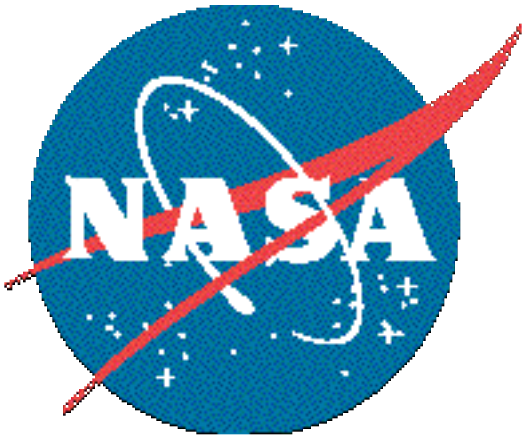

National Aeronautics and Space Administration

January 16, 2001

NRA-01-OES-xx

RESEARCH ANNOUNCEMENT

INSTRUMENT INCUBATOR PROGRAM

Letters of Intent due February 6, 2001
Proposals due March 20, 2001

OMB Approval No. 2700-0087

INSTRUMENT INCUBATOR PROGRAM

NASA Research Announcement
Soliciting Research Proposals
For
Period Ending
February 23, 2000

NRA 01-OES-xx
Issued January 16, 2000

Office of Earth Science
National Aeronautics and Space Administration
Washington, DC 20546

EARTH SCIENCE ENTERPRISE (ESE)
INSTRUMENT INCUBATOR PROGRAM (IIP)

The National Aeronautics and Space Administration (NASA) announces the solicitation of proposals for the Instrument Incubator Program (IIP), a technology development program in support of the Earth Science Enterprise (ESE). The IIP seeks proposals for technology development activities leading to new system and subsystem level airborne and space-based measurement techniques to be developed in support of ESE science research and applications.

I Introduction

(a) Earth Science Enterprise

The mission of NASA's Earth Science Enterprise (ESE) is to develop a scientific understanding of the Earth system and its response to natural or human-induced changes and improve prediction capabilities for climate, weather, global air quality and natural hazards. The Earth science research program aims to acquire a deeper understanding of the components of the Earth system and their interactions. These interactions occur on a continuum of spatial and temporal scales ranging from short-term weather to long-term climate scales, and from local and regional to global scales. The Enterprise also seeks to provide accurate assessments of changes in the composition of the atmosphere, the extent and health of the world's forest, grassland, agricultural resources, and phenomena that lead to natural hazards.

The ESE program is and will continue to operate in a restrictive budget environment for the foreseeable future. Consequently, a major objective of the ESE science program is to achieve lower cost science measurements. An effective way to achieve this objective is to implement future missions with small instruments. Though not all science measurements lend themselves to small instrument designs, large, expensive scientific instruments will generally not be affordable in this new environment and innovation is essential to the future success of the ESE science program. A major part of this enabling process is the rapid development of small, less costly instruments.

Small instruments will allow small launch vehicles and thus lower mission costs or conversely, greater science return for comparable costs. Similarly, smaller airborne instruments could enable greater science return by requiring lower volume, power and weight resources. In addition, for space-based remote sensing, it is anticipated that commercial rather than custom spacecraft will be used for many missions. These commercial spacecraft will only support smaller payloads and simplified, common interfaces.

(b) Instrument Incubator Program

The objectives of the IIP are to identify, develop and, where appropriate demonstrate new measurement technologies which:

- Reduce the risk, cost, size, and development time of Earth observing instruments, and
- Enable new Earth observation measurements.

The IIP is designed to reduce the risk of new, innovative instrument systems so that they can be successfully used in future science solicitations in today's fast track (3 year) acquisition environment. Figure 1 shows the idealized relationship between the IIP and development of future missions.

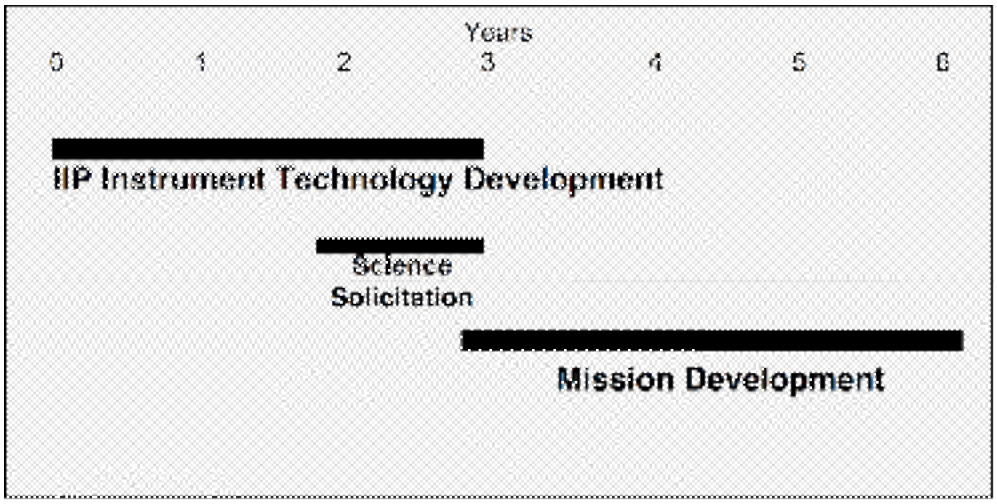

Figure 1 Idealized Relationship between IIP and Future Flight Missions

Critical to this design is the relationship between the various technology development programs that the ESE has available to enable missions. Within this development environment, the IIP will rely upon the Advanced Technology Initiatives Program (ATIP) and the New Millennium Program (NMP) for instrument component technology development and space flight validation, respectively. Technology Readiness Level (TRL) is a systematic metric/measurement system that supports assessments of the maturity of a particular technology and the consistent comparison of maturity between different types of technology (see Appendix E for TRL definitions). Figure 2 shows the Technology Readiness Levels for these programs and future science missions.

