequent CANs.

Respondents must submit proposals by November 26, 2002. Proposals will be evaluated by mail review and/or peer-review panel. Selection of successful proposals is planned for late February, 2003, but this date is dependent on the number of proposals received. NASA will notify all respondents of the results of the proposal evaluations.

Printed copies of this CAN and the documents it references are available by request by calling (202) 358-3552 and leaving a voice message. Please leave a full name and address, including zip code, and a telephone number, including area code.

NASA's ability to fund the cooperative agreements selected under this CAN is contingent upon the availability of appropriated funds.

IV. General Information

The following information is relevant to **all** submissions to this CAN.

A. Requirements for Preparing and Submitting Proposals

Specific evaluation criteria for all types of proposals submitted in response to this CAN are in Appendix C. Respondents are responsible for following the instructions in Appendix B and the information in that appendix and materials cited in the appendix.

NASA will directly contact both successful and unsuccessful respondents.

B. Other General Requirements

All REASoN projects will meet the following requirements:

- Maintain a public WWW-compliant presence.
- Data and information shall be publicly available preferably via Internet transfer.
- Descriptions of all products and services shall be provided to the NASA GCMD
- The products shall contain and be searchable via FGDC compliant metadata.
- REASoN projects shall apply for membership to the existing Federation

C. Schedule

- September 27, 2002 CAN-02-OES-01 Distributed
- October 10, 2002 Pre-proposal Conference (see Section IV.D below)
- November 1, 2002 Letters of Intent Due (see Section IV.L. below)
- **November 26, 2002** **Proposals Due** (see Appendix B for instructions)
- February 26, 2003 Selection announcement

D. Pre-proposal Conference

A pre-proposal conference for this CAN will be conducted October 10, 2002. Attendance at the conference is NOT required to submit a proposal. Participants in the conference will hear presentations describing the CAN and will have the opportunity to submit questions. All questions submitted during the conference and the answers provided will be made available on the ESE research website for public access (http://research.hq.nasa.gov/code_y/nra/current/CAN-02-OES-01/index.html).

The pre-proposal conference will be held in the Washington D.C. metropolitan area. Conference information and logistics will be available on the ESE home page, prior to the pre-proposal conference.[10] Please check the home page for details.

E. NASA Participation

NASA will contribute to the research, applications and education REASoN projects by providing:

- SEEDS provisional process recommendations for evaluation;
- NASA ESTO and SEEDS expert consultation in identifying opportunities and needs for leveraging or developing advanced technology;
- Assistance in locating and accessing input data sets; and
- A web page organizing ESTO technology investments, including research titles and abstracts.

Additional NASA participation may be proposed by potential recipients.

F. Funding

NASA anticipates funding about 50 cooperative projects with varying annual budgets, commensurate with the proposed activities and needs for particular targeted support, and, depending on the proposed co-funding, ranging between $200k and a maximum of $700k to $1000k per year. The upper limit is for proposals that have a well articulated balance of research, education and technology or applications, education and technology. Proposals that include an optional SEEDS Open-Source Prototype/testbed should indicate the amount of funding required for that activity. It is anticipated that the allocation by subject will be in the following range, based on total funding available or number of projects:

Research	50%±10%
Applications	35%±10%
Education	15%±5%

Funding for selected REASoN projects will be for up to five years. NASA's ability to fund the REASoN projects selected under this CAN is contingent upon the availability of appropriated funds.

Educational institutions, federal or state government agencies within the US, and other non-profit organizations are encouraged to propose cost sharing.

Commercial recipients of cooperative agreements are expected to match the funds received by that commercial recipient from NASA. Recipient contributions may be cash, non-cash, (in-kind) or both.[11] Cost sharing for commercial recipients is addressed in paragraph 1274.204 (b) and for educational institutions and other non-profit organizations is addressed in paragraph 1260.13 (c) of the NASA Grant and Cooperative Agreement Handbook.

G. Eligibility

Participation in this program is open to all categories of domestic organizations. Organizations include industry, educational institutions, nonprofit organizations, non-governmental organizations, other federal agencies, and state and local government agencies. Federal departments and agencies may participate. Potential recipients from NASA centers, U.S. government agencies, and FFRDCs will be transferred funds through the appropriate mechanism and will not receive Cooperative Agreements. Proposals are encouraged that demonstrate effective partnerships, or cooperative arrangements, among institutions and among the government, non-profit and commercial sectors.

H. Joint Proposals

Joint proposals that demonstrate effective partnerships or cooperative arrangements among institutions and among the government, non-profit and commercial sectors are encouraged. (See http://ec.msfc.nasa.gov/hq/grcover.htm – NASA Grant and Cooperative Agreement Handbook – for the guidelines for of cooperative arrangements.)

I. Withdrawal

The respondent may withdraw a proposal at any time. Respondents are requested to notify NASA if a proposal is funded by another organization or of other changed circumstances that dictate termination of evaluation.

J. Foreign Participation

NASA accepts proposals from entities outside the U.S. in response to this CAN on a no-exchange-of-funds basis. Proposals from non-U.S. entities should not include a cost plan. Non-U.S. proposals, and U.S. proposals that include non-U.S. participants, must be endorsed by the government agency or funding/sponsoring institution from the country in which the non-U.S. participant is located. Such endorsement should indicate that if the proposal is selected, sufficient funds will be made available by the sponsoring foreign agency to undertake the activity proposed.

NASA gives notice to non-U.S. organizations that already have agreements with NASA involving data system interoperability with EOSDIS that these agreements remain in force. Further, foreign organizations are not required to respond to this CAN in order to participate in cooperative efforts with NASA.

K. Cancellation of CAN

NASA reserves the right to make no awards under this CAN and, in the absence of program funding or for any other reason, to cancel this CAN by having a notice published in Federal Business Opportunities (http://fedbizopps.gov/). NASA assumes no liability for canceling the CAN or for anyone's failure to receive actual notice of cancellation.

L. Notice of Intent

To determine in advance of proposal submission the expertise required of peer reviewers and to increase the efficiency of proposal management, it is requested that all respondents submit a Notice of Intent. Please follow the instruction in Appendix E to submit a Notice of Intent.

M. Evaluation Criteria

Evaluation criteria for this CAN are described in Appendix B.

N. Points of Contact

Questions or comments regarding the CAN shall be submitted by email to the NASA team through:
oescomm@hq.nasa.gov

OR for

Research REASoN projects:
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IV.O Selecting Official

Dr. Mary Cleave
Deputy Associate Administrator (Advanced Planning)
Office of Earth Science
NASA Headquarters
Washington DC 20546

Appendix A:
Background - NASA's Earth Science Enterprise

The Office of Earth Science of the National Aeronautics and Space Administration uses NASA's unique capabilities in space to study the fundamental Earth processes that power climate, weather, and natural hazards, and the impact of those processes on the quality of life. The Office has the responsibility to assure that the data, technology and attendant capabilities acquired and developed by NASA to meet the scientific mission of the agency are exploited to the maximum extent possible for the benefit of society and the economy of the nation, i.e., to understand and protect the planet.

ESE's goal is to develop an understanding of the complex, interrelated nature of the Earth – the nature of the solid earth, the atmosphere, the biosphere, the cryosphere, and the hydrosphere – so that we can better understand, predict, prepare for, and respond to, changes in climate, weather, natural disasters, and other events that threaten our economic and social well-being.

The NASA Earth Science program is driven by the recognition of the societal importance of the natural variability of the planetary environment and the realization that humans are causing significant changes in atmospheric composition, land use and land cover, water resources, and biodiversity. NASA embraces the concept of "Earth system science" – the idea that the Earth can only be understood as an interactive system that includes the atmosphere, oceans, continents and life. This concept of Earth system science focuses on interdisciplinary science to understand the interactions between the Earth system components. NASA also clearly recognizes the societal importance of Earth system science, as the scope and pace of natural and human induced changes occurring in the Earth system combine with increasing pressures on land, water, and air resources to increase the demands for accurate environmental information about the present and future.

A. Organizational Elements

The ESE is organized along three functional elements:

- *Research*, to increase in our knowledge of the Earth system
- *Technology*, to enable new, breakthrough or lower-cost capabilities for the study of the Earth system in the future
- *Applications*, to enable NASA-developed data science and technical capabilities to serve as the basis for practical tools that address national applications and support formal and informal education and workforce development related to Earth science

Research uses the observations and measurements to answer key questions about how the Earth functions in its natural state and human effects on natural Earth processes. Technology provides the instruments and platforms that generate observations and measurements. Applications extracts full social and economic benefit from NASA Earth science research and technology. All three elements are driven by the imperative to support policy needs and national applications requirements.

1. Research

The ESE's research program focus is to increase our knowledge of the Earth system.[12] Science objectives contribute to the goal to observe, understand, and model the Earth system to learn how it is changing, and the consequences for life on Earth. The Research Strategy[13] identifies twenty-three questions organized under a basic hierarchical rubric of variability, forcing, response, consequence, and prediction, a pathway defined by the five questions listed in Section II.A.

This structure highlights one of the most important and intellectual challenges of the study of the Earth system – that most responses the Earth system makes to a forcing (either natural or human-induced) can in turn become a forcing factor themselves. This is the definition of a feedback process. Thus, the understanding of feedback processes in the Earth system is central to NASA's study of the Earth system.

The intellectual capital for both the planning and exploitation of Earth system observations is vested in a robust research and analysis program. It assures the linkage between global satellite observations, ground-, aircraft-, and balloon-based observations, including those used for studies of long-term system evolution and shorter-term process-oriented studies, and the computation models used to provide both a framework for interpretation of observations and a tool for prediction.

Given the wide range of disciplines and processes that could be productively studied, a number of prioritization criteria are defined to help in selecting and ordering both the specific scientific questions and programs to be implemented. From a scientific perspective, the following criteria are considered to be in descending order of priority, starting with Scientific Return; from the standpoint of implementation, they are listed in ascending order of priority:

- Scientific Return
- Benefit to Society
- Mandated Programs
- Appropriate for NASA
- Partnership Opportunity
- Technology Readiness
- Program Balance
- Cost

NASA has recognized two fundamentally different, but complementary, types of measurements needed from our satellite program: systematic measurements and exploratory measurements.

- **Systematic Measurements**: the long-term (nominally but not necessarily continuous) measurement of a select number of critical environmental parameters, typically those that cannot currently be inferred from other parameters. For these measurements, the focus will be on the construction of consistent data sets from multi-instrument, multi-platform, and multi-year observations with careful attention to calibration and validation. These typically will involve incremental advances in technology rather than revolutionary innovations. By the end of this decade, an increasing fraction of these may be obtained from operational entities, as the quality, calibration, and availability of such systems are improved to meet

scientific research needs.

- **Exploratory Measurements:** those observations that can yield new scientific breakthroughs by providing comprehensive information about a particular Earth system component or process. These are intended to be pursued for a finite period of time. They are likely to take advantage of innovative, even revolutionary, technologies.

The vast amounts of data that will be generated by ESE must be selected, organized and available in ways to support their easy use by the research, applications and education communities for their strategic needs. Data systems that can facilitate use of data and information, especially those needed to contribute to our ability to develop critical systematic measurements and to support comprehensive information about particular Earth system components, processes, or interdisciplinary science studies, are required.

2. Technology

The technology program manages the development of advanced technologies and applications required for cost-effective missions. It includes a full range of components, subsystems and computational technology developments. This program plays a major role in shaping ESE research and application programs of the future, aggressively pursuing promising scientific and engineering concepts and ensuring that the program maintains an effective balance of investments the Earth Science Technology Office (ESTO) at Goddard Space Flight Center manages ESE technology investments, and the New Millennium Program at the Jet Propulsion Laboratory manages technology flight projects for ESE.[14]

The Advanced Information Systems Technology (AIST) program, a development area within ESTO, has objectives to identify, develop, and (where appropriate) demonstrate advanced information system technologies which

- Reduce the risk, cost, size, and development time of ESE space-based and ground-based information systems,
- Increase the accessibility and utility of Earth science data, and
- Enable new, breakthrough Earth observation measurements and information technologies

Technology infusion is part of the investment strategy of the ESE technology program. ESTO currently identifies ESE technology needs in the Capabilities and Needs database, and solicits community input on AIST needs annually. The AIST program invests in both on-board and ground based technologies. Work is in progress within ESTO to increase visibility into technology investments, including an annual technology conference and publishing annual accomplishments.

Given the broad, distributed user base of Earth information data and information systems and services, one can argue that technology development, leveraging, and infusion to evolve within this arena has increased complexity. ESTO is working closely with the SEEDS formulation (see Section II.D.2. of this CAN) to evolve the Earth observation data systems in the near-term and has identified technology needs for access and delivery, interoperability, and knowledge

management (see Section II.D). ESTO will track any advanced technologies developed by REASoN projects in support of their research, applications, and education products and/or services.

3. Applications

The Applications Program plan for serving the nation, as described in the applications strategy of ESE,[15] focuses on serving national priorities through solutions that include the integration of the results of NASA's research and development into decision support tools. The approach is market-driven and citizen-centered. Applications of Earth science results are to be national in scope in terms of having significance in multiple states and regions. The objective of Earth science applications programs is to provide opportunities and partnerships with industry, universities, federal agencies and state, local, and tribal governments to develop sustainable solutions using predictions and observations resulting from Earth Science Enterprise research and development programs.

NASA/ESE identifies candidate national applications by their potential to serve national needs as documented in one or more of the following:

- Identified as a national priority by the Executive and/or Legislative branches
- Relevant to national program(s) of one or more federal agencies
- Requirements that are identified and validated by federal agencies and other user organizations through interagency working groups and the program planning and analysis processes NASA,
- Significant societal and/or economic value measured by clearly defined metrics, such as quality of life improvements, potential lives saved, and economic or resource savings

Using the sources above, NASA has identified twelve candidate, high priority application areas[16]:

- Agricultural competitiveness
- Air quality management
- Aviation safety
- Carbon management
- Coastal zone management
- Community growth for infrastructure
- Community preparedness for disaster management
- Early warning for homeland security
- Energy forecasting
- Invasive species management
- Public health
- Water management and conservation

These applications are described in Appendix F.

ESE profiles candidate applications projects using a systems-level "roadmap." The roadmaps illustrate the relationships among, a) Earth system science, b) remote sensing activities and related technologies being conducted by ESE and other organizations, c) potential applications, and d) desired outcomes and expected impacts. Potential milestones and endpoints are identified in the roadmaps. NASA management works with third parties to conduct objective assessments of candidate applications using pre-established guidelines and metrics. The application projects are then prioritized based on prioritization criteria laid out in the Applications Strategy.

In implementing individual applications, ESE establishes linkages between available science and technology capabilities and specific application requirements. To define the linkages, NASA works with its partner(s) to develop a project plan describing a systematic approach to demonstrate the viability of the application for operational use by the partnering organization. This stage identifies the appropriate approaches and organizations to fill the technical and/or business gaps identified in an application project plan. NASA addresses the requirements to fill the research and engineering gaps with solicitations for projects that provide opportunities for the public, academic, and private sector communities to contribute solutions. NASA prioritizes project proposals received in response to the solicitations using priority criteria described in the Applications Strategy: 2002 -2012. Documentation is compiled of all phases of the implementation of an application and made available for public benefit and to be used as a benchmark for operational implementation.