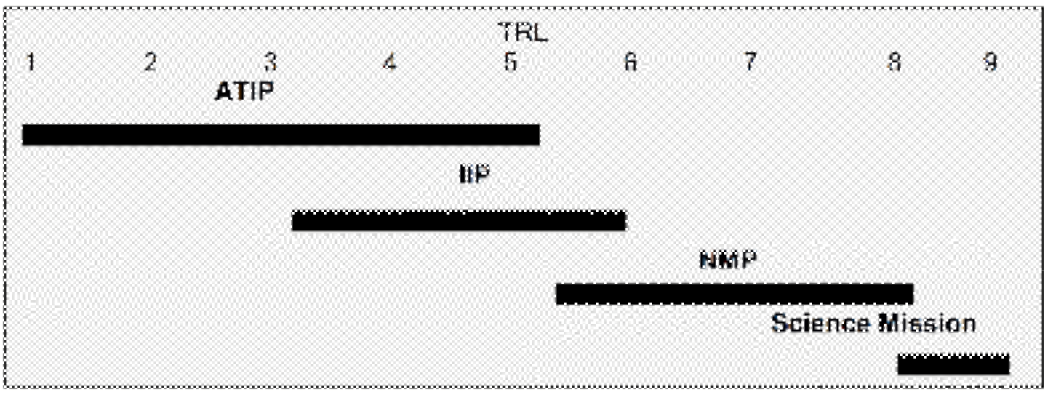

Figure 2 TRL Ranges for Technology Development Programs

II NASA Research Announcement

(a) Goals

This NASA Research Announcement solicits instrument design, engineering model construction, lab demonstrations, and field demonstrations for innovative measurement techniques that have the highest potential to meet the goals of the IIP and the measurement capability requirements of the ESE.

The IIP is envisioned to be flexible enough to accept instrument and measurement concepts at various stages of maturity (see Figure 3), and through appropriate risk reduction activities (such as requirements analysis, design, construction of laboratory breadboards and engineering models, and

field demonstrations on the ground or on airborne platforms), advance the system's technology readiness level to that necessary to compete successfully in future science solicitations or New Millennium Program space flight demonstrations . The proposer must define the starting point for the instrument or measurement technique and the exit or success criteria for their proposal activity.

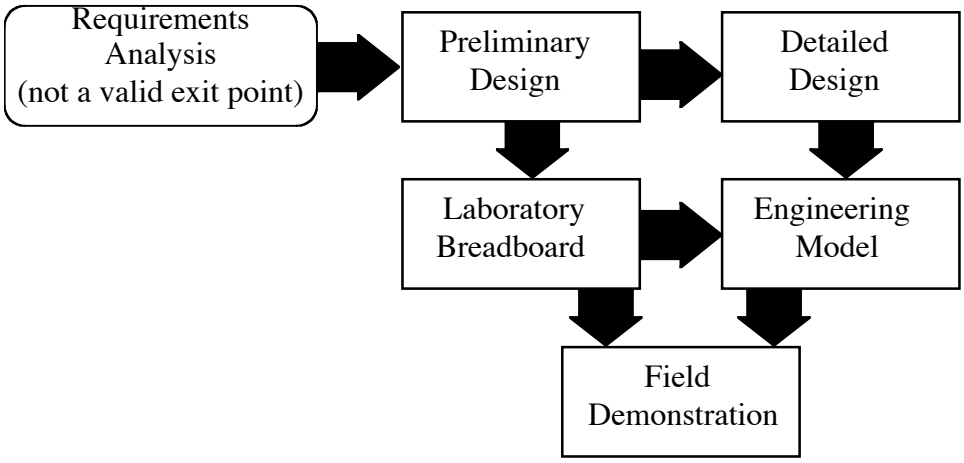

Figure 3 Entry and exit points defined by proposer

(b) Proposal Research Topics

The first Instrument Incubator solicitation, released in 1998, was a broad announcement open to all areas of Earth Science. This current solicitation is focused on areas needing near term investment to support high-priority measurements.

The *NASA ESE Research Strategy for 2000-2010* describes the Enterprise goal of obtaining a scientific understanding of the entire Earth system on a global scale. This involves several challenges. The first challenge is the characterization of the present state of the Earth system and the forcings that affect the Earth System to serve as the baseline information for research. A second challenge is the quantitative description elucidating how the Earth system's component parts and the interactions between them have evolved, how they function, and how they may be expected to continue to evolve on all time scales. The last challenge is to develop the capability to predict those changes that will occur in the future over seasonal, interannual, decadal, and even longer time scales, both naturally and in response to human activity.

The strategic objective of the Enterprise is to provide scientific answers to the overarching question:

How is the Earth changing and what are the consequences for life on Earth?

The key research topics studied by NASA's Earth Science Enterprise fall largely into three categories: forcings, responses, and the processes that link the two and provide feedback mechanisms. This conceptual approach applies to all research areas of NASA's Earth Science program, although it is particularly relevant to the problem of climate change. The scientific strategy to address this complex problem can be laid out in five fundamental questions, each raising a wide range of cross-disciplinary science problems.

- *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 change in the Earth system for human civilization?*
- *How well can we predict the changes to the Earth system that will take place in the future?*

While these five questions define a logical progression in the study of global change, each one covers a range of topics too broad to serve as a simple guide for program implementation. The IIP program must also anticipate implementation timelines and readiness for future missions. For the purpose of this announcement, more specific research questions are presented below and are articulated in the ESE Research Strategy for 2000-2010. Given the three-year timeline for the IIP program and the goal of a three-year time interval between mission selection and launch, successful IIP proposals are anticipated to contribute to missions in 2007 and beyond. The science questions identified here as priorities for this announcement are those for which the highest priority for technology development to enable missions in the 2007 timeframe is needed. The questions below are the complete set of research topics solicited by this NRA and no priority should be construed from their relative order below.

Atmospheric Chemistry: Tropospheric profiles of O_3, CO, NO_x

- ***What are the effects of regional pollution on the global atmosphere, and the effects of global chemical and climate changes on regional air quality?***

Understanding and predicting tropospheric transport, physics and chemistry will be a frontier area of atmospheric research for the next decade and probably beyond. Tropospheric chemistry poses an interdisciplinary challenge for the Earth science community. These are global scale problems that are particularly well suited to the use of space observations and correlative *in situ* measurements. Knowledge of these phenomena is needed to evaluate the effects of chemical changes on the global hydrological cycle, the cycling of nutrient compounds through the earth environment, the accumulation of greenhouse gases, the acidity of rain and snow, and the formation of ozone in the troposphere.

The growth in human population and the increasing levels of industrial activity, especially in developing countries are likely to combine and lead to dramatically increased gaseous and particulate matter pollution of the atmosphere in some parts of the world (e. g. south and east Asia and Latin America), with attendant consequences for human health and ecosystem productivity. There is evidence that pollutant gases from densely populated regions, notably carbon monoxide, sulfur dioxide and oxides of nitrogen, can be transported over very large distances by the atmospheric circulation, thus causing air quality problems in regions far removed from the sources. It has been recognized recently that the transport of pollutants in the troposphere takes place principally within thin layers that may extend over very long distances. Such long-distance transport creates risks of increased pollution far away from the sources, for instance pollutants from one continent crossing the ocean to another. Surface air quality data have given support to such connections. Such long-range transport is also capable of transporting nutrients over long distances (for example, from the Saharan desert to the subtropical Atlantic Ocean or the Amazon) and thus play an important role in ecosystem productivity and biogeochemical cycling for a broad range of nutrients.

Tropospheric profiles of O_3, CO, NO_x

Two specific challenges need to be addressed to effectively investigate tropospheric chemical processes: horizontal/vertical resolution and temporal sampling. Tropospheric ozone is expected to show considerable vertical stratification and fine horizontal structures that contain information on the origin and age of important species. Likewise, the altitude distribution of upper tropospheric ozone is a critical parameter in climate models. Temporal and horizontal variability is also important, including significant diurnal variations. The current vision for meeting these

measurement challenges involves a combination of approaches. Spectral imaging from geostationary or L-1 orbit could provide the necessary high temporal and horizontal resolution to observe rapidly evolving chemical events and quantify export from large source regions to the global atmosphere. Active remote-sensing (lidar) observations from low Earth orbit could possibly provide high vertical resolution to observe ozone and aerosols layers, and quantify the chemical, transport and radiative consequences of these vertical structures.

Solid Earth: Topography and the Deformation of Land and Ice

- ***How is the Earth's surface being transformed and how can such information be used to predict future changes?***

The Earth's surface is shaped by powerful tectonic and gravity forces as well as the interaction with the Earth's atmosphere and oceans through forces including wind, temperature change, precipitation, ice and fluvial flow. Characterizing, understanding and predicting these forces and the response of the Earth's lithosphere and cryosphere will lead to better utilization of natural resources including water and land use, the mitigation of natural hazards such as earthquakes, volcanoes, flooding, sea level change, and severe storms, as well as a fundamental improvement in understanding the Earth system.

NASA developed airborne and space-borne technologies have made very significant contributions to the study of the solid Earth, its topography and surface change. Space geodesy now provides a millimeter scale reference frame that enables the accurate measurement of land, ocean, and ice cap topography. Airborne and space-borne synthetic aperture radar (SAR) and lidar technologies provide a new geodetic imaging capability for the mapping of surface topography and its change. Last year's Shuttle Radar Topography Mission (SRTM) provided the most accurate mapping yet of the Earth's topography, measuring most of the Earth's surface in just ten days with decameter precision. Space-borne gravity and altimetry missions such as GRACE, Icesat, and Jason will soon track changes in ocean and acquifer mass as well as the complementary changes in ice mass stored in the polar ice caps. These measurement strategies for topography and surface change are supported by strong interdisciplinary modeling programs. NASA's unique observing tools permit large-scale measurements, support quantitative analysis, and provide a global perspective that allows comparison among different regions of the planet within a common geodetic reference frame.