Education

The ESE Education Program is the functional element in the Enterprise that is an integral part of NASA's core mission in education. Its vision – in ten years – is a continuous, dynamic, and engaging learning environment for all citizens that expands and deepens the Nation's awareness, appreciation, and understanding of Earth system science and encourages pursuit of careers in science and technology. Its approach is to leverage NASA's accomplishments in the research and development of Earth science, remote sensing and information technologies to create a national architecture that enables scalable, systemic, and sustainable solutions for the delivery of ESE scientific findings and the delivery of Earth system science education.

Education has been a key component of NASA's programs since the launch of the TIROS in 1959. What began as a professional development effort training technicians to read and translate satellite imagery has evolved into a robust and dynamic program of national importance. Tens of thousands of trained educators and hundreds of thousands of students worldwide have collected and archived over eight million measurements of the Earth atmosphere, hydrology, soil, land cover and phenology through the GLOBE Program. A large collection of high-quality, peer reviewed NASA Earth science education products exists (http://earth.nasa.gov/education/) and is routinely transferred to classrooms, museums, park learning centers, and other learning venues. An exceptional on-line professional development capability also exists to provide in-depth Earth system science to educators nationwide. Today, with a suite of 13 Earth satellite missions on orbit (in contrast to 2 or 3 in years past) providing an unprecedented amount of data on our ever-changing planet, it is an imperative that the Earth Science Enterprise shares its excitement, science results, and new knowledge with citizens around the world in a timely manner. The challenge is to create an architecture that enables scalable, systemic, and sustainable solutions for continuous and dynamic delivery of our

scientific findings that leads to engaged learning about the Earth system and the environment for children and adults, professionals and laymen alike.

The ESE Education Program focuses on

- K-16 formal education in science, math, engineering and technology as related to Earth system science
- informal learning of citizens of all demographic, social-cultural, and economic variables, and mental and physical abilities about the Earth system and the environment, and
- workforce development for a vigorous Earth science research community and a competitive Earth remote sensing industry.

Particularly relevant to this CAN are projects that develop (select, redirect, translate, integrate, enhance and evaluate) educational content, resources, programs and tools that serves as the bridge between ESE and the educational infrastructure, providing continuous feedback and assessment as well as contributing to public literacy about the Earth system and the environment and the development of a competitive science and technology workforce for the 21st century.

B. Meeting the Cross–Cutting Challenge: Data Products and Information Systems and Services

1. Past and Present

The Earth science community is witness in this decade to unprecedented views of Earth from space. The depth and breadth of observation, and attendant enhanced quality and quantity of these observations and associated derived information products, are enabling new scientific exploration and discoveries of our home planet and establishing a solid foundation for informed economic and policy decisions.[17] The acquisition of more data from public and commercial systems – data with better spectral and spatial resolution than ever before – presents a challenge to government and commerce to make those data and data products readily available to the user community, to extract the information and knowledge content from these rich observations, and assimilate the data and knowledge into decision support systems.

The central element of NASA's response to the challenge is the Earth Observing System Data and Information System (EOSDIS). EOSDIS archives, distributes, and manages data and information from ESE activities and other data required for production and effective use of Earth observations. A set of discipline-oriented Distributed Active Archive Centers (DAACs) provides production, distribution and user services to members of the community.

Concurrent with the implementation of the DAACs, ESE sponsored projects to facilitate use of the ESE data for specialized research community needs and to support broader user community access to the data and data products from the ESE missions. These projects included Pathfinder Datasets, the Regional Earth Science Applications Centers (RESACs), the Applications Research Centers (ARCs), Earth Science Information Partners (ESIPs) and the Synergy Program.

Pathfinder data sets date to1991. They were compiled and released under the EOS Program to provide research-quality, consistently-calibrated and -processed datasets to the community prior to the availability of data from the EOS satellites. The Pathfinder data sets focused initially on

long term, calibrated and validated data sets for studying climate change. In 1995, additional types of data products were added along with reprocessing of some earlier product sets and the development of new data processing algorithms.

In 1995 the National Research Council recommended that NASA shift appropriate functions of its EOSDIS implementation to a federation of competitively selected ESIPs. Three types of ESIPs were defined. Type 1 ESIPs are responsible for standard data and information products and associated services whose production requires considerable emphasis on reliability and disciplined adherence to schedules. While the DAACs provide some processing, much of the production for EOS Standard Products has shifted to Science Investigator-Led Processing Systems (SIPS). Type 2 ESIPs are responsible for data and information products and services in support of Global Change Research (other than those provided by the Type 1 ESIPs) that are developmental or research in nature and where emphasis on flexibility and creativity is key to meeting the advancing research needs. Type 3 ESIPs provide data and information products and services to users beyond the ESE science research community. Type 2 and 3 ESIPs were awarded in two solicitations issued in 1997[18].

The RESACs, established in 1998, focus NASA's Earth science research on applications of regional significance, integrate remote sensing and its attending technologies into the local decision-making processes, and support regional assessments associated with the U.S. global change research. Through the ARCs, NASA encourages partnerships between U.S. companies and university affiliates to work on commercialization of information technologies, including spatial information technologies, remote sensing, geographic information systems, and the Global Positioning System. The ARCs help project participants become familiar with remote sensing technologies, and the information provided by the technologies.

The ESIPs federated in 1998 as part of the NASA-assigned prototyping activities and in recognition that a federation would assist its members in meeting project objectives. The existing Federation has embraced the nomenclature of ESIPs, and has grown to include new non-NASA-funded members.[19] The existing Federation encourages and establishes the use of best science practices in the production of high quality data, information, products and services; ensures that data and information are readily accessible and easily exchanged so that Earth science data products can be developed readily; contributes to the development of an Earth science information economy through the comprehensive consideration of applications, research and commerce; and increases the diversity and breadth of users and uses of Earth science data, information, products and services.

In 1999, the Pathfinder Program also focused on understanding critical interactions and feedback mechanisms among physical, chemical, and biological processes. In order to study these processes, a more regional focus was required, with combined data sets consisting of the available satellite and airborne remote sensing data along with relevant *in situ* data for tuning algorithms and validating results.

The US Congress promoted the broader use of data and information resulting from NASA’s Earth science program through the Synergy program and other individual Congressionally-directed Earth science applications activities. Synergy, initiated in February 2000 and implemented through the Raytheon Corporation, is working with several universities and state and local governments in the US to explore the potential utility of satellite remote sensing in

urban planning, water resource management, disaster management, natural resource management and precision agriculture. Output from Synergy includes "InfoMarts" that service the decision-making needs of state, local, regional, and tribal government organizations. As the user community grows, efforts are underway to explore the self-sustainability of InfoMarts.[20]

The Earth Science Enterprise extends its interest in dissemination of Earth science information to the education community. Making information on ESE scientific discoveries and applications demonstrations available for formal, informal and professional education is essential to assure a pool of well trained science professionals upon which NASA and the Nation can draw upon. As part of the educational component of ESE, NASA/ESE recognizes that the types of products and services provided by the ESIPs, RESACs, ARCs and Synergy are vital to meet the goals of the Enterprise. These goals reflect the management priorities of the current administration especially e-government and education[21]. EOSDIS, the foundation for distribution of ESE data and information products, was initiated before the current, broad commitment of ESE to extend its science to applications and education. The rapid growth in scientific knowledge, the rapid development of information technology, and the transition from an emphasis on understanding fundamental Earth processes to prediction and delivery of information and knowledge for economic and policy decisions all require the ESE data and information systems to evolve while continuing to serve the user community.

2. Future

The ESE accepts the responsibility to assure that all the information, knowledge, and capabilities derived from its research program achieve maximum usefulness in research, applications and education. ESE is evolving its science data and information systems towards a more open, distributed set of data systems and service providers. This approach will capitalize on the expertise and resources of the community of providers and facilitate innovation. Implementation of this approach relies, in part, on leveraging information technologies from the commercial sector, such as web-based techniques for data discovery and access, and involving the end user community in technology assessment and evolution.

The ESE has a number of initiatives to advance its data systems and deliver data products and results to the Nation. First, it initiated a multiyear ESIP Experiment that formed a federation of competitively-selected data centers to explore the issues associated with distributed, heterogeneous data and information system and service providers (see http://esipfed.org/). Second, the EOSDIS architecture evolved to accommodate the generation of data products by external processing systems developed under the direction of the EOS instrument teams. Third, the ESE chartered a study team called New Data and Information Systems and Services, or "NewDISS," to capture and consolidate the input from the community in a series of recommendations. SEEDS is an outcome of this study and is chartered to work with the Earth science user and data provider communities to generate approaches and plans for future ESE data and information systems.

The guiding principles of SEEDS were defined in the NewDISS Strategy Document.[23] SEEDS starts from the premise that systems and services must be informed by, and supportive of, key science concerns and questions. It is also recognized that individual scientists and disciplinary communities of scientists are key consumers and producers of data products and derived information, and therefore must be key partners. Other key principles relate to the issue of

immediate and long-term services for a highly distributed and heterogeneous user base in the face of rapid technological change. These key principles are summarized as follows:

- Science questions and priorities must determine the design and function of systems and services.
- Future requirements will be driven by a high data volume, a broader user base and increasing demand for a variety of data and data products.
- Technological change will occur rapidly: systems and services must be able to take advantage of these changes.
- Competition is a key NASA tool for selection of NewDISS components and infrastructure.
- Principal Investigator (PI) processing and PI data management will be a significant part of future missions and science.
- Long-term stewardship and archiving must occur.
- NewDISS evolutionary design must move beyond data and information and towards knowledge-based systems.

The objective of the SEEDS Formulation Team is to recommend a framework and management strategy to enable evolution of ESE data systems towards a future network of ESE data systems and providers that:

- Leverages the capabilities and lessons learned from the EOSDIS and other ESE data systems efforts;
- Encourages development and evolution of heterogeneous systems and services;
- Gives systems and service providers appropriate local control over data system design, implementation, and operation;
- Leverages competition, technology infusion, and reuse to improve system effectiveness;
- Ensures that products and services meet norms for utility and accessibility;
- Ensures that systems and products meet NASA security and survivability requirements;
- Monitors collective performance in meeting the Enterprise objectives and goals;
- Maintains sufficient organizational structure to allow effective resource management and implementation for NASA to carry out its science mission.

Appendix B:
Instructions for Responding to
NASA REASoN Cooperative Agreement Notice

1.0 Foreword

The NASA Grant and Cooperative Agreement Handbook (NPG 5800.1D, dated July 23, 1996) is published as part 1260 and part 1274 of title 14 of the Code of Federal Regulations (CFR).[22] Subscriptions to the handbook (the basic edition plus all changes issued for an indefinite time) may be purchased from the Superintendent of Documents, United States Government Printing Office, Washington, DC 20402, telephone (202) 512-1800. Requests should cite GPO Stock No. 933-001-00000-8.

The Grant and Cooperative Agreement Handbook provides a standard Data Rights provision which will be used for all REASoN projects except for those focused on research. NASA wishes to ensure that scientific data products and algorithms supported to advance the understanding of the Earth system are available on a non-discriminatory basis, without restriction, and at no more than the marginal cost of fulfilling user requests. Requirements and guidelines for Data Rights for Research REASoN projects are described in Appendix G.

2.0 Proposal Submission Requirements and Deadline

Ten (10) copies of the proposal shall be sent to the following address:

REASoN
NASA Peer Review Services
Suite 200
500 E Street SW
Washington D.C. 20024-2760
(202) 479-9030 (Use only for overnight service)

Proposals must be received at the above address by 4:30 p.m. (EST) November 26, 2002.

3.0 Proposal Instructions

Each proposal copy shall contain all submitted material, including a copy of the transmittal letter. The proposals shall have a fully completed and signed cover page and certifications, as described in Appendix D, Section 1. When completing the prefatory forms, please note that for proposals in response to CANs, NASA recognizes only one PI for each proposal. Other investigators are designated Project Members (PMs), even if their contributions to the proposal and responsibilities are comparable to that of the PI.

The respondent's sponsoring institution must endorse the proposal. Only properly endorsed proposals are acceptable. The cover page contains space for this endorsement by an institutional representative authorized to legally bind the institution to perform the proposed effort. If substantial collaborations with other institutions are involved, letters of endorsement shall be

submitted by the responsible officials from those institutions. Each endorsement letter shall indicate agreement with the nature of the collaboration detailed in the proposal, which shall be identified by title and date of submission. All endorsement letters shall refer to the "Earth Science REASoN – Research, Education and Applications Solutions Network: A Distributed Network of Data and Information Providers for Earth Science Enterprise Science, Applications and Education", CAN-02-OES-01.

Proposals shall contain:

- Transmittal letter (Subsection 3.2)
- Cover sheet (Appendix D.1.)
- Table of Contents
- Abstract (Subsection 3.3)
- Project description (Subsection 3.4)
- Technology Development (Subsection 3.5)
- Preferences for participation in the Federation and SEEDS working group(s) (Subsection 3.6)
- Metrics (Subsection 3.7)
- Management approach (Subsection 3.8)
- Personnel (Subsection 3.9)
- Proposed costs (Subsection 3.10 and Appendix H)
- Cooperative Agreement payment schedule (Subsection 3.11)
- Statement of current and pending support (Subsection 3.12)
- Identification/description of special matters (Subsection 3.13)
- Certification: "Assurance of Compliance with the NASA Regulations Pursuant to Nondiscrimination in Federally Assisted Programs" (Appendix D, section 2.)
- Certification: "Certifications, Disclosure and Assurances Regarding Lobbying and Debarment and Suspension" (Appendix D, section 3.)

NASA's Earth Science Enterprise purchases commercial data and data products, when available and appropriate, to meet its research, applications and education goals. NASA encourages the use of commercially available data sets by Principal Investigators as long as such data meets project requirements and is cost-effective. Respondents to this CAN should identify the commercial data sources intended for use and the associated cost.

Proposals must be written in English and are expected to be concise. The total length of proposal ***excluding*** transmittal letter, cover page, Curriculum Vitae, budgetary information, certifications, statement of support, and list of references shall not exceed **20 pages** of 8.5" x 11" paper, with a maximum of 52 lines per page (point size 12 or larger, with 1-inch margins). ***Exception to page length:*** Proposals that include new technology development and/or open source prototyping, as described in the CAN and so indicated as a proposal topic for evaluation on the cover sheet, shall not exceed 25 pages. ***Proposals using type smaller than 12 points, compressed type, or less-than normal leading (space between lines), will be returned un-reviewed.***

Review panels will schedule reviews based on 20 pages of technical material per proposal (25 pages for proposals that include technology development and/or open source prototyping). Technical and resource reviewers will be instructed to consider the first 20 (25) pages of technical material only.

To facilitate the recycling of shredded proposals after review, proposals shall be submitted on plain, white paper only. Precluded are cardboard stock, plastic covers, colored paper, and binders such as 3-ring, GBC, spiral, plastic strips, etc.

3.1 Restriction on Use and Disclosure of Proposal Information

It is NASA policy to use information contained in proposals for evaluation purposes only. While this policy does not require that the proposal bear a restrictive notice, offerers or quoters should, in order to maximize protection of trade secrets or other information that is commercial or financial, and confidential or privileged, place the notice below on the title page of the proposal and specify the information subject to the notice by inserting appropriate identification, such as page numbers, in the notice. In any event, information (data) contained in proposals will be protected to the extent permitted by law; but, NASA assumes no liability for use and/or disclosure of information not made subject to the notice.