Topography and Surface Change

There is strong community wide sentiment that space-borne and airborne measurement of topography and surface change will lead to significant near term advances in the understanding of earthquakes, volcanoes, landslides, flooding, acquifer charge, cryospheric dynamics, and coastal zone interactions. Interferometric SAR (INSAR) capable space-borne radars such as SIR-C, ERS-1/2, and JERS-1 detected subtle changes in land surface response to tectonic forces, volcanic inflation, and acquifer depletion. There is a need to develop supporting technologies that will permit more efficient and flexible airborne and space-borne geodetic imaging including, onboard processing, bistatic technologies, and real time dynamic positioning to accommodate repeat pass interferometry.

Airborne lidar measures topography with centimeter scale vertical resolution and meter level horizontal resolution in the presence of vegetative cover. NASA's Solid Earth and Natural Hazards program seeks to develop a wide swath space-borne lidar to measure decimeter level topography with meter level postings to provide global high accuracy measurement of selected targets such as coastal zones, flood plains, or fault zones to enable more rapid risk assessment and geological analysis. Real time, high accuracy positioning technologies are required to provide accurate sensor positioning and enable more advanced onboard processing.

Gravity and Geomagnetic Field Measurements:

Geopotential field measurements are currently the only space-borne techniques available to significantly penetrate the Earth's sub-surface. Space-borne gravity sensors can provide a very sensitive measurement of regional changes in mass associated with the dynamics of the cryosphere, hydrosphere and atmosphere. The GRACE gravity mission will recover temporal variations in the Earth's gravity field enabled by new positioning and accelerometer technologies. The interpretation of the GRACE data set will rely upon surface air pressure estimates to isolate changes in the hydrosphere and cryosphere from atmospheric mass flux. Presently the estimation of surface air pressure is dependent upon global circulation models and relatively sparse surface measurements. Instrumentation to provide accurate space-borne measurement of surface air pressure at mesoscale or better resolution will greatly improve the utility of future space-borne gravity measurements. Also, technologies to extend the accuracy of space-borne gravity measurements are highly desirable including space-borne accelerometers, gravity gradiometers, ranging systems, and high resolution surface air pressure mapping instruments.

Geomagnetic measurements provide a second means to study the structure and dynamics of the Earth's interior. Space-borne magnetic measurements are the best means of accurately measuring the geomagnetic field and its secular variations. Extrapolations of secular change yield new insights into the dynamics of the Earth including decadal scale changes in the length of day and a mechanism for regional subsidence of the Earth's surface. Spatial and temporal changes in the Earth's geomagnetic field are also linked to structural, petrologic, electrical, and perhaps stress related variability in the Earth's upper crust. Magnetospheric and ionospheric disturbances significantly add to the observed field and complicate the separation of the main geomagnetic field and crustal sources. Significant advances in geomagnetic probing of the Earth's interior will come from high-resolution synoptic and continuous field measurement through a constellation of geomagnetic nanosatellites or sensor flights of opportunity. Solid Earth science applications require accurate high frequency measurement of the Earth's magnetic field vector to better than one part in 100,000 because measurements are compared over decadal time scales. Present day systems with this accuracy are not suited to nanosatellite applications or sensors flights of opportunity. A cost effective space-borne low power and low mass magnetometer capable of providing an accurate high frequency vector measurement including attitude and positioning is required to develop the synoptic continuous observation of the geomagnetic field.

Global Carbon Cycle: CO_2 Column Abundance and Profile

- ***What trends in atmospheric constituents and solar radiation are driving global climate?***

In recent times the most significant anthropogenic forcing of the planetary environment has been the modification of the composition of the atmosphere, leading to rising concentrations of a number of reactive and radiation absorbing gases that contribute to depleting the stratospheric ozone layer and to increasing the atmospheric greenhouse effect. Measurements at the Mauna Loa observatory and several other stations have documented a recent upward trend of about 0.4% per year in atmospheric carbon dioxide (CO_2), amounting to a 30% increase in global atmospheric concentration since the beginning of the industrial era. The buildup of atmospheric CO_2, driven by the combustion of fossil fuels along with deforestation and other changes in land use, is the largest contributor to the global increase in the greenhouse effect. Quantifying the fraction of CO_2 from anthropogenic sources that accumulates and remains in the atmosphere (about half of total emission) is, in itself, a very complex problem, considering that CO_2 fluxes from the combustion of fossil fuels and changes in land use are but a small fraction of the large natural fluxes between atmospheric, terrestrial ecosystem, and oceanic reservoirs. However, since the natural processes

have been "in balance" even seemingly small perturbations in the sources and sinks due to human activity can lead to significant changes in atmospheric CO_2 levels.

CO_2 Column Abundance and Profile

Every region of the Earth's surface with a major carbon dioxide source or sink leaves a signature of excess or depleted carbon dioxide in the overlying troposphere. Available *in situ* measurements of near-surface atmospheric carbon dioxide concentrations have been used recently to constrain inverse models of atmospheric transport and predict hemispherical scale distributions of carbon sources and sinks. However, deficiencies in the geographic coverage and spatial distribution of these observations severely limit the utility of the inverse modeling approach. An ability to make direct space-based measurements of atmospheric carbon dioxide concentrations, with sufficient accuracy and precision, would provide the needed global coverage and overcome problems with surface measurements within continents. Such observations would make it possible to identify, and at least roughly quantify, regional and sub-regional sources and sinks of carbon dioxide and to further constrain the location and/or identity of the missing global carbon sink(s). Advances in solid-state laser technologies suggest that it may be possible to make precise active remote sensing measurements of the total column and vertical profile abundance of carbon dioxide. Simulations also show that a high-resolution spectrometer employing solar flux reflected from the ground could possibly provide precise measurements of total column carbon dioxide. Measurements of the carbon and oxygen isotopic composition of atmospheric carbon dioxide also might be possible. NASA is interested in such space-based carbon dioxide measurements and the potential for a future mission focused on carbon cycle dynamics which may be able to provide the observations needed to help answer the questions posed above.

Global Water and Energy Cycle: Precipitation Rate, Tropospheric Winds, Sea Surface Salinity/Soil Moisture

- ***How are global precipitation, evaporation, and the cycling of water changing?***

According to model predictions, the most significant manifestation of climate change would be an acceleration of the global water cycle, leading to increased global precipitation, faster evaporation and a general exacerbation of extreme hydrologic regimes, floods and droughts. Since the release of latent heat associated with condensation is the principal source of energy for rapid cyclogenesis, a more active water cycle would generate more frequent and/or more severe weather disturbances. Paleoclimatic and historical records indicate the occurrence of devastating floods and droughts in past times but these ancient hydrologic events do not constitute compelling evidence of global change in the hydrologic cycle, as most regional anomalies are just manifestations of local weather variability. Knowledge of global atmospheric energy and water budgets, as well as global precipitation, is needed in order to investigate the existence of significant global trends in the rate of the water cycle.

Precipitation Rate

Precipitation information can be inferred from passive microwave imaging radiometer data acquired by existing operational environmental satellites (DMSP) and eventually NPOESS. Recent results from the Tropical Rainfall Measuring Mission (TRMM) show that the detailed cloud particle profile information provided by an active microwave sensor (Precipitation Radar) can be used effectively to improve the accuracy of rain rate estimates based on passive microwave measurements only. However, none of the existing or planned operational systems (nor *a fortiori* the single EOS Aqua mission) will provide sufficient sampling frequency globally (repeat interval of 3 hours or less) to capture the considerable spatial and temporal variability of precipitation events and provide a

reliable estimate of total rainfall. New ideas and developments that may contribute to the concepts for a global precipitation measurement are sought.

Global Tropospheric Winds

Direct observation of the global wind field would be extremely valuable for numerical weather prediction, as well as scientific diagnostics of large-scale atmospheric transport, weather systems, and boundary layer dynamics. Because of the lack of reliable, sufficiently dense, and accurate wind observations, uncertainties in model-derived estimates of divergent flow component of the global atmospheric circulation constitute a serious limitation in our understanding of the global energy cycle and the atmospheric transport of water, energy, and chemical species.

For over 20 years, researchers have been pursuing the development of Doppler lidar techniques for measurement of atmospheric winds in clear air. Space-based lidar observations of atmospheric winds constitute a significant challenge in terms of sensitivity, accuracy and spatial coverage. Yet, given their importance to both scientific research and operational weather forecasting, the demonstration of Doppler lidar wind measurement from space could be a promising operational precursor mission. On the other hand, much technological progress leading to the development of more powerful, more energy-efficient and more reliable lasers is needed in order to realize the full potential of this active sounding technique for scientific research and applications.

Wind information can also be inferred from the motion of clouds (or patches of moist air) observed by geostationary satellites. Such measurements currently lack precision, especially in the assigned altitude level of the observed wind vectors but future high-resolution geostationary imager-sounder instruments may provide useful tropospheric wind profile information to follow, hour-by-hour the evolution of severe weather disturbances, notably hurricanes. Concepts that meet this challenge are sought.

Soil Moisture

At present soil moisture is the only primary hydrologic variable that cannot be measured at large spatial scales. Scientific evidence shows that soil moisture is the most significant indicator of the state of the terrestrial hydrologic system, and is the governing parameter for partitioning rainwater among evaporation, infiltration, and runoff. Soil moisture also plays a critical role in vegetative processes and provides the critical link between the physical climate system (water and energy) and biogeochemical cycles. Recent research has demonstrated that knowledge of soil moisture enhances predictability of summertime precipitation over much of the U.S.

The unresolved problems in measuring soil moisture from space are obtaining useful signals under a substantial vegetation canopy and reaching a useful depth within the uppermost soil layer while, at the same time, achieving useful spatial resolution (on the order 10-30 kilometers) and temporal sampling (repeat intervals of 1 to 3 days). To make these measurements using passive or active techniques requires large real or synthetic apertures in the low-frequency range of the microwave spectrum.

Another potentially promising measurement concept is the gravimetric determination of changes in soil water storage, based on extremely precise observation of time-dependent changes in the Earth gravity field. The experimental GRACE gravity-mapping mission will explore the extent to which this concept is applicable to land hydrology but there is potential that improved measurement technology using this approach could lead to improvements in this class of measurement, and is thus relevant for consideration here.