NOTICE

Restriction on Use and Disclosure of Proposal Information

> The information (data) contained in [insert page numbers or other identification] of this proposal constitutes a trade secret and/or information that is commercial or financial, and confidential or privileged. It is furnished to the Government in confidence with the understanding that it will not, without permission of the offerer, be used or disclosed other than for evaluation purposes; provided, however, that in the event a grant or cooperative agreement is awarded on the basis of this proposal, the Government shall have the right to use and disclose this information (data) to the extent provided in the grant or cooperative agreement. This restriction does not limit the Government's right to use or disclose this information (data) if obtained from another source without restriction.

3.2 Transmittal Letter Requirements

The transmittal letter shall contain the following information:

a. Type of proposal, i.e., research, applications (type 1 or type 2), education, identified. More than one element may be selected;
b. The legal name and address of the organization and specific division or campus identification, if part of a larger organization;

c. A brief, scientifically valid project title intelligible to a scientifically literate reader and suitable for use in the public press;
d. Type of organization; e.g., profit, nonprofit, educational, small business, minority, women-owned, etc.;
e. Name and telephone number of the Principal Investigator and business personnel who may be contacted during evaluation or negotiation;
f. Identification of any other organizations that are currently evaluating a proposal for the same effort;
g. Identification of the specific CAN, by number and title, to which the proposal is responding (CAN-02-OES-01); "Earth Science REASoN – Research, Education and Applications Solutions Network"
h. Dollar amount requested of NASA, desired starting date, and duration of project;
i. Dollar amount contributed, contributed entity;
j. Date of submission;
k. Signature of a responsible official or authorized representative of the organization, or any other person authorized to legally bind the organization.

3.3 Abstract

Include a concise (no more than 300 words) abstract describing the objective of the proposed effort and the method of approach. Abstracts from will be placed in the public domain.

3.4 Project Description

The project description shall contain a detailed description of proposed effort focused on the CAN objectives. Specific areas to be addressed in the project description are listed below.

1) Relevance of the environmental data and information and/or associated services to be provided -- this section shall include a description of new or enhanced data sets, products, and/or services, and a discussion of how they will support and enhance Earth system science research and their relevance to the goals and objectives of this CAN (as discussed in Section II.). Proposals bidding technology development efforts must show relevance of proposed technology beyond the immediate data system or service.

2) Approaches for data production, distribution, and user support -- the proposal shall discuss the information technologies and approach that will be used. Effectiveness and cost benefits of the information technologies and approach chosen should be explained.

3) Earth system science user support -- the proposal shall outline the approach taken to support users. The respondent shall identify the specific user community(ies) targeted. The proposal must also address the distribution and availability of data

products for the greater Earth system research, applications, and education community.

4) SEEDS Guiding Principles (Section II.D.2): The proposal must address relevancy to the goals and objectives of SEEDS, including the SEEDS principles and the various elements of the SEEDS unifying framework. The proposal should address how the project will engage community involvement, identify the basis for determining the proposed levels of service, discuss appropriate reuse, and outline strategies for technology evolution infusion and evolution.

5) All REASoN Projects will be required to participate in a SEEDS Working Group: The proposal should discuss the level of participation and the contributions that the project will make to the SEEDS formulation and process development efforts. The SEEDS guiding principles (Section II.D.2., Appendix A Section B.2. and Appendix J) are intended to prompt respondents to consider various tradeoffs and to describe their basis for selection. The principles are predicated on the assumption that the bidders should determine and justify their choice as to whether or not and how they are applied to their particular situation.

   To aid in evaluating the contribution the project could potentially make to the SEEDS activity, proposals should address the following points:

   a. Data format and content. Describe the proposed data format and content, basis for selection, and community involvement in the selection process.
   b. Interface standards. Describe external interfaces, basis for selection, and use of existing standards in defining those interfaces.
   c. Software Reuse - Describe reuse options that were considered and the basis for selection. Describe any software that is available for reuse
   d. Evolution – Describe steps taken to enable evolution of system capability/capacity.
   e. Technology Utilization - Describe proposed utilization of advanced technologies in the production/delivery of proposed product/service to minimize barriers to access and use of Earth Science information. Note that directions for technology development are listed below (Section 3.5).
   f. Levels of Service – Describe proposed levels of service to enable discovery, identification, selection, translation/subsetting, ordering, and delivery of products and services. Describe any partnering arrangement to support these levels of service.
   g. Metrics – Propose metrics to measure the quality, capability, and value of the proposed products and services, and the progress towards those goals. REASoN projects shall provide all NASA-required metrics to the existing Federation (see Section 3.7).

h. Provide non-proprietary data for the ESE Data Systems Cost Model currently under development (see the SEEDS homepage Cost Estimation link for information on the model).

i. The proposal will discuss the participation of the project investigators and staff on SEEDS Working Groups. Discuss special expertise the project collaborators can contribute to SEEDS study activities (Appendix J). At a minimum, NASA expects the projects to participate in at least one Working Group at a level of .25 FTE. The proposal should discuss the contributions the project will make to its preferred and, at least, one other alternate working group.

j. Projects can optionally propose to develop an Open-Source Prototype/testbed for the Architecture and Reuse Working Group. Projects proposing to develop an open-source prototype should discuss their technical approach for completing the prototype in detail and should specifically address contributions they will make to the SEEDS Architecture and Reuse study goals.

6) All REASoN projects will meet the following requirements:

a. Maintain a public WWW-compliant presence.

b. Data and information shall be publicly available preferably via Internet transfer.

c. Descriptions of all products and services shall be provided to the NASA GCMD.

d. The products shall contain and be searchable via FGDC compliant metadata.

e. REASoN projects shall apply for membership to the existing Federation.

7) The general guidelines for projects (items 1-6 listed above) apply to the **ALL** REASoN projects; however, proposals for Research REASoN projects *must also include* the following elements:

Each proposal that is funded is expected to make its data, information, or services available to the user community. Data set(s) and accompanying documentation may be made available by the project through such a mechanism as described in the project. At the end of the project, or at such time when the project no longer plans to offer the data set(s), the data sets should be offered for distribution and archive to existing National Data Centers or other depositories of climate and environmental data. However, not all information products will need to be transferred for long-term archive.

a. Each proposal should include a negotiated process for determining whether there is a need to archive data with a NASA Distributed Active Archive Center (DAAC), a NOAA Data Center, or a World Data Center for final disposition and distribution of the data set. For example, a NASA

DAAC might utilize its User Working Group to determine the priority for acquiring a particular information set. Each information set must be accompanied with clear, comprehensive, and concise documentation so that specialists and non-specialists alike will be able to understand how the data can be used.

b. Adequate funds must be included in the proposal to ensure the smooth distribution the end-products of research activities, including complete documentation, applicable metadata and supporting peer-reviewed articles. Proposals should include concurring correspondence from the selected archive to ensure that the included funding profile is realistic.

8) In addition to the information requested in the general guidelines for projects, items 1-6 listed above, **Applications** REASoN projects; *must also include* the following elements:

a. A description of the application including the linkage to an application of national importance (see Appendix F.)
b. The description of the utilization of NASA data, and/or science results, and/or technology products in the project/application
c. The current state (condition) of development of the application (research, validation and verification, demonstration) and the end state anticipated by the REASoN project.
d. Identification of the end user(s) of the application(s). If the project is directed toward application demonstration, commitment from an end user to incorporate the application into the user's decision support must be demonstrated.
e. Proposals that carry an application from one stage of development through another, i.e., from research to demonstration, must include milestones to evaluate the readiness of the application to move to the next development stage. Criteria for evaluating whether a milestone has been met must also be included.
f. Proposals shall include a post-Cooperative Agreement intent/plan. NASA funding for a project awarded under this CAN will cease no later than the ending date stipulated on the Cooperative Agreement (CA) between NASA and the respondent. If the intention of a proposed project is to continue its function following completion of the CA term, the proposal must include a plan to fund on-going activities in the post-CA period. If the intention of the proposal is to cease activity at the conclusion of the CA term, that intention must be so stated in the proposal. Proposals that lack a plan for post-CA activity or a stated rationale for ceasing activity at the conclusion of the CA term will be considered non-responsive to the CAN and returned to the respondent

9) The general guidelines for proprosals (items 1-6 listed above) apply to the **Education** REASoN projects; however, Education REASoN proposals should also include the following elements:

a. Rationale - Define the educational need the proposed solution will meet, and how the proposed solution will uniquely contribute to NASA's priorities for its educational mission (Section II.C).
b. Goals - Define the proposed educational goals and objectives, and describe how they contribute to the vision of the ESE Education Program (Appendix A.3.).
c. Audience - Clearly define the target audience. Do primary and secondary audiences exist? What is known about the audience's learning or operating levels and styles? What does the audience know about the topic? What misconceptions might they have about the topic that might influence the learning or communication outcomes? Estimate the size of the target audience.
d. Activity – Thoroughly describe the proposed solution. Describe how the project will be accomplished and the goals achieved. Include a timeline of the developmental period.
e. Dissemination - Describe how the activity or solution will be broadly disseminated. Dissemination involves the marketing or announcing the activity, as well as developing the mechanisms to ensure that the intended audience will use the activity.
f. Evaluation - Describe how the project will be evaluated against both the project goal and the ESE education vision. Formative: What procedures will be used during the developmental phase of the project to assure a good product when it is completed? Who will do this work? Summative: How will it be determined that the educational goals have been achieved? Describe the means by which the impact of the project on the target audience will be examined? Who will do the evaluation?

3.5 Technology Development

Projects that include new technology development should include the following items:

a. Description of proposed technology - Provide a description of the proposed element, subsystem, or system technology. Describe the technical approach and include an operational concept or use scenario of the proposed element, subsystem, or system technology that addresses REASoN, and therefore, SEEDS needs. Discuss any possible commercial benefits.
b. Applicability of proposal to serve intended community – Describe the benefit to ESE systems and science capabilities, which could utilize the proposed elements, subsystems, or systems. Include a discussion of potential technology infusion paths to other REASoN projects for proposed technologies.
c. Comparative technology assessment – Describe the anticipated advantages of this technology compared to those currently in use, e.g., cost reduction, improved performance, or enabling of a new capability not previously

possible. Review the current state of the art and relate to the current state of the proposed work.

d. Technology Readiness Level (TRL) assessment – Provide the current TRL assessment of the element, subsystem, or system technology, and the anticipated progression of TRL levels throughout the proposed effort. See Appendix L for Technology Readiness Levels definitions. The entry TRL of 3 or above must be substantiated in the proposal.

3.6 Participation in the Other Organizations

Successful respondents must participate in the existing Federation. Projects will discuss their anticipated contributions to the Federation including adherence with Federation standards and practices. In addition, successful respondents must identify an area within the SEEDS study teams to which they can lend their expertise (see Appendix J). Proposals should discuss participation in at least one SEEDS Working Group, with one or more alternatives proposed. Successful respondents will become members of the pertinent SEEDS Working Groups formed from those study teams.

3.7 Metrics

Successful respondents will be required to submit metrics indicating the state of the project and the success in meeting project and NASA objectives. All projects will be required to meet the metrics established and adopted by the Federation. In addition, and to the extent that the Federation metrics do not provide the same information, the projects will respond to the metrics described in Section 3.4.5)g. and provide the following on quarterly basis:

1) Inputs**:** Data, models, and other information and products used to complete and carry out the project. This includes human and physical capital and materials required for the research, applications or education process or function. It describes the cost of doing business and includes: budget, number of researchers/teams, participating users, data required, and use of other assets e.g., ancillary data.
2) Outputs: Immediate observable products of the project. Outputs include data sets and models developed, number of presentations made, papers published, number of graduate students supported (if applicable), and other direct results of the project.
3) Outcome: Longer term results to which the project contributes such as understanding gained, applications demonstrated, resulting programmatic decisions enabled.
4) Impact: The consequences of the program, including intended benefits and utility and socio-economic benefit to the end users/customers. Impact addresses questions such as: "Why were the results of the projects useful?" "How were they useful?" "How were the end results (i.e., applications and

data products developed) used in decision-making?" "What kind of significant economic or policy consequence resulted from the project?" Most important, it answers the question, "So what?" and includes assessments such as new knowledge shared, cost saved, new applications or functions that were done that were not possible before. How did or would the results impact the public good or expanded commercialization of value-added Earth Science data?

Respondents may propose additional metrics for measuring the performance of the REASoN project and state how the project intends to provide these metrics

3.8 Management Approach

The respondent shall describe the proposed REASoN project management approach. For efforts involving interactions among individuals from more than one organization, plans for dissemination of responsibilities and any necessary arrangements for ensuring a coordinated effort should be described. Note that if the cooperative agreement is to be awarded to a consortium, a completed, formally executed Articles of Collaboration is required prior to award. All parties participating in performance of the project shall be part of the consortium. Subcontracting is limited to vendors of supplies and routine services. Proposal should address how this requirement will be met. Aspects of any required intensive working relation with NASA field centers shall also be discussed.

Provide a Statement of Work that concisely describes each task or milestone to be accomplished in the course of the effort. Define the success criteria associated with each task or milestone. Also include a milestone chart that identifies critical dates and deliverables in the research and development program. Identify the roles of key personnel.

3.9 Personnel

For each PI or PM, submit a brief biographical sketch referencing related work, along with citations of the most relevant recent publications and any exceptional qualifications covering the past five years. The biographical sketch and publications list shall not exceed one page per PI or PM. A summary of other participants shall not exceed one page. Include qualifications for participants involved in technology development.

The Principal Investigator is responsible for direct supervision of the work and participates in the conduct of the project regardless of whether or not compensation is received under the award. Omit social security number and other personal items which do not merit consideration in evaluation of the proposal. Give similar biographical information on other senior professional personnel who will be directly associated with the project. Give the names and titles of any other scientists and technical personnel associated substantially with the project in an advisory capacity. Universities should list the approximate number of students or other assistants

participating in the proposed effort, together with information as to their level of academic attainment. Any special industry-university cooperative arrangements should be described.

3.10 Proposed Costs

Proposals shall contain cost and technical parts in one volume; do not use separate "confidential" salary pages. In addition to the instructions contained here, respondents are referred to Appendix H which contains a model format for a yearly Budget Summary and line-by-line instructions.

The budget section of the proposals shall include a budget breakdown by Government fiscal year (October 1 to September 30) for each year of the proposed work. Full cost accounting (FCA) is required in all proposals. For those submitted by NASA, FCA should be provided beginning in FY04 commensurate with NASA accounting methods. To assist in the selection process, proposals that include any U.S. Government costs must submit budgets that clearly indicate the costs with and without FCA.

If proposals involve collaborations with PMs who are at institutions different from that of the PI, and those PMs require funding support, the budget total of each participating institution shall be listed under category "3.a. Subcontracts" in the Proposal Budget Summary of the PI. Details of the budgets of such participating institutions shall be provided separately.

Describe available facilities and major items of equipment especially adapted or suited to the proposed project, and any additional major equipment that will be required. Identify any Government-owned facilities, industrial plant equipment, or special tooling that are proposed for use on the project. Before requesting a major item of capital equipment, the respondent should determine if sharing or loan of equipment already within the organization is a feasible alternative to purchase. Where such arrangements cannot be made, the proposal should so state. Title and disposition of equipment purchased with Government funds will be determined for each cooperative agreement depending upon the nature of the recipient (i.e., nonprofit or profit making company) and other factors.