Climate Variability and Prediction: GPS Altimetry and Ocean Surface Winds

- ***How is the global ocean circulation varying on interannual, decadal, and longer time scales?***

The circulations of the Earth's oceans and the global atmosphere provide the mechanism by which the excess energy received from the Sun in the tropics is redistributed to the whole planet. Heat transport by the oceans amounts to about half the cycling of heat from equator to pole. The oceanic circulation also controls the supply of nutrients that feeds marine productivity and modulates the global biogeochemical cycles (notably, the carbon cycle). Any significant change in the oceanic circulation that results in variations of ocean surface temperature patterns has an immediate impact on atmospheric winds, weather and climate. The best known among these variations are the transient changes associated with El Niño/Southern Oscillation (ENSO) phenomena. The existence of other modes of variability is surmised, but establishing the statistical robustness of such preferred modes, characterizing the mechanism that may cause them, let alone predicting their future evolution and their impact on climate, are major scientific challenges. A record of variations in the global ocean circulation is essential information needed to address this problem.

Characterizing and understanding the current variations in global ocean circulation calls for new global space-based observations of oceanic variables (such as salinity, mentioned above), as well as development of modeling tools to assimilate such satellite data together with a wide range of contemporaneous *in situ* oceanographic measurements. The principal NASA research in this domain will be understanding the dynamics of the ocean circulation and developing the capability to predict the response of the ocean circulation and sea ice to changes in surface forcing, on the basis of relatively short global oceanic data sets spanning only 10-20 years. As global oceanography is still in a development stage, scientific progress is critically dependent upon improved global observations of the ocean circulation, sea-ice, and surface fluxes of momentum, heat, and fresh water.

Global Sea Surface Topography and Surface Winds

The precision encoded transmission of GPS has found many applications. Reflections of these signals off the sea surface are being examined for possible use as a source of wind speed and ocean surface topography information. The forward scattered GPS waveform depends on the roughness of the sea surface. The characteristics of the surface can be determined from the distribution of the reflected signal as a function of delay and Doppler shift. Wind speed is estimated using surface roughness models. Altimetric information can also be obtained although with significantly less accuracy than current radar altimeters. However, this measurement is still promising because of the significant increase in temporal/spatial coverage that might be obtained to complement precision altimetry missions. Scattering by the rough sea surface strongly attenuates the ocean-reflected GPS signal compared to that over a perfectly smooth ocean. For satellite reception, the large distance from the scattering surface accentuates this attenuation problem and significant increase in receiver antenna gain will be required and remains a technological challenge of interest here.

(c) Technology Readiness Level (TRL) Guidance

The proposer must define the starting point TRL, the exit TRL, and success criteria for their proposal activity. Past and ongoing work in the research activity should determine the entry point. Research within this NRA will be restricted to an exit TRL less than or equal to 6. The proposer should seek an alternate technology program for developments that exceed TRL 6 (see Appendix E). For this solicitation, the entry TRL can be from 3 to 5. Over the duration of the research, the activity must advance by at least one TRL. For example, an activity can enter the technology development activity at TRL 4 and exit at TRL 5 or 6. These limitations naturally preclude space qualification from being performed in the IIP Program. The results at the exit point should provide convincing evidence that the instrumentation can make the proposed measurements and that an operational instrument can be built within the context of the new shorter acquisition cycles.

Each proposed instrument development should include an evaluation of feasibility, requirements analysis, instrument design, construction of breadboards, and/or construction of an engineering model. All proposed efforts should include evaluation of anticipated performance and an estimate of the entry and exit TRL. To aid in the planning of future, potential technology activities, the proposal should also include an estimate of the resources (cost and schedule) to develop a flight quality instrument and documentation of technology dependencies. An instrument or measurement design concept or actual design should be produced as well as a concept for data product generation. These items will be documented as contract deliverables.

Laboratory and field demonstrations may be funded and are expected to produce a working instrument or specific instrument subsystems (breadboard or engineering model) and data documenting performance measured either in the laboratory or in the field. The final report should document these measurements.

(d) Relationship to Other Programs

For technology infusion to take place according to some predetermined timetable, appropriate funding must be applied at each stage or readiness level associated with the development of a specified end item. The OES is responsible for planning technology development activities so that all technological risk is retired prior to a mission Announcement of Opportunity. A focused, requirements driven approach with direct project connectivity is proposed to effectively harness supplier capabilities and leverage available funds. NASA technology programs that may be applicable to the IIP are the Cross-Enterprise Technology Development Program, the Advanced Technology Initiatives Program and the New Millennium Program. The ESE actively pursues opportunities to invest in technology developments funded by sources outside the Enterprise or NASA.

(i) Cross-Enterprise Technology Development Program

The Cross-Enterprise Technology Development Program (CETDP) is NASA's primary vehicle for undertaking basic research within the agency to enable planned missions, stimulate new concepts for missions not yet conceived, and to confront directly the grand challenges that face the agency in the first decade of the 21st century. The program moves technology readiness from articulation of initial concept through laboratory demonstration, and leads to infusion to enterprise-specific, focused programs to ensure robustness and space qualifiability. The IIP could draw on components developed in the CETDP.

(ii) Advanced Technology Initiatives Program

The Advanced Technology Initiatives Program (ATIP) is an ESE-funded program designed to advance ESE instrument components and subsystems in the following classes:

1. innovative component and subsystem developments that enable new measurement implementations and science investigations,
2. component and subsystem developments that improve current implementations in order to reduce life cycle cost and development risk, and
3. selected technologies that advance the state-of-the-art in the selected domain and that have the potential to impact a broad set of future missions which are relevant to ESE strategy.

Instrument technologies developed in the ATIP could be used in IIP.

(iii) New Millennium Program

NASA created the New Millennium Program (NMP) to enable exciting 21st century missions by the identification, development, and space flight validation of emerging technologies. In order to fulfill program goals, affordable missions with highly focused objectives are chosen that also enhance scientific capability. The program encourages revolutionary and breakthrough technologies that traditionally have been difficult to incorporate into a science mission because of the inherently high risk associated with their first use. Key areas include lower mass systems to reduce launch costs, greater autonomy in space and on the ground to cut operations overhead, and shorter project life cycles to increase mission frequency.

The ESE Technology Program will depend upon NMP for space flight validation, where necessary, of instruments developed in IIP.

(e) International Participation

This announcement is open to the international science and technology community. International cooperative proposals, with co-investigators from U.S. institutions participating in foreign-led proposals or with co-investigators from non-U.S. institutions on the teams of proposals from U.S. institutions, are also encouraged. These proposals should be on a "no-exchange-of-funds" basis for their non-U.S. elements and should identify any requirements for NASA financial support for U.S. participants. Proposals from non-U.S. institutions are encouraged, but only on a "no-exchange-of-funds" basis. Specific instructions for proposals from non-U.S. institutions are included in Appendix C.

(f) Period of Performance

The minimum period of performance is one twelve (12) month phase. The total proposed period of performance must not exceed 36 months. It is expected that awards covering more than one twelve month phase will be handled as contract options with no guarantee that any options will be funded.

(g) Funding

The U.S. Government's obligation to make awards is contingent upon the availability of appropriated funds from which payment for award purposes can be made and the receipt of proposals that are determined to be acceptable by the Government for award under this announcement. Funding of the successful proposals will be via a contract. Interagency agreements will be issued, though grants will *not* be awarded for this solicitation. Because the Government has limited funds for this solicitation, cost overruns encountered during execution of the award will not be funded. Subject to availability of funding, the Government expects to make approximately 8-12 awards under this solicitation, with each award having an annual cost in the approximate range of $500,000 to $2 million. Since awards may span one to three years, the total cost range for each award is $500,000 to $6 million.

(h) Reference Material

This announcement and appendices are available on the Earth Science Enterprise home page on the World Wide Web (WWW), at http://www.earth.nasa.gov/ (look under "Research Opportunities").

The draft *NASA ESE Research Strategy Plan 2000-2010* is available on the World Wide Web at http://earth.nasa.gov/visions/ (look under "Strategies and Policies")

The Earth Science Technology Office (ESTO) hosts a World Wide Web page, http://esto.gsfc.nasa.gov, that can be a source of information on the various elements of the Earth Science Technology Program.

(i) Guidance to proposers; Procedures

Participation in this NRA or a subsequent similar NRA is not a prerequisite to selection as a science investigation as part of any future ESE NRA or AO. Similarly, participation in this NRA does not guarantee continued participation in the IIP or success in any future ESE NRA or AO competitions. Successful participation in this NRA is intended to give innovative measurement techniques the scientific and technical pedigree they need to compete in relevant ESE solicitations against any good ideas developed elsewhere. Solicitations similar to this announcement will be issued periodically to select additional instruments for development and demonstration.

All prospective proposers are strongly encouraged to submit a letter of intent to propose to NASA in response to this announcement. This letter will help to scope NASA's planning for the peer review process. The notice of intent should be submitted via email to *OESresponse@hq.nasa.gov* or fax to 202-479-0511. The notice of intent should include the following information:

- NRA number
- PI and Co-I names and addresses (including zip + 4)
- Title of proposal
- Telephone and fax numbers of PI
- Email address
- Brief summary of the proposed work (not to exceed 300 words)

For this announcement, proposals will be submitted electronically via an Electronic Handbook. Proposals should be prepared and submitted in accordance with specific information provided in Appendices A-F of this Announcement. Appendix A provides additional instructions for proposers to this announcement. Appendix B contains the general instructions needed for preparation of solicited proposals in response to NASA Research Announcements. Appendix C provides the list of required declarations and the proposal cover sheet. Appendix D contains the required budget summary format. Appendix E contains a definition of technology readiness levels. Appendix F contains a list of acronyms used. All proposals submitted to NASA in response to this announcement must have a completed cover-sheet-form and information on current and pending research support from all other sources (see Appendix C) attached. All proposals from investigators from the U.S. and other countries will be reviewed and evaluated by NASA.

Submit proposal electronically to:

http://www.esto.gsfc.nasa.gov
Under IIP-01 Solicitation

Submit paper copy proposal to:

ESE IIP NRA
NASA Peer Review Services, Code Y
500 E Street, SW, Suite 200
Washington, DC 20024-2760
(For overnight delivery purposes only, the recipient telephone number is 202-479-9030)

Selecting Official:

Associate Administrator, Office of Earth Science
NASA Headquarters

Point of Contact for Solicitation:

Lucien Cox, Program Coordinator
Office of Earth Science/Code YF
NASA Headquarters
Washington, DC 20546-0001
Tel: (202) 358-0775
Fax:(202) 358-2769
lcox@hq.nasa.gov

Point of Contact for Science:

Dr. Eric J. Lindstrom
Office of Earth Science/Code YS
NASA Headquarters
Washington, DC 20546-0001
Tel: (202) 358-4540
Fax:(202) 358-2770
elindstr@hq.nasa.gov

Point of Contact for Implementation:

Frank Peri, Program Manager
Earth Science Technology Office
NASA Goddard Space Flight Center, Code 710.1
Greenbelt, MD 20771
Tel.: (301) 286-9475
Fax: (301) 286-2756
frank.peri@gsfc.nasa.gov

Proposals submitted to NASA Headquarters will cause a delay in receipt of your proposal, therefore, please adhere to "Submit proposals to" noted above.