Costs of mandatory participation in the existing Federation should be included in the costs. These costs include site implementation and maintenance of any system-wide requirements, standards and protocols, and work to be performed by the REASoN projects to interact with each other (e.g., meetings and telecons). Respondents should budget for attendance to at least four meetings per year. Existing Federation meetings are held twice per year; existing SEEDS meetings are held twice per year. It is our intention to enable any required reporting on SEEDS working group activities at either set of meetings. Meeting and working group activity should be budgeted at a target level of 0.25FTE.

Costs for metrics collection and reporting should be included in the costs. Metrics required by the Federation and other proposed metrics should be factored into these costs.

If proposals include an optional technology development component or an open source prototype demonstration, these costs will be uniquely identified and totaled by year as an identifiable cost.

3.11 Cooperative Agreement Payment Schedule

Respondents shall provide a schedule of performance–based payment milestones – the initial milestone for the period February to December 2003, then on a December/ June basis for the remaining term of the cooperative agreement. Milestones must signify verifiable events as opposed to the passage of time. Meaningful milestones should be based on provision of science information and/or services, any development of technologies, and participation in and support for the Federation and SEEDS. Team payments will be based upon completion of milestones. Funds will be disbursed to commercial organizations upon achievement of milestones (see Section 1274.204 (d) of the NASA Grants and Cooperative Agreements Handbook). Funds will be transferred to other recipients as advanced payments. Milestone payments will be finalized during negotiations of formal Cooperative Agreements.

3.12 Current and Pending Support

Following the budget section, the proposal shall contain a summary of current and pending Federal support of all projects with substantial involvement of the PI and each PM for whom support is requested. The information content shall include: source of support, project title with grant or contract number, award amount by Government fiscal year, and total award amount, award period, level of effort in person-months, and the location where the work is to be performed.

3.13 Special Matters

Include any required statements of environmental impact of the work, human subject or animal care provisions, conflict of interest, or on such other topics as may be required by the nature of the effort and current statutes, executive orders, or other current Government-wide guidelines.

Respondents should include a brief description of the organization, its facilities, and previous work experience in the field of the proposal. Identify the cognizant Government audit agency, inspection agency, and administrative contracting officer, when applicable.

All commercial awardees will be subject to terms and conditions under NASA Grant and Cooperative Agreement Handbook, Part 1274, Sections 901 through 942 unless otherwise indicated in this CAN, when Cooperative Agreements are negotiated after notification of selection. Respondents should pay careful attention to these referenced provisions and conditions and indicate in their proposal if they take exception to any of these terms and conditions.

Appendix C:
Proposal Evaluation Criteria

1. Evaluation Factors for RESEARCH Proposals

The following five factors will be used to evaluate RESEARCH proposals. Factors 1 through 5 are rated equally.

Factor 1R: The nature and quality of the contribution to Earth system science research

a. The overall technical merit of the proposed science products and services, including their relevance to the overall goals and objectives of ESE and the ability to meet identified needs of the broad (or a targeted segment of the) Earth system science research community towards addressing NASA Earth System science priorities.
b. The competence and relevant experience of the proposed Earth system science researchers included on the team as an indication of their ability to carry the proposed activity to a successful conclusion. Past performance will be considered in the evaluation.

Factor 2R: Degree to which the REASoN project meets the needs of the various segment(s) of the community it intends to serve in addressing NASA Earth System science priorities, and the segment(s)'.

a. Identification of the user community, including any multiple segments, and the needs for products, information, knowledge, and services.
b. The degree of understanding of the targeted user community and their requirements as documented in the proposal.
c. Proposed methodologies of working with the users and assessment of effectiveness of such partnerships throughout the lifetime of the proposed project.
d. The likely flexibility and responsiveness of the proposed REASoN project capabilities to meet evolving user needs as evidenced by the discussion of the approach to this issue in the proposal.

Factor 3R: Contributions to SEEDS objectives and considerations:

Factor 3R.1: Degree to which SEEDS proposal requirements are addressed.

a. Proposes innovative software/hardware solutions to enhance efficiency and effectiveness of NASA Earth science data and information management activities
b. Describes process for selecting and describing data format and content.
c. Describes the level of services (e.g., timeliness, quality, quantity, availability) of proposed products and services; and anticipated customers.
d. Describes the metrics for evaluating the progress in implementing the proposed products or services; self assessments (and customer

assessments) of the usage, quality, timeliness, and value of the products and services.

e. Describes interface standards and protocols for data and information archive, distribution, processing as appropriate.
f. Identifies candidate software to be considered for reuse in the proposed projects as-well-as potential software available for subsequent reuse.
g. Describes extent to which proposed products and services provide insight or capabilities for evolution of ESE data systems.
h. Identifies non-proprietary cost data to be provided to SEEDS cost estimation model development effort.

Factor 3R.2: Potential contributions of Project to SEEDS.

Depending on what SEEDS Working Group participation is proposed, the following evaluation criteria will be used:

Factor 3R.2.1 – Standards and Interfaces

Degree of expertise in:

- Developing or adopting or approving data and information standards;
- Developing and maintaining standards-based software tools;
- Performing user support functions including consulting/help desk functions, developing documentation and providing training; and,
- Active cooperation with formal standards bodies and organizations to enhance NASA Earth System science priorities.

Factor 3R.2.2 – Technology Infusion

Degree of expertise in:

- Developing and/or maturing technology for operational use; and,
- Cooperating actively with technology development and/or evaluation with standards bodies and organizations.

Factor 3R.2.3 – Architecture and Reuse

Degree of expertise in:

- Knowledge of ESE software needs and open source efforts.
- To win an “open-source prototype demonstration” a successful proposers will demonstrate knowledge of software, open source activities, and ESE software needs. In addition, he/she will provide clear references to ESE development efforts that want to reuse the software.

Factor 3R.2.4 – Metrics Planning and Reporting

Degree of expertise in:

- Metrics development, collection, and reporting.
- Developing and maintaining software tools for metrics collection and reporting if proposal offers to provide such tools.

Factor 4R: The practicality and likely effectiveness of the proposed activities

a. Adherence to good management practices as exhibited in the management approach, including provision of data life cycle management plan, explanation of marginal distribution charges (excluding electronic distribution).
b. The soundness of the implementation for production and publishing/distribution functions and the user services approach, including mechanisms for continued interaction with the particular research community being served for product and service effectiveness.
c. The degree of understanding of scientific data management issues.
d. The innovation shown in applying or developing advanced technology to minimize barriers to data access, promote interoperability, or manage knowledge.
e. The general commitment and support of the proposing institution(s) for this activity and for on-site(s) Earth system science research and the quality, appropriateness and extent of collocated research using the data and information to be produced and/or published by the proposed REASoN project. Alternatively, the respondents may demonstrate how their teaming arrangements with remotely located partners can result in effective and practical collaboration with researchers using appropriate technology. The adequacy of the facilities, staffing, and equipment to support the proposed activity.

Factor 5R: Best value and cost

a. The value to the Earth system science research community of the proposed project relative to its costs.
b. The extent of cost sharing in the proposed partnership and the nature and reliability thereof.
c. Cost realism of the proposed budget, particularly as an indication that respondents understand the nature of the proposed partnership.
d. Total cost to NASA.

II. Evaluation Factors for <u>APPLICATIONS</u> proposals

Applications projects submitted in response to this CAN may address a specific application **(**Type I) or provide cross cutting solutions to a class of applications (Type II). In either case, proposals will be evaluated on the nature of the application(s), the technical merits of the proposal, the contributions to SEEDS, and the management plan. These four factors will be weighted equally.

Factor 1A: Nature and relevance of the application

a. National priority: The rationale for the application The rationale for the application. The objective is to serve applications of national importance as identified by the legislative or executive branches of the federal government, one or more federal agencies, or national organizations. Candidate national applications are described in Appendix F. Type II

proposals must include a list of applications that will be addressed and a description of the national priority(ies) served.

b. Socio-economic value: Assessment of prospective societal and economic benefits e.g., public safety and health, national security, environmental quality, economic threats and opportunities, populations affected, and related factors. This factor will be evaluated on the basis of referenced independent value/benefit analyses that address the extent of likely societal or economic value.
c. Application feasibility**:** Assessment of user readiness to accept applications of Earth science and technology in operational decision support systems (or configurations). The time required to develop and implement an application is considered in the review. A threshold for application feasibility is the identification of a specific information mandate or discrete decision support system that benefits specifically from knowledge, data, and/or technology defined and proposed for development as an application solution.
d. NASA contribution: The extent to which an application makes productive use of the unique or complementary assets and capabilities of NASA, and could not be accomplished as effectively by other government agencies or private entities. High spatial resolution, commercial imaging satellites are considered complementary to NASA owned medium to coarse resolution satellites.

Factor 2A: Technical merit of the proposal

a. Overall merit: The technical feasibility of the proposed products and services, including the ability to meet identified needs of the user community.
b. Science and technology readiness: The extent to which science and/or technology results can be developed to the level of maturity proposed – research, validation and verification, or benchmarking a solution approach.
c. Innovation shown in applying or developing advanced software/hardware technology to minimize barriers to data access, promote interoperability, or manage knowledge.
d. The competence and relevant experience of the proposed project staff included on the team as an indication of their ability to carry the proposed activity to a successful conclusion.
e. The degree of understanding of the targeted user community and their requirements as documented in the proposal.

Factor 3A: Contributions to SEEDS objectives and considerations: Same as Factor 3R

Factor 4A: Management plan

a. Partnership opportunity: The extent to which applications can be carried out in collaboration with partners, especially appropriate U.S. federal agencies, state and local governments. The objective of partnerships is to leverage resources and establish commitment by public and private partners to the effective transition of ESE results to operational uses.
b. Cost sharing: The extent of cost sharing in the proposed partnership and the nature and reliability thereof.
c. Metrics: Extent to which the proposal provides the metrics described in Appendix B, and describes the change in state that will follow completion of the project and how that change of state will be verified.
d. Cost / budget context: The evaluation and analysis of costs, constraints and directions of the ESE with regard to available budgets and funding profiles. The Applications Division seeks to ensure that the financial risk of a project is acceptable and balanced with the potential for cost savings or improved user decision-making.
e. Plan for post-REASoN activity: The viability of the plan for self-sufficiency of the project following completion of the project term. In all instances, NASA sponsored data and information products will be available to the project at no cost beyond the term of the cooperative agreement.
f. Total cost to NASA.

III. Evaluation Factors for <u>EDUCATION</u> proposals

Factor 1E: Relevance to NASA and ESE educational objectives

a. Merit of the identified educational need
b. Degree to which the effort addresses NASA's priorities for its educational mission and/or contributes to the vision of the ESE Education program.
c. Anticipated impact on the national education agenda and alignment with national agenda in science, mathematics, engineering, technology and geography education

Factor 2E: Technical merit

a. Overall educational and/or technical merit, particularly regarding effective or innovative methods, approaches, concepts that is well founded in education research, and/or advanced technologies demonstrated by the proposal.
b. Quality of project design; evidence of a genuine, good idea and thoroughness in implementation
c. Robustness of the education plan
d. Engagement of underrepresented groups in science and technology
e. Scalability, sustainability beyond NASA investment, partnerships, and "multiplier" effect
f. When appropriate, synergy among formal, informal, and professional educational activities

g. The qualifications, capabilities, and experience of the proposed Education team leader and members, or key personnel critical in achieving the proposed objectives
h. The innovation shown in applying or developing advanced technology to minimize barriers to data access, promote interoperability, or manage knowledge.
i. Overall standing among similar proposals and/or evaluation against the state-of-the-art or acknowledged "best practices"

Factor 3E: Contributions to SEEDS objectives and considerations: Same as factor 3R

Factor 4E: Management and Cost

a. Partnership opportunity: Extent to which the proposed educational activities can be carried out in partnership with organizations other than NASA, including the ability for the project to sustain once NASA concludes its financial investment.
b. Metrics: Extent to which the proposal provides and verifies the metrics described in Section 3.7 of Appendix B, including educational evaluation
c. Cost: Consideration of the realism and reasonableness of the proposed cost and the comparison in relation to impact.

IV. Additional Evaluation Factors for Optional Technology Development Components within Proposals

Factor 1T – Relevance to SEEDS Technology and Evolution Goals

a. The technology element's or subsystem's relevance and potential contribution to REASoN technical objectives and SEEDS evolution goals, and the potential of the matured technology being used within the REASoN project.
b. The potential of the technology component to be integrated, once matured, into other operational REASoN projects. Integration potential will be assessed in part on the basis of the entry TRL and planned exit TRL.
c. The potential for the technology component to reduce the risk, cost, and development time of future ESE systems. Potential cost reductions should be clearly stated and substantiated to the extent possible, with supporting analysis–indicating scalability.

Factor 2T –Feasibility of Technology Approach

a. Feasibility and merit of the proposed technical approach to achieve the technology analysis or development objectives; possibility of commercial benefit.
b. Degree of innovation of the proposed technology analysis or development concepts and approach.

c. Substantiated justification that the technical development is at the appropriate level of readiness (TRL). A minimum entry TRL of 3 is required; a minimum exit TRL of 7 is permitted.
d. Feasibility of obtaining the potential reduction in risk, cost, and development time with the proposed element, subsystem, or system and measurable TRL increases.

IV. Evaluation Process

Proposals will be selected following review by discipline specialists in research, applications and education, technical review by technology or technique innovation area specialists, and evaluation of management and costs. Final decisions will be made by the designated NASA selecting official.

Proposals will be evaluated and selected independently for Research, Education, and Applications in accordance with their respective criteria. NASA reserves the right to make judgments during final project selection based on programmatic factors, including the overall balance of viable proposals across Earth system science disciplines and across technology and technical innovation areas. Projects will be selected with consideration to the balance and importance of the eventual products/services and the overall contribution of the REASoN project to the entire user community.

Appendix D:
CAN Proposal Forms

1. Required Proposal Cover Sheet(s) and Instructions

TWO proposal cover pages are required as part of the proposal. The first is a **hard copy** (see below for instructions on how to acquire the proposal hardcopy from the online system) which must be signed by the Principal Investigator and an official by title of the investigator's organization who is authorized to commit the organization. This authorizing signature also certifies that the proposing institution has read and is in compliance with the required certifications printed in full, therefore, these certifications do not need to be submitted separately. This page will not be counted against the page limit of the proposal.

The second proposal cover page must be submitted **electronically** to the SYS-EYFUS Web site located at **http://proposals.hq.nasa.gov/**. If the respondent has submitted an electronic Notice of Intent (Appendix E) to SYS-EYFUS, the same user UserID and password can be used to complete the electronic proposal cover page. If the respondent obtained a User ID and password in the process of submitting a proposal for a previous research opportunity announcement, the same user UserID and password can be used to complete the electronic proposal cover page in response to this research opportunity announcement. Be sure to click on "Edit Personal Information" if any of your correspondence information in SYS-EYFUS is not current.

If you do not have a SYS-EYFUS UserID or password, you may obtain one electronically by going to *http://proposals.hq.nasa.gov* and performing the following steps:

- Click the hyperlink for **new user, which** will take you to the Personal Information Search Page.
- Enter your first and last name. SYS-EYFUS will **search** for your record information in the SYS-EYFUS database.
- Confirm your personal information by **choosing** the record displayed.
- Select **continue**, and a User ID and password will be e-mailed to you.
- Once you receive your User ID and Password, **login** to the SYS-EYFUS Web site and follow the instructions for **New Proposal Cover Page.**

Respondents without access to the Web or who experience difficulty in using this site may contact the Help Desk at proposals@hq.nasa.gov (or call 202.479.9376) for assistance. After you have submitted your notice of intent or proposal cover page electronically, if you are unsure if it has been successfully submitted, do not re-submit. Please call the Help Desk. They will be able to promptly tell you if your submission has been received. Please note that submission of the electronic cover page does not satisfy the deadline for proposal submission.

Proposal Cover Page

Proposal Number (leave blank) _____

Date: __/___/_____

roposal Title:	
lame of Submitting Institution:	**ongressional District:**
ype of REASoN Applying For:	check all that apply) ☐ Research ☐ Education ☐ Applications: ☐ Type 1 ☐ Type 2
ptional Proposals Included:	check all that apply) ☐ Technology ☐ SEEDS Open Source
Vorking Group Interest:	____ Standards & Interfaces _____Technology Infusion
ndicate 1st and 2nd choice)	____ Architecture and Reuse _____ Metrics Planning and Reporting

Certification of Compliance with Applicable Executive Orders and US Code

By submitting the proposal identified in this *Cover Sheet/Proposal Summary* in response to this Research Announcement, the Authorizing Official of the proposing institution (or the individual proposer if there is no proposing institution) as identified below:

* certifies that the statements made in this proposal are true and complete to the best of his/her knowledge;
* agrees to accept the obligations to comply with NASA award terms and conditions if an award is made as a result of this proposal; and
* confirms compliance with all provisions, rules, and stipulations set forth in the two Certifications contained in this CAN [namely, (i) *Assurance of Compliance with the NASA Regulations Pursuant to Nondiscrimination in Federally Assisted Programs, and (ii) Certifications, Disclosures, And Assurances Regarding Lobbying and Debarment & Suspension*].

Willful provision of false information in this proposal and/or its supporting documents, or in reports required under an ensuing award, is a criminal offense (U.S. Code, Title 18, Section 1001).

NASA PROCEDURE FOR HANDLING PROPOSALS

This proposal shall be used and disclosed for evaluation purposes only, and a copy of this Government notice shall be applied to any reproduction or abstract thereof. Any authorized restrictive notices that the submitter places on this proposal shall also be strictly complied with. Disclosure of this proposal for any reason outside the Government evaluation purposes shall be made only to the extent authorized by the Government.

Principal Investigator Name:		**Authorized Institutional Official Name:**	
Organization:		**Organization:**	
Department:		**Department:**	
Mailing Address:		**Mailing Address:**	
City, State Zip:		**City, State Zip:**	
Telephone Number:		**Telephone Number:**	
Fax Number:		**Fax Number:**	
Email Address:		**Email Address:**	
Principal Investigator Signature:	_____	**Authorized Institutional Official Signature:**	_____
Date:		**Date:**	

Co-Investigator(s) (Include a separate sheet if more space is needed):

Name	Telephone	Email	Institution	Address

Budget:

Year	Budget	xplanation (i.e., cost sharing, phasing, or other special circumstances)

'otal		

2. Certifications

Assurance of Compliance with the NASA Regulations Pursuant to Nondiscrimination in Federally Assisted Programs

The *(Institution, corporation, firm, or other organization on whose behalf this assurance is signed, hereinafter called "Applicant ")* hereby agrees that it will comply with Title VI of the Civil Rights Act of 1964 (P.L. 88-352), Title IX of the Education Amendments of 1972 (20 U.S.C. 1680 et seq.), Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. 794), and the Age Discrimination Act of 1975 (42 U.S.C. 16101 et seq.), and all requirements imposed by or pursuant to the Regulation of the National Aeronautics and Space Administration (14 CFR Part 1250) (hereinafter called "NASA") issued pursuant to these laws, to the end that in accordance with these laws and regulations, no person in the United States shall, on the basis of race, color, national origin, sex, handicapped condition, or age be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Applicant receives federal financial assistance from NASA; and hereby give assurance that it will immediately take any measure necessary to effectuate this agreement.

If any real property or structure thereon is provided or improved with the aid of federal financial assistance extended to the Applicant by NASA, this assurance shall obligate the Applicant, or in the case of any transfer of such property, any transferee, for the period during which the real property or structure is used for a purpose for which the federal financial assistance is extended or for another purpose involving the provision of similar services or benefits. If any personal property is so provided, this assurance shall obligate the Applicant for the period during which it retains ownership or possession of the property. In all other cases, this assurance shall obligate the Applicant for the period during which the federal financial assistance is extended to it by NASA.

This assurance is given in consideration of and for the purpose of obtaining any and all federal grants, loans, contracts, property, discounts, or other federal financial assistance extended after the date hereof to the Applicant by NASA, including installment payments after such date on account of applications for federal financial assistance which were approved before such date. The Applicant recognizes and agrees that such federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant, its successors, transferees, and assignees, and the person or persons whose signatures appear on the Proposal Cover Sheet above are authorized to sign on behalf of the Applicant.

CERTIFICATIONS, DISCLOSURES, AND ASSURANCES REGARDING LOBBYING AND DEBARMENT & SUSPENSION

1. LOBBYING

As required by Section 1352, Title 31 of the U.S. Code, and implemented at 14 CFR Part 1271, as defined at 14 CFR Subparts 1271.110 and 1260.117, with each submission that initiates agency consideration of such applicant for award of a Federal contract, grant, or cooperative agreement exceeding $ 100,000, the applicant must **certify** that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit a Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

2. GOVERNMENTWIDE DEBARMENT AND SUSPENSION

As required by Executive Order 12549, and implemented at 14 CFR 1260.510, for prospective participants in primary covered transactions, as defined at 14 CFR Subparts 1265.510 and 1260.117—

(1) The prospective primary participant **certifies** to the best of its knowledge and belief, that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded by any Federal department or agency;

(b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (l)(b) of this certification; and

(d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

(2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

Appendix E:
Instructions for Notice of Intent to Propose

In order to plan for a timely and efficient peer review process, *Notices of Intent* (NOI's) to propose are strongly encouraged by the date given in this CAN. The submission of a NOI is not a commitment to submit a proposal, nor is information contained therein considered binding on the submitter. NOI's are to be submitted electronically by entering the requested information through SYS-EYFUS Web site located at **http://proposals.hq.nasa.gov/**.

User identifications (IDs) and passwords are required by NASA security policies in order to access the SYS-EYFUS Web site.

If the proposer obtained a User ID and password in the process of submitting a proposal for a previous research opportunity announcement, the same user UserID and password can be used to complete the electronic Notice of Intent to Propose in response to this research opportunity announcement.

If you do not have a SYS-EYFUS UserID or password, you may obtain one electronically by going to *http://proposals.hq.nasa.gov* and performing the following steps:

- Click the hyperlink for **new user, which** will take you to the Personal Information Search Page.
- Enter your first and last name. SYS-EYFUS will **search** for your record information in the SYS-EYFUS database.
- Confirm your personal information by **choosing** the record displayed.
- Select **continue**, and a User ID and password will be e-mailed to you.

Once you receive your User ID and Password, **login** to the SYS-EYFUS Web site and follow the instructions for **New Notice of Intent.**

At a minimum, the following information will be requested:

- CAN number, alpha-numeric identifier, (Note: this may be included on the Web site template);
- the Principal Investigator's name, mailing address, phone number, and E-mail address;
- the name(s) of any Co-Investigator(s) and institution(s) known by the NOI due date;
- a descriptive title of the intended investigation; and,
- a brief description of the investigation to be proposed.

A separate NOI must be submitted for each intended proposal.

Appendix F:

Applications Division – Descriptions of Candidate National Applications

1. Weather and Climate predictions for Agricultural Competitiveness
A primary factor impacting production and yield on a given field is weather. Weather is a regional phenomenon that can be predicted from global indicators (i.e., El Nino). Improvements in agricultural competitiveness require better understanding of weather and climate, especially prediction of events with increasing accuracy and longer lead times. Solutions serving this application will draw directly from the results of NASA research and development of Earth science and technology that have potential to address weather and climate predictions and observations that can be integrated into local and regional decision support systems used in agriculture management. This national application draws upon, and contributes to, other information solutions associated with early warning for homeland security, water management and conservation, air quality management, carbon management, and invasive species management.

2. Global Measurements and Models for Air Quality Management
Although air quality and visibility management practices have improved significantly in the last 30 years, millions of people are still exposed to air pollution levels that exceed air quality standards. Numerous studies have shown significant effects of air pollution on human health, agriculture, ecosystems, and physical infrastructure. Earth science-based solutions are needed to support decision making related to the development of policies and practices associated with air quality standards and to evaluate emission control strategies to achieve the standards. Measurements of air pollutant constituents include those identified by the US Environmental Protection Agency and related tropospheric constituents measured by NASA Earth observing satellites. Models of air quality, photochemistry, and long-range transport utilize these measurements to set boundary conditions and initial conditions. This application supports partnering agencies and organizations in forecasting air quality with increasing accuracy and longer lead times. Solutions for air quality applications impact decision support systems developed for public health, community growth, agricultural competitiveness, disaster management, and homeland security.

3. Weather, Climate and Natural Hazards Predictions for Aviation Safety
To compete in the global economy of the 21st Century, America needs a healthy, vibrant aviation industry. The health and vibrancy of aviation depend on improved levels of safety, security and modernization. Safety issues related to the atmosphere and near Earth environment are important to in-flight operations and landing of aircraft. Airspace situation awareness during in-flight operations includes air traffic spacing and altitude, wind speeds and directions, turbulence and temperatures. Special in-flight considerations can include trajectory and dispersion of volcanic ash, severe and weather events Landing operations require awareness of wind directions and speed, potential wind shear forces, temperatures, precipitation and icing conditions, landscapes and terrain features. Earth science-based

solutions serving aviation involve partnerships with other agencies and national/international organizations.

4. Global Monitoring and assessments for Carbon Management

Carbon is the basis for the food and fiber that sustain life on Earth and is a primary energy source around the global. Burning of carbon-based fuels has led to a steady increase in the concentration of atmospheric carbon dioxide (CO_2) during the last 100 years. Atmospheric CO_2 is a primary contributor to the planetary greenhouse effect and, a major parameter in models predicting climate change.

Natural ecosystems on land and in the oceans sequester over half the CO_2 put into the atmosphere each year through human activities. Research indicates that changes in land management practices and additions of CO_2 and nutrients (iron) can enhance terrestrial and oceanic carbon sinks and reduce the rate of increase of atmospheric CO_2. Carbon sequestration in soil has the potential for subsistence farming communities with respect to improving the fertility and productivity of soil and providing a source of income for community and personal needs. Significant uncertainty remain about how much additional carbon storage could be achieved through management of soils, ecosystems or engineering approaches, how long such storage would persist, and how vulnerable or resilient the global carbon cycle and ecosystems are to human manipulation of sources and sinks.

Potential Earth science contributions to carbon management include direct measurement of CO_2 in the troposphere to understand the impact of regional land, atmosphere and ocean interactions, monitoring soil carbon concentration and farming practices to verify soil carbon sequestration activities and effectiveness, and monitoring of vegetation biomass as a measure of carbon sources and sinks on land. These global monitoring and measurements can be integrated into solutions that directly support local, regional and global decision making, and contribute to other national applications related addressing climate change, weather, water cycle, and coastal processes. This application supports federal agencies, including USDA and USAID, and contributes to, and draws upon other national applications including agricultural competitiveness, air quality, invasive species, weather and climate and water management.

5. Global Measurements and Predictions for Coastal Management

The US has approximately 95,000 miles of coastline. The coastal zone provides resources for human and natural populations, unique ecosystems, and a range of economic activities. Currently, more than half the US human population lives in coastal counties. The carrying capacity of the coastal zone, effects from human impacts, alternations of food webs, and the mitigation of natural and anthropogenic hazards are of vital importance to the nation. Several interagency programs are developing operational observing systems to identify and monitor changes and potential threats within the coastal zone. Earth science-based solutions to this application involve the use of NASA's measurements, scientific knowledge, data assimilation techniques, and modeling into public and private decision tools to support coastal management, especially issues concerning harmful algal blooms, hypoxia, and coastal

inundation. Measurements and information products include temperature, salinity, phytoplankton, hydrology, shoreline changes, bathymetry, and soil moisture. Assessments and predictive capability are needed to predict onset of events that may significantly effect human health, critical wetlands and ecosystems, and economic development.

6. Weather, Climate and Natural Hazards Earth Science for Community Growth for Infrastructure

Community growth for infrastructure development involves two aspects of urban expansion: 1) urban growth and its effect on local/regional environments; and 2) urban growth and its impact on the biophysical characteristics that influence human health. Forecasts and strategies for managing urban dynamics include value indexes for trading development for rural benefits that can assist regional development planners. Land protection, housing stock assessment, revitalization and in-fill development are considered important characteristics of the urban landscape.

Forecasts or assessments of urban air quality are an important aspect of the urban/rural interface landscape. Remote detection and monitoring concentrations of ground level ozone, SO_X,NO_X, and particulate matter less than 10 microns, along with the mapping and visualization of trajectory and dispersion are important to protecting human health.

7. Global Measurements and Predictions for Disaster Management

Community preparedness for disaster management involves assessments of vulnerability, risk, and response to short-lived phenomena in the Earth's atmosphere, land and oceans. Particular episodic events are of concern such as severe weather (thunderstorms, tornadoes, and hurricanes), as well as tsunamis, river flooding, plain/coastal flooding, volcanic ash, earthquakes, harmful ocean blooms and human-made disasters such as petroleum releases in rivers and oceans. Communities need an increased understanding of the effects of short-term events on the physical, chemical, and biological processes that interact to affect human safety, the environment, and the economy. Improved decision support systems are being developed that may address human life and property damage, meet the requirements of planners, early warning systems, first responders, and contribute to impact assessments, risk communication, mitigation, and implementation of relief efforts. Disaster management applications will evolve in cooperation with federal agencies such as FEMA. The applications will draw upon, and impact other national applications including coastal management, community growth, homeland security, public health and water management.

8. Global Monitoring and Predictions for Homeland Security

Federal, State, and local governments are cooperating to prevent and reduce America's vulnerability to terrorism, minimize possible damage, and recover from attacks that do occur. Agencies are strengthening aviation and border security, preparing the defense against bioterrorism, improving information sharing, and deploying more resources to protect our critical infrastructure. NASA's measurements, observations, and modeling can provide data and information to Homeland Security networks to support risk assessments, vulnerability

assessments, and mitigation assessments. Data and information can support decision making to ensure the adequacy of preparing for, preventing against, responding to and recovering from terrorist threats or attacks. Earth science-based solutions can serve this application by drawing on developments in several other applications, such as air quality, water management, public health, and disaster management. This application will focus especially on providing NASA data, information, and models to support governmental decision tools that identify, track, and forecast agents from anthropogenic disasters and terrorism introduced into the air and water. Prediction of events, hazardous situations, and impacts with increasing accuracy and longer lead times is a significant part of this application.

9. Weather, Climate and Natural Hazard Predictions for Energy Forecasting

The commercial and residential demand for energy and energy availability is affected by natural and human influences. Human influences that can effect demand are growth in urban areas creating changes in land pattern surfaces from pervious to impervious, natural green areas to heat islands create micro-climates. Population concentrations increase localized gas emissions (COx, SOx, NOx) that impact local air quality and contribute to the overall green house effect. Natural influences that can effect demand are normal seasonal weather patterns, abnormal periods of excessively hot or cold temperature within a normal seasonal pattern, and inter-annual climate variations. The Earth's oceans are believed to be the primary driver of weather and climate variations. The ability to accurately predict risk and vulnerability to both natural and human influences on energy demand will improve decision making in energy use and conservation planning, trading and transmission infrastructure building and the use of renewable and non-renewable resources needed to generate energy. Development of decision support systems for energy forecasting will impact government and industrial organizations at all levels. This application will draw upon and affect climate change, carbon management, air and water quality and public health.

10. Invasive Species Management

Invasive species is one of the major environmental issues of this century. The economic cost to the US of invasive species is at least $137B per year. Invasive species threaten endangered species and/or are a cause of the endangerment. Invasive species are defined as non-native species whose introduction is likely to cause harm to the economy, environment or human health. Non-indigenous invasive species include: 1) diseases such as malaria and West Nile Fever that affect public health; 2) agricultural pathogens; 3) plant and animal species that compete with native species and/or have significant negative economic impact. The number of invasive species entering the US per year is in the thousands.

The USG has formed a National Invasive Species Council in response to the problem. The US Geological Survey (USGS) has the lead role for dealing with invasive species in natural and semi-natural environments. Identified needs include: 1) on-demand, predictive landscape- and regional-scale models and maps for biological invasions; 2) data integration and sharing; and 3) comprehensive information on control efforts and cost.

NASA can contribute to invasive species control through data, science and technology. NASA satellite Earth observations provide measurements of key ecosystem attributes needed to predict invasive species distribution. NASA satellite technology and remote sensing methods are used for extracting land cover data for models that describe the potential for invasive species spread, probable sites, critical locations, etc. A number of planned missions in the near to mid term will expand these measurements to include land cover three-dimensional structure.

NASA will also contribute through improvements in weather and climate predictions and regional scale ecological forecasting. Weather and climate have a direct impact on environment and species habitat. NASA provides the computational capabilities and expertise in large-scale, coupled Earth system modeling needed to assure the successful transfer of the data and technology into operational decision support systems. Invasive species management will be accomplished through cooperative efforts with other federal agencies such as USDA and USGS. This application will overlap with agricultural competitiveness, carbon management, water management, coastal zone management, community growth and public health.

11. Public Health

Public health issues such as vector borne infectious diseases, respiratory illness, skin and eye diseases are related to the conditions in the environment. Vector borne diseases are almost always tied to weather parameters such as humidity and temperature either directly or in relation to the impact these parameters have on forests and wetlands that are crucial habitats for such organisms. Climate variability in rainfall and temperature may have an influence on the changes, distribution and quantity of vectors and therefore an influence on these diseases. Respiratory diseases in combination with elevated temperatures provide increased stress on the human circulatory systems. Increasing temperatures also impact cities with high ozone levels because pollutant levels tend to be reached earlier in the day and maintained at high levels for longer durations. Skin and eye diseases are believed to have a strong link to prolonged exposure to sunlight and particularly ultra violet (UV) wavelengths of radiation. Air quality and greenhouse gases contributing to atmospheric variations of ozone in the tropospheric layer cause noxious pollutants, in the stratosphere ozone depletion is allowing increased levels of UV radiation to reach the Earth's surface. Decision support systems for public health will draw upon the output from other national applications including air and water quality, invasive species, and coastal zone management.

12. Water Management and Conservation

Water availability, quality and conservation are issues in every region of the country. Monitoring water quality and identifying the location and magnitude of existing and potential pollution sources and impacts are important activities to ensure adequate supply of this natural resource. Both surface and ground water are of importance. Surface water is both flowing water in streams and rivers; and impounded water in natural lakes and man-made reservoirs. Watershed management is important in land use changes that affect pervious and impervious surfaces. 1) In surface water the Total Maximum Daily Loads that are influenced

by surface run off is highly variable with water flow rates. Pollution from point sources has been well identified and is relatively well characterized. Non-point source pollution locations, intermittent flow and the relation to the variability in stream flow rates are less well understood. 2) For groundwater the issue is aquifer recharge in its location, recharge rate and the potential for leeching surface contaminants. Weather cycles and climate changes can also contribute to the quality and availability of water. Improvements in water quality monitoring and locating pollution sources are needed. Decision support systems for water management will impact multiple agencies including EPA, USDA, USGS and other national applications.

Appendix G:
Data Rights and Related Issues

1.0 Introduction

NASA wishes to provide standard rights in data provisions, as defined by the NASA Grant and Cooperative Agreement Handbook, for data related to information systems and services capabilities. However, to meet the objectives of this program, scientific data product algorithms and data products or services produced through the program shall be made available to the user community on a non-discriminatory basis, without restriction, and at no more than the marginal cost of fulfilling user requests.

Included below is the Data Rights section created specifically for this type of partner agreement, which will be part of the Cooperative Agreement between NASA and successful research REASoN respondents.

2.0 Data Rights Created for Research REASoN Cooperative Agreements [Replaces section 1260.30 of the "NASA Grant and Cooperative Agreement Handbook"]

NASA intends to protect the recipient's rights to data developed at its own expense prior to this study as well as to certain data that will be developed in the course of this study. No data transfer or "cross fertilization" of concepts will be performed by NASA participants, should two or more cooperative agreements be awarded. The results developed under this program will be made available to senior management for planning of potential future missions. While NASA will require that the data generated by the recipients be delivered to NASA for dissemination to employees of NASA, of JPL, and of appropriate support contractor personnel, proprietary data marked with a suitable notice or legend will be protected for the 2-year period of exclusivity. All support contractor personnel receiving access to the data generated as a part of these studies will not be a competitor of the recipient (defined as another recipient of a cooperative agreement resulting from CAN-02-OES-01 and/or development of science information systems and services). The support contracts involved will be required to contain provisions pertaining to the handling of data and organizational conflicts of interest.

A. Definitions

1. "*Data*" Recorded information, regardless of form, the media on which it may be recorded, or the method of recording. The term includes, but is not limited to, data of a scientific or technical nature, software and

documentation thereof, and data comprising commercial and financial information.

2. "*Computer Data Base*" A collection of data in a form capable of being processed and operated on by a computer through the use of a computer program performing the function of storing, manipulating, or formatting. A "computer data base" is not software.

3. "*Computer Program*" A set of statements or instructions, in object code, to be used directly or indirectly in a computer in order to bring about a certain result.

4. "*Object Code*" Machine language, i.e., that programming language directly readable by a computer.

5. "*Software*" Computer programs, source code, source code listings, and design details, algorithms, processes, flow charts, formulae and related material that would enable the software or a functionally equivalent software to be reproduced, recreated, or recompiled, regardless of the form or media on which such information is recorded.

6. "*Software Documentation*" Data that explain the capabilities of the software, or provide operating instructions for using the software to obtain the desired results from a computer such as: a) owner's manuals, b) user's manuals, c) installation instructions, d) operating instructions, and other similar items.

7. "*Metadata*" Information about a data set provided by the data supplier or the generating algorithm and which provides a description of the content, format, and utility of the data set. Metadata provide criteria, which may be used to select data for a particular scientific investigation. Information describing a data set, including data user guide, descriptions of the data set in directories, and inventories, and any additional information required to define the relationships among these.

B. Data Products

1. The following data products shall be treated as falling under the data category "General," as data exchanged without restriction as to its disclosure, use or duplication.

    a. <u>Scientific Data</u>: Earth system science products, with accompanying metadata and quality assessments, made available through production or services provided by the REASoN project. Some examples of scientific data include: geophysical parameters, such as sea surface

temperature, sea surface height, atmospheric pressure/temperature levels, precipitation, atmospheric chemical species and aerosols, ice sheet mass balance, and various terrestrial surface measurements.

b. Scientific Computer Data Base: Collection of scientific data.

c. Scientific Software: Scientific software is that software used for processing raw instrument data into scientific data.

2. The following data products may be treated by Recipient as "Data first produced by Recipient," as under C.3., except for object code which shall be treated under "General" as data exchanged without restriction as to its disclosure, use or duplication. The parties also agree to the following additional terms. Within one month of the completion of this agreement, the recipient shall provide written documentation of its intent to commercialize "Data first produced by Recipient" under this agreement. If the Recipient intends to commercialize data first produced by the recipient it shall be responsible to ensure such data is appropriately marked with a suitable notice and NASA shall maintain such data in confidence for a period of two years after completion of this agreement. NASA agrees not to disclose such data to any third party without the Recipient's written approval until the aforementioned restricted period expires. NASA agrees that whenever it reveals such data to third parties, it shall require them to maintain the data in confidence for a period of two years after completion of the agreement. After the restricted period expires NASA shall have the rights specified in C.1.b. If the Recipient determines it is not going to commercialize (or otherwise make available to the user community, such as "freeware") such data, or if the Recipient fails to provide written documentation indicating its intent to commercialize the data, the Recipient agrees that all such data can be made available without restriction as to its disclosure, use or duplication. Alternatively, at NASA's option, NASA may require the recipient to assign any copyright to such data to NASA or its designee.
   a. Information System Software: Software that comprises any part of, access to, or management of data in the data system of the REASoN project, or tools that access, manipulate, or analyze Scientific Computer Data Base. Some examples of Information System Software include client/server applications, user interfaces, tools for selecting, manipulating, analyzing scientific data, database management software, etc.

      Information System Software will be that which have been produced as part of the project pursuant to the technology objectives of the Cooperative Agreement. A primary objective of this program is to facilitate the enhancement of the National Information Infrastructure to affect the emergence of an Environmental Information Economy

capable of providing for the routine exchange of environmental data and information.

C. Data Categories

1. General : Data exchanged between NASA and Recipient under this cooperative agreement will be exchanged without restriction as to its disclosure, use or duplication except as otherwise provided below in this provision.

2. Background Data : (Recipient's and NASA's)
   a. *Recipient*: In the event it is necessary for Recipient to furnish NASA with Data which existed prior to, or produced outside of, this cooperative agreement, and such Data embodies trade secrets or comprises commercial or financial information which is privileged or confidential, and such Data is so identified with a suitable notice or legend, the Data will be maintained in confidence and disclosed and used by NASA and its contractors (under suitable protective conditions) only for the purpose of carrying out NASA's responsibilities under this cooperative agreement. Upon completion of activities under this agreement, such Data will be disposed of as requested by Recipient.
   b. *NASA:* Earth Observing System Core System (ECS) Software - No license rights to the ECS software are granted or implied by this agreement. ECS software is being provided for Government purposes and may not be used for commercial purposes during or upon completion of this agreement. Upon completion of activities under this agreement, such Data will be disposed of as requested by NASA. Any modification to these rights will be expressly made through a separate written agreement.

3. Data first produced by Recipient: In the event Data first produced by Recipient in carrying out Recipient's responsibilities under this cooperative agreement is furnished to NASA, and Recipient considers such Data to embody trade secrets or comprise commercial or financial information which is privileged or confidential, and such Data is so identified with a suitable notice or legend, the Data will be maintained in confidence for a period of two years after completion of this agreement and be disclosed and used by the Government and its contractors (under suitable protective conditions) only for use as a tool for Government research by or on behalf of the Government during that period. In order that the Government and its contractors may exercise the right to use such Data for the purposes designated above, NASA, upon request to the Recipient, shall have the right to review and request delivery of Data first produced by Recipient. Delivery shall be made within a time period specified by NASA.

4. Data first produced by NASA: As to Data first produced by NASA in carrying out NASA's responsibilities under this cooperative agreement and which Data would embody trade secrets or would comprise commercial or financial information that is privileged or confidential if it had been obtained from the Recipient, will be marked with an appropriate legend and maintained in confidence for an agreed period of up to (2) years after completion of this agreement, with the express understanding that during the aforesaid period such Data may be disclosed and used (under suitable protective conditions) by or on behalf of the Government for Government purposes only, and thereafter for any purpose whatsoever without restriction on disclosure and use. Recipient agrees not to disclose such Data to any third party without NASA's written approval until the aforementioned restricted period expires.

5. Copyright:

(i) In the event Data is exchanged with a notice indicating the Data is protected under copyright as a published copyrighted work, or are deposited for registration as a published work in the U.S. Copyright Office, the following paid-up licenses shall apply:

a. If it is indicated on the Data that the Data existed prior to, or was produced outside of, this agreement, the receiving party and others acting on its behalf, may reproduce, distribute, and prepare derivative works for the purpose of carrying out the receiving party's responsibilities under this cooperative agreement; and

b. If the furnished Data does not contain the indication of paragraph C.5.(i).a. of this section, it will be assumed that the Data was first produced under this agreement, and the receiving party and others acting on its behalf, shall be granted a paid-up, nonexclusive, irrevocable, world-wide license for all such Data to reproduce, distribute copies to the public, prepare derivative works, and perform publicly and display publicly, by or on behalf of the receiving party subject to the confidentiality obligations of C.2. For Data that is computer software, the right to distribute shall be limited to potential users in the United States.

(ii). When claim is made to copyright, the Recipient shall affix the applicable copyright notice of 17 U.S.C. 401 or 402 and acknowledgment of Government sponsorship to the data when and if the data are delivered to the Government.

6. Oral and Visual Information: If information which the Recipient considers to embody trade secrets or to comprise commercial or financial information which is privileged or confidential is disclosed orally or visually to NASA, such information must be reduced to tangible, recorded form (i.e., converted into Data as defined herein), identified and marked with a suitable notice or legend, and furnished to NASA within 10 days after such oral or visual disclosure, or NASA shall have no duty to limit or restrict, and shall not incur any liability for, any disclosure and use of such information.

7. Disclaimer of Liability : Notwithstanding the above, NASA shall not be restricted in, nor incur any liability for, the disclosure and use of:

1. Data not identified with a suitable notice or legend as set in paragraph B.2. of this section; nor
2. Information contained in any Data for which disclosure and use is restricted under paragraphs C.2. or C.3. of this section, if such information is or becomes generally known without breach of the above, is known to or is generated by NASA independently of carrying out responsibilities under this agreement, is rightfully received from a third party without restriction, or is included in data which Participant has, or is required to furnish to the U.S. Government without restriction on disclosure and use.

D. Marking of Data

All Data or Information Systems System Software object code created under this cooperative agreement, by NASA or the Recipient, shall be marked with a suitable notice or legend indicating the data was generated under this cooperative agreement. Such a legend is provided below:

> "Copyright year of first publication, Participant (Copyright notice not applicable to U.S. Government created works). This work has been developed under Cooperative Agreement xxxx-xxx with NASA and the Government has certain rights. This work is released without restriction as to its disclosure, use or reproduction. Software shall not be disassembled, reverse engineered or made into human readable form."
>
> "This work is provided "as is" without any warranty of any kind, either express, implied, or statutory, including, but not limited to, any warranty that the software will conform to specifications, any implied warranties of merchantability, fitness for a particular purpose, and freedom from infringement, and any warranty that the documentation will conform to the program, or any warranty that the software will be error free."
>
> "In no event shall NASA be liable for any damages, including, but not limited to direct, indirect, special or consequential damages, arising out

of, resulting from, or in any way connected with this work. Whether or not based upon warranty, contract, tort or otherwise, whether or not injury was sustained by persons or property or otherwise, and whether or not loss was sustained from, or arose out of the results of, or use of, the work provided hereunder."

E. Lower Tier Agreements

The Recipient shall include this provision, suitably modified to identify the parties, in all subcontracts or lower tier agreements, regardless of tier, for experimental, developmental, or research work.

Appendix H: Budget Summary

BUDGET SUMMARY

For period from _____ to _____

- Provide a complete Budget Summary for year one and separate estimated for each subsequent year.
- Enter the proposed estimated costs in Column A (Columns B & C for NASA use only).
- Provide as attachments detailed computations of all estimates in each cost category with narratives as required to fully explain each proposed cost. See *Instructions For Budget Summary* on following page for details.

		NASA USE ONLY	
	A	**B**	**C**
1. Direct Labor (salaries, wages, and fringe benefits)	_____	_____	_____
2. Other Direct Costs:			
a. Subcontracts	_____	_____	_____
b. Consultants	_____	_____	_____
c. Equipment	_____	_____	_____
d. Supplies	_____	_____	_____
e. Travel	_____	_____	_____
f. Other	_____	_____	_____
3. Indirect Costs*	_____	_____	_____
4. Other Applicable Costs	_____	_____	_____
5. SUBTOTAL--Estimated Costs	_____	_____	_____
6. Less Proposed Cost Sharing (if any)	_____	_____	_____
7. Total Estimated Costs	_____	_____	XXXXXXX
8. APPROVED BUDGET	XXXXXX	XXXXXXX	_____

***Facilities and Administrative Costs.**

INSTRUCTIONS FOR BUDGET SUMMARY

1. Direct Labor (salaries, wages, and fringe benefits): Attachments should list the number and titles of personnel, amounts of time to be devoted to the grant, and rates of pay.

2. Other Direct Costs:
    a. Subcontracts: Attachments should describe the work to be subcontracted, estimated amount, recipient (if known), and the reason for subcontracting.
    b. Consultants: Identify consultants to be used, why they are necessary, the time they will spend on the project, and rates of pay (not to exceed the equivalent of the daily rate for Level IV of the Executive Schedule, exclusive of expenses and indirect costs).
    c. Equipment: List separately. Explain the need for items costing more than $5,000. Describe basis for estimated cost. General purpose equipment is not allowable as a direct cost unless specifically approved by the NASA Grant Officer. Any equipment purchase requested to be made as a direct charge under this award must include the equipment description, how it will be used in the conduct of the basic research proposed and why it cannot be purchased with indirect funds.
    d. Supplies: Provide general categories of needed supplies, the method of acquisition, and the estimated cost.
    e. Travel: Describe the purpose of the proposed travel in relation to the grant and provide the basis of estimate, including information on destination and number of travelers where known.
    f. Other: Enter the total of direct costs not covered by 2a through 2e. Attach an itemized list explaining the need for each item and the basis for the estimate.

3. Indirect Costs*: Identify F&A cost rate(s) and base(s) as approved by the cognizant Federal agency, including the effective period of the rate. Provide the name, address, and telephone number of the Federal agency official having cognizance. If unapproved rates are used, explain why, and include the computational basis for the indirect expense pool and corresponding allocation base for each rate.

4. Other Applicable Costs: Enter total explaining the need for each item.

5. Subtotal-Estimated Costs: Enter the sum of items 1 through 4.

6. Less Proposed Cost Sharing (if any): Enter any amount proposed. If cost sharing is based on specific cost items, identify each item and amount in an attachment.

7. Total Estimated Costs: Enter the total after subtracting items 6 and 7b from item 5.

* Facilities and Administrative (F&A) Costs

Appendix I:

Reporting Requirements

All submissions shall be made in Microsoft Word, Microsoft Excel, Microsoft PowerPoint, or Adobe PDF.

The following deliverables shall be required of awarded proposals. In cases where subcontract arrangements exist, consolidated project reports, including financial reports, are the responsibility of the PI. In this context "Annual" refers to a calendar year task effort, which commences at award.

Initial Plans and Reports

Within 30 days of award, the awardee shall prepare a project plan, an initial Quad Chart, an initial list of metrics, and an initial list of 6-month milestones. This information and supporting data shall be sent to the appropriate official electronically.

The project plan shall identify plans for all technical, schedule and resource activities for the proposed life of the project.

The Quad Chart shall contain the following information:

- First Quadrant: A visual, graphic, or other pertinent information
- Second Quadrant: "Description and Objectives"
- Third Quadrant: "Approach" and "Co-Is/Partners"
- Fourth Quadrant: "Schedule and Deliverables"

The Quad Chart shall be updated for each 6-month review (see Section 3.10).

Required Reports

1. Monthly Reports

REASoN Projects will be required to report metrics in response to ESE GPRA reporting to the Federation Metrics Working Group prior to the tenth day of each month.

2. Quarterly Task Reports

A quarterly task report shall focus on the preceding quarter's efforts. Each report shall address:

- Technical status: The awardee shall summarize accomplishments for the preceding month, including technical accomplishments (trade study results,

requirements analysis, design, etc.), technology development results, and results of tests and/or demonstrations.

- Schedule status: The awardee shall address the status of major tasks and the variance from planned versus actual schedule, including tasks completed, tasks in process and expected to complete later than planned, tasks that are delayed starting with rationale for each, and recovery plans as appropriate.

- Metrics status: The awardee shall address the status of any required metrics not already reported through the Federation.

Task Reports shall be delivered monthly electronically to the appropriate official. Reports shall be submitted in Microsoft Word or PowerPoint compatible formats by the 10th of the required month, or the close of business of the first workday following the 10th if the 10th is on a weekend or a holiday. A teleconference or brief meeting may be conducted between NASA and the awardee to review and discuss each report.

3. Interim Reviews

The awardee shall provide an Interim Review every six months, coinciding with the 6-month milestone and payment schedule, commencing from the date of award. The awardee must provide a presentation summarizing the work accomplished, milestones achieved, and results leading up to this Interim Review and must:

- Describe the primary findings, technology development results if any, and status

- Describe the work planned for the remainder of the project and critical issues that need to be resolved to successfully complete the remaining planned work.

- Describe the status of any metrics reported on over the prior six months.

- Summarize the cost and schedule status of the project, including any schedule slippage/acceleration. A schedule milestone chart of all major task activities shall be created and maintained and shown at all reviews. A cost data sheet shall be created and maintained, showing total project costs committed, obligated, and costed, along with a graphical representation of the project cost run outs.

NASA will conduct the Interim Review via teleconference. The presentation provided at the review will constitute the Interim Report. The presentation shall be delivered electronically to the appropriate NASA official.

4. Final Review

The awardee shall provide a Final Review at the completion of the activity. The awardee shall provide a review summarizing the work accomplished and anticipated results at the end of the task. Each review must include:

- A description of the work accomplished and the results leading up to this review.

- A summary of the primary findings, technology development results and final TRL assessment if applicable, and status, The PI may provide a demonstration, if appropriate, to show technical results and status.

- A summary of the cost and schedule status of the project *since inception*.

- The Final Review must provide conclusions of the work performed, lessons learned, and make recommendations for follow-on activities that should be pursued, with estimates of the cost and schedule to achieve the desired end state.

This review will be conducted at a mutually agreed-upon location, with the length of presentation tailored, as appropriate, depending on the amount of work to be discussed. The Final Review should be comprehensive. In addition to hard copy handouts at the review, the review package shall also be delivered electronically to the appropriate NASA official at least two (2) working days prior to the review.

5. Annual and Final Reports

The awardee shall provide Annual and a Final Report, due 30 days after the reporting period. The report shall contain brief information on each of the following:

- Comparison of actual accomplishments with the goals and objectives,
- Major results/key findings including a summary of the metrics collected,
- Lessons learned and recommendations for follow-on activities. Technology results must include a TRL assessment and steps to take technology results to utilization.

Appendix J:
SEEDS Activities

Study Teams

To achieve its objective, the SEEDS Formulation Team has set up study teams to investigate specific subjects of concern to SEEDS and make recommendations. Currently there are seven study teams with members from government agencies, universities, and industry. The seven study teams and their tasks are:

- Standards for Near-Term Missions. The tasks of the team include considering ESE's near-term systematic measurement missions; recommending science data, metadata, and interoperability standards for applications; and incorporating advice and experience of mission science community in making recommendations.
- Levels of Service, Benchmarks and Cost Estimation. The study team will work with the research and applications communities to develop the minimum and recommended levels of service for core data sets and services required from ESE data management service providers. It will determine, from benchmarking, what data management services should cost, and develop a capability to perform end-to-end cost estimates for ESE data management services.
- Standards and Interfaces Processes. This study team will define a process for SEEDS to develop, adopt, evolve, and maintain standards and interfaces for data and information systems and services across the Earth Science Enterprise. The process should capitalize on the methods and experience of existing relevant data systems standards bodies (e.g., ISO, OGC) and NASA programs (e.g., EOSDIS, ESIP Federation).
- Data Life Cycle and Long-Term Archive: The tasks of this study team are to ensure safe handling of SEEDS-era data products as they migrate from data providers to active archive and long-term archive (LTA), even as numerous individuals and institutions take responsibility for the product during its life-cycle.
- Reference Architecture and Reuse Assessment: This study team tries to answer the following questions in its study. Should NASA/SEEDS invest in a software & component reuse effort? Should NASA/SEEDS invest in developing a reference architecture? If NASA/SEEDS should invest in either of these efforts (i.e., reuse and/or a reference architecture), what is the best method to assure effective and accountable community involvement, what is the best technical approach? Criteria for judging in priority order are cost savings over time; increased flexibility/responsiveness to new missions, research, and applications use of NASA data; and increase in effective and accountable community participation.
- Metrics Planning and Reporting: This study team will define appropriate metrics and reporting requirements for the participants in ESE Data Management Activities and demonstrate that proposed SEEDS organization structure can provide adequate accountability.
- Technology Needs and Infusion Plans: This study team will determine processes by which technology needs are identified and technology investments are infused into the evolving NewDISS. New strategies for technology infusion are being

explored for the SEEDS[23] initiative to address the gap for technology development beyond the research stage and into the mid technology readiness levels. The study team will recommend ways for SEEDS to leverage the processes of NASA ESTO's AIST Program ESTO, involve ESE user community, and designate roles of ESTO AIST and SEEDS with regard to prototyping needs.

Formulation Principles

Some general principles and assumptions apply to the entire effort. Over the past decade, NASA ESE has made a substantial investment in the development of data and information systems. This is most evident in the EOSDIS Core System (ECS) but also includes unique components developed by the DAACs, the data processing systems developed by the instrument teams and a variety of other capabilities that are still actively used and maintained as a result of heritage missions and initiatives. SEEDS is not intended to be a replacement of these capabilities but rather the evolution of existing systems, through improved effectiveness and efficiency of operation, and services to maximize the return on those previous investments.

The SEEDS formulation effort will be outward looking in response to the actual, or perceived, insular nature of previous NASA approaches to the development of data and information systems. Wherever appropriate, the SEEDS studies are addressing as wide a range of related activities as possible, within government, industry and academia in the U.S. and abroad. By taking a broad view, it is expected that the recommendations that emerge from the SEEDS studies will capitalize on the extended experience base and the best practices and latest technical approaches available to achieve maximum effectiveness and efficiency in development and operation of NASA Earth science data and information management system.

SEEDS will also seek the active and substantial involvement of users and providers of Earth science data and services in the definition and execution of the SEEDS processes, practices and policies. A number of the study teams have representatives of these communities either as members or consultants and all of the teams individually and collectively are making every opportunity to interact with the community, through interviews, meetings and workshops.

Sample Study Task – Standards and Interfaces Processes

A brief overview of the activities and current results of the Standards and Interfaces Processes study task illustrates the general approach of the SEEDS Formulation Team. The team performing this study has individuals with experience from previous NASA data systems development projects but also has representation from other federal agencies and academia. The approach is to begin by assembling an extensive collection of information on the standards and standard interfaces activities of heritage data system development projects within NASA and other agencies and on the standards and standard processes employed by relevant formal standards bodies and organizations. These organizations include the International Standards Organization (ISO) Technical

Committee on Geographic Information/Geomatics (TC 211), the Open GIS Consortium (OGC), the World Wide Web Consortium (W3C), the Consultative Committee for Space Data Systems (CCSDS), the FGDC and the Internet Engineering Task Force (IETF). All of this information has been collected into a SEEDS Standards and Interfaces Survey Document.

The survey document has provided the foundation for the team to identify and characterize a potential approach and process options that can be used to support the ESE in making decisions on data and information standards. The overall process recommends that the enterprise consider the use of existing standards before initiating a new standard development activity. This use could be to adopt the existing standard as is or to constrain or extend it to meet the specific needs of the enterprise. If a development activity is deemed to be necessary, the process should consider alternate approaches to develop a standard (request for proposal (RFP), testbed/specification with external standards organization, collaboration, etc.). For either a new or an existing standard or standard interface, an approval process is required with appropriate representation from NASA officials, the community of data providers and users and other stakeholders. An important feature of the process of several standards organizations is that software and tools that implement and or support the standard must be available prior to its approval. This has been incorporated into the study team's proposed approval process.

The survey results and the process options that were derived from their analysis are being discussed with the ESE management and the community of providers, users and stakeholders through a series of meetings and workshops. The need for associated activities such as user support, tool development, outreach and training are also topics that are being considered. The discussions also are addressing participation and the respective roles and responsibilities of NASA and the community of data providers and users in both the processes and the associated activities. A set of recommendations that incorporates the results of these interactions will be the final product of this study.

While the final plans for SEEDS will depend on the results of both the studies, community interactions and decisions by NASA management, the current view is that SEEDS will not be responsible for implementing or operating any data systems. The NASA programs and projects selected to develop and operate new ESE flight missions and the research projects of the NASA-funded scientific communities will hold that responsibility. The results of these development efforts will be the more open, distributed and heterogeneous data systems that were envisioned in the earlier NewDISS studies.

The collection of study results produced by the SEEDS Formulation Team will be used to develop management guidelines, a standards framework and decision support capabilities for overall ESE data systems planning and coordination. These functions will ensure that the aggregation of the mission and science data systems can work in concert to meet the overall objectives of the NASA Earth Science Enterprise and maximize the return on its investment in these efforts.

Appendix K: Integrated Precipitation Data System: A SEEDS Prototype

In the EOS era, NASA flew the Tropical Rainfall Measurement Mission, which has been recording rainfall data over the tropics since it was launched in 1997. TRMM has already achieved or surpassed many of its original goals, including collecting data on rainfall and the heat release associated with rainfall, as well as information about interactions between water vapor, clouds and precipitation that are central to regulating the climate system. NASA is currently engaged in advanced studies and discussions with partners for a Global Precipitation Mission, which could fly in 2008. NASA is presently formulating the Integrated Precipitation Data System for the emerging Systematic Measurement of global precipitation as a SEEDS prototype. Evolution of the TRMM Science Data and Information System (TSDIS) is currently being planned.

Examples of needed science and information capabilities include (but are not limited to) Extensible Markup Language (XML) Simple Object Access Protocol (SOAP)-based servers which provide for easy referral and service handoff among precipitation sites for services available at those sites, generic tools for the automated combination of precipitation data from satellites with dissimilar resolutions, footprints, altitudes into combined products, tools for extracting precipitation data from current and future products and combining into Geographic Information Systems (GIS) applications, generic tools that can filter a wide range of precipitation data (and can easily be configured to handle all or most precipitation data) on parameters and create subsets and combinations of data, etc.

In essence, thematic and systematic-parameter-oriented research systems offer additional precipitation value-added products and services outside the scope of any single mission.

Examples include (but are not limited to):

- Development and distribution of discipline and/or interdisciplinary-focused products that combine data from several satellite missions, ground data, field experiment data, etc. Code producing such product could be run at the developing site or at a mission processing center for the developing site
- Development and distribution of discipline and or interdisciplinary-focused products subsetted in appropriate ways from existing and future precipitation products that service the needs of the research system’s specific community.
- Development and provision of value added scientific research methods/techniques (analysis, tools, etc.) to serve the science community focused on water and energy cycle research or other relevant components of Earth science.
- Development of advanced real time applications and tools. For example, a service could access distributed precipitation, sea-surface temperature and wind speed data and create merged products that are "immediately" viewable by personal workstation users and provide a "total" picture of the weather systems.

Appendix L: Definition of Technology Readiness Levels

TRL 1 Basic principles observed and reported

Transition from scientific research to applied research. Essential characteristics and behaviors of systems and architectures. Descriptive tools are mathematical formulations or algorithms.

TRL 2 Technology concept and/or application formulated

Applied research. Theory and scientific principles are focused on specific application area to define the concept. Characteristics of the application are described. Analytical tools are developed for simulation or analysis of the application.

TRL 3 Analytical and experimental critical function and/or characteristic proof-of-concept

Proof of concept validation. Active Research and Development (R&D) is initiated with analytical and laboratory studies. Demonstration of technical feasibility using breadboard or brassboard implementations that are exercised with representative data.

TRL 4 Component/subsystem validation in laboratory environment

Standalone prototyping implementation and test. Integration of technology elements. Experiments with full-scale problems or data sets.

TRL 5 System/subsystem/component validation in relevant environment

Thorough testing of prototyping in representative environment. Basic technology elements integrated with reasonably realistic supporting elements. Prototyping implementations conform to target environment and interfaces.

TRL 6 System/subsystem model or prototyping demonstration in a relevant end-to-end environment (ground or space)

Prototyping implementations on full-scale realistic problems. Partially integrated with existing systems. Limited documentation available. Engineering feasibility fully demonstrated in actual system application.

TRL 7 System prototyping demonstration in an operational environment (ground or space)

System prototyping demonstration in operational environment. System is at or near scale of the operational system, with most functions available for

demonstration and test. Well integrated with collateral and ancillary systems. Limited documentation available.

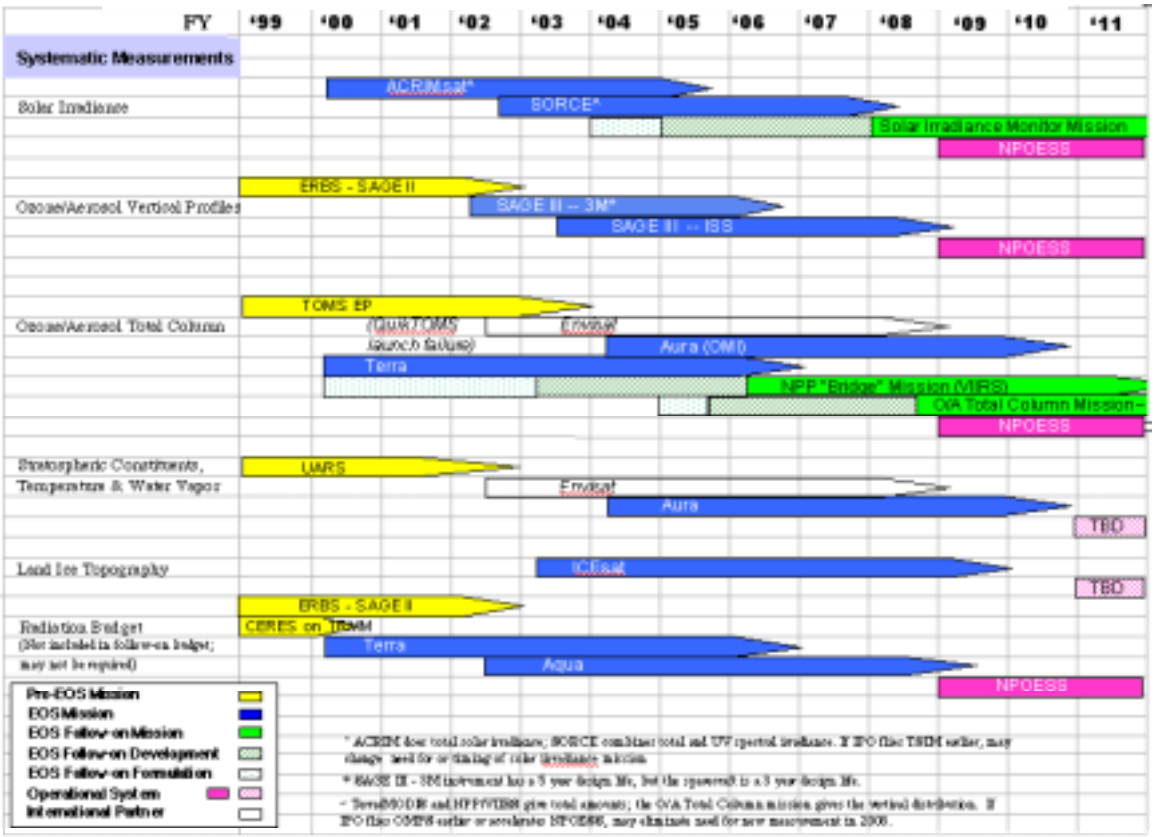
TRL 8 Actual system completed and "mission qualified" through test and demonstration in an operational environment (ground or space)

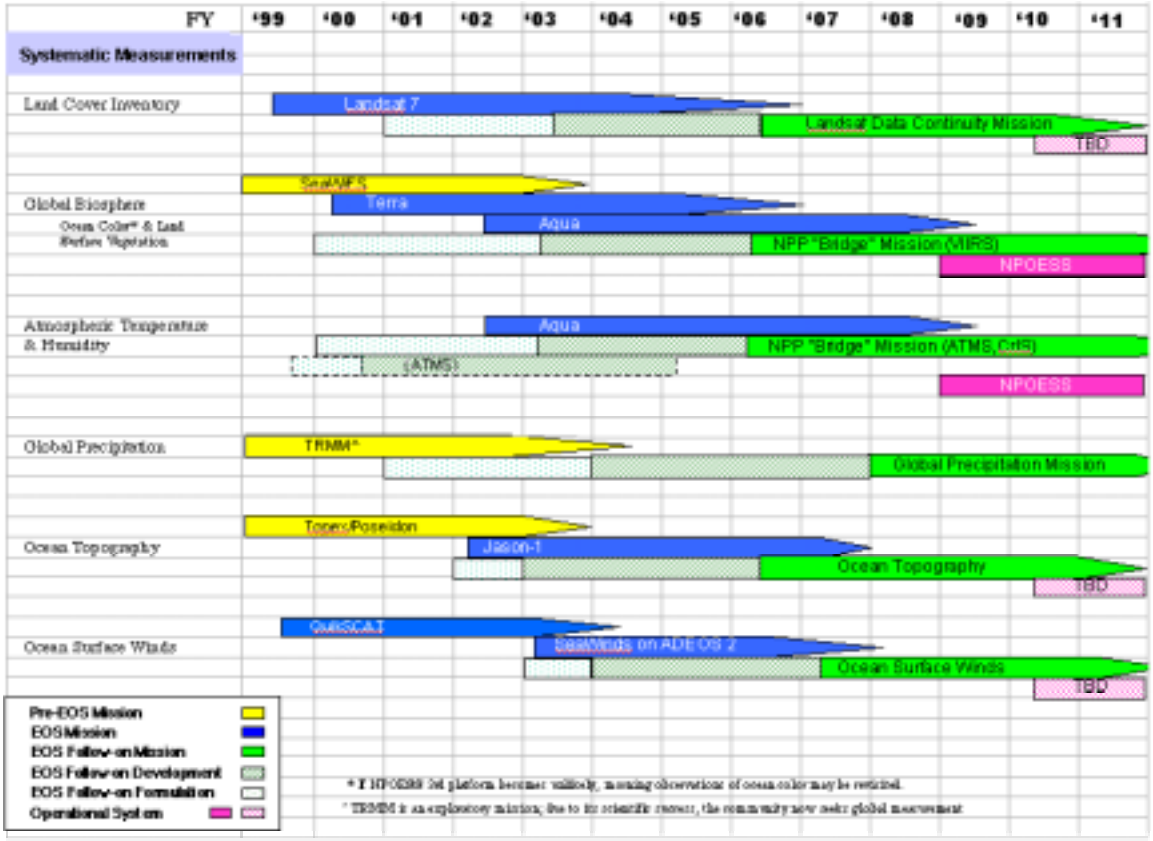
End of system development. Fully integrated with operational hardware and software systems. Most user documentation, training documentation, and maintenance documentation completed. All functionality tested in simulated and operational scenarios. Verification and Validation (V&V) completed.

TRL 9 Actual system "mission proven" through successful mission operations (ground or space)

Fully integrated with operational hardware/software systems. Actual system has been thoroughly demonstrated and tested in its operational environment. All documentation completed. Successful operational experience. Sustaining engineering support in place.

Appendix M: NASA/ESE Systematic Measurements/Missions





Appendix N: Acronyms

AIST	Advanced Information Systems Technology
ARC	Applications Research Center
ASF	Alaska SAR Facility
CA	Cooperative Agreement
CAN	Cooperative Agreement Notice
CCSDS	Consultative Committee for Space Data Systems
CFR	Code of Federal Regulations
DAAC	Distributed Active Archive Center
DLESE	Digital Library for Earth System Education
DMSP	Defense Meteorological Satellite Program
DSS	Decision Support Systems
ECS	EOSDIS Core System
ENSO	El Niño Southern Oscillation
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
EPA	Environmental Protection Agency
ESE	Earth Science Enterprise
ESIP	Earth Science Information Partner
ESMF	Earth System Modeling Framework
ESTO	Earth Science Technology Office
FGDC	Federal Geographic Data Committee
GCMD	Global Change Master Directory
GPRA	Government Performance Results Act
GIS	Geographic Information Systems
IETF	Internet Engineering Task Force
ISO	International Standards Organization
JPL	Jet Propulsion Laboratory
LTA	Long term archive
MPARWG	Metrics Planning and Reporting Working Group
NASA	National Aeronautics and Space Administration
NewDISS	New Data and Information Systems and Services
NGO	Non-governmental Organization
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPG	NASA Policy Guideline
NRA	NASA Research Announcement
NSDI	National Spatial Data Infrastructure
OGC	Open GIS Consortium
PI	Principal Investigator
PM	Project Member
REASoN	Research, Education and Application Solutions Network
RESAC	Regional Earth Science Applications Centers

RFP	Request for Proposal
SAR	Synthetic Aperture Radar
SEEDS	Strategic Evolution of ESE Data Systems
SIMBIOS	Sensor Intercomparison and Merger for Biological and Interdisciplinary Oceanic Studies
SIPS	Science Investigator-led Processing Systems
SIWG	Standards and Interfaces Working Group
SOAP	Simple Object Access Protocol
TRMM	Tropical Rainfall Measuring Mission
USDA	US Department of Agriculture
USG	US Government
USGS	US Geological Survey
UV	Ultra violet
W3C	World Wide Web Consortium
XML	Extensible Markup Language

Appendix O: Reference Endnotes

[1] For information on the Global Change Master Directory, visit http://gcmd.gsfc.nasa.gov/
[2] Information on the National Spatial Data Infrastructure is available at http://www.fgdc.gov/nsdi/nsdi.html
[3] For more information on the Federal Geographic Data Committee, see http://www.fgdc.gov
[4] The President's Management Agenda is available at http://www.whitehouse.gov/omb/budget/fy2002/mgmt.pdf
[5] For information on the President's e-government initiative see http://www.whitehouse.gov/omb/inforeg/egovstrategy.pdf
[6] For ALL references in this announcement to strategy for *research* of the Office of Earth Science, please see, "ESE's Research Strategy for the Next Decade, NASA Earth Science Enterprise Research Strategy for 2000-2010" (NASA, 2000), at http://www.earth.nasa.gov/visions/researchstrat/Research_Strategy.htm
[7] For more on SAR data products available through JPL, go to http://www-radar.jpl.nasa.gov/rgps/radarsat.html
[8] See also http://usingdata.comm.nsdlib.org/ for more on ethical uses of data.
[9] For information on the Government Performance Results Act, visit http://www.whitehouse.gov/omb/mgmt-gpra/gplaw2m.html
[10] Check http://research.hq.nasa.gov/code_y/code_y.cfm under "Current (Open) Solicitations,". for pre-proposal conference information and a link to questions and answers on the CAN.
[11] See NASA Grant and Cooperative Agreement Handbook (http://ec.msfc.nasa.gov/hq/grantd.doc) Section D §1274.204 (b)(1).
[12] For information on NASA's ESE Research Program, see http://www.earth.nasa.gov/Introduction/welcome.html
[13] Op.Cit. #6.
[14] For information on the Earth Science Technology Office and its programs, see http://esto.nasa.gov/
[15] "Earth Science Enterprise Applications Strategy for 2002-2012", Report to Congress from the National Aeronautics and Space Administration, January 2002. (Available at: http://www.earth.nasa.gov/visions/index.html)
[16] Information on the applications areas of the Applications Division, and associated roadmaps, are available at http://www.esnetwork.org.
[17] See http://eosdatainfo.gsfc.nasa.gov/ for information on the EOS Missions' data for missions launched during 1997-2003 timeframe.
[18] "Creative and Innovative Working Prototype Earth Science Information Partnerships in Support of Earth System Science" CAN-97-MTPE-01 May 8, 1997; and "Extending the Use and Applications Of Mission to Planet earth (MTPE) Data and Information to the Broader User Community" CAN-97-MTPE-02 May 8, 1997 (see http://research.hq.nasa.gov/code_y/dynamic.cfm?op_fy=1997).
[19] The ESIP Federation website is at http://www.esipfed.org/.
[20] For more information on Synergy see http://earth-outlook.east.hitc.com:1500/
[21] "President's Management Agenda: Fiscal Year 2002" http://www.whitehouse.gov/omb/budget/fy2002/mgmt.pdf
[22] The Grants and Cooperative Agreement Handbook and related information is located at http://ec.msfc.nasa.gov/hq/grcover.htm
[23] See http://lennier.gsfc.nasa.gov/seeds for all information on SEEDS and the SEEDS Study Teams, and for the NewDISS Document.