(j) Selection Schedule

All proposals submitted in response to this announcement are due in accordance with the schedule shown below. Late proposals will not be considered for review and funding, unless it is judged to be in the interest of the U.S. Government.

A proposal schedule is given below:

Bidder's Conference	January 23, 2001
Letter of Intent to Propose due	February 6, 2001
Proposals due	March 20, 2001
Announcement of Final Selections	May 2001

Your interest in participating in this opportunity is heartily welcomed.

Ghassem R. Asrar
Associate Administrator for
Office of Earth Science

Enclosures:

Appendix A. Specific Guidelines for Proposers
Appendix B. Instructions for Responding to NASA Research Announcements
Appendix C. Proposal Cover Sheet, Formats, Forms, and Required Declarations
Appendix D. Budget Summary
Appendix E. Definition of Technology Readiness Levels
Appendix F. List of Acronyms Used in this Research Announcement

APPENDIX A

SPECIFIC GUIDELINES FOR PROPOSERS

I. Evaluation Factors

The following evaluation factors will be used to evaluate the proposals. They replace and supersede those contained in Appendix B, paragraph (i) Evaluation Factors.

Factor 1: Applicability to ESE Science Measurements and Technology Needs (40% of total value)

1. The proposal's relevance and potential contribution to NASA's Earth Science Enterprise.

2. The potential for the measurement system to reduce the risk, cost, size, and development time of ESE systems, or to enable a new measurement that cannot now be made. Potential cost reductions should be clearly stated and substantiated to the extent possible, with supporting analysis that indicates scalability.

3. The potential of the measurement system to be integrated, once matured, into an operational agency/nongovernmental measurement system.

4. The potential for the measurement system to be have commercial benefits.

Factor 2: Technical Merit (30% of total value)

1. Feasibility and merit of the proposed technical approach to achieve the technology development objectives.

2. Degree of innovation of the proposed study or technology development concepts and approach.

3. Substantiated justification and appropriateness of the entry and exit technology readiness level (TRL).

Factor 3: Cost and Programmatic Realism (30% of total value)

1. Adequacy and realism of proposed milestones.

2. Realism and reasonableness of the proposed cost and available funds.

3. Adherence to sound and consistent management practices appropriate to the TRL level of the proposed task.

4. Past performance and related experience in the proposed area of technology development.

5. Qualifications of key personnel, and adequacy of facilities, staff, and equipment to support the proposed activity.

6. Commitment of the organization's management to the proposed technology development (evidenced by cost and resource sharing, prior teaming arrangements, etc.). Proposers should identify any previous investment by the organization/program and provide supporting documentation.

II. Proposal Development Guidance

The technical proposal must address each of the items below, which supplement the guidance provided in Appendix B, Paragraph (c)(4).

A. Applicability to ESE Measurements – Describe the benefit to future ESE science measurements (as defined in this NRA in Section II, Paragraph (b) Proposal Research Topics) that could utilize the proposed measurement system. *Failure to describe relevancy to a specific research topics may be a cause for non-selection.*

B. Description of Proposed Technology - Provide a description of the proposed measurement system technology. Describe the technical approach and include an operational concept or use scenario of the proposed measurement system technology that address ESE needs.

C. Comparative Technology Assessment – Describe the anticipated advantages of this measurement system technology compared to those currently in use - e.g., reduction of size, mass, power, volume or cost, improved performance, or enabling of a new capability not previously possible. Review the current state of the art and relate to the proposed work.

D. TRL Assessment – Provide the current TRL assessment of the measurement system technology, and the anticipated progression of TRL levels throughout the proposed effort. See Appendix E for guidance on Technology Readiness Levels. *Failure to report TRL assessments may be cause for non-selection.*

E. Research Management Plan – Provide a statement-of-work that concisely describes each task or milestone to be accomplished in the course of the research and development. Also, include a milestone chart that identifies critical dates and deliverables in the research and development program. At least two milestones per twelve (12) month period should be defined. Identify the roles of key personnel.

F. Budget – Full cost accounting (FCA) is required in all proposals, including those submitted by U.S. Government agencies. To assist in the selection process, Government proposals should be submitted with budgets that clearly indicate the costs with and without FCA. Cost sharing or matching arrangements should also be indicated, if applicable. Appendix E describes the requested budget summary format. In addition, a monthly cost plan should be submitted to facilitate contract negotiation. *Failure to provide complete budget information as requested in Appendix E may be a cause for non-selection.*

III. Proposal Submission Guidance

Appendix B, Paragraph (e) is revised as follows:

The maximum length of each proposal is limited to 15 non-reduced, single-space typewritten pages for the technical proposal, defined as: the project description, management approach, personnel, and facilities and equipment sections (i.e., the proposal, excluding the proposal cover sheet and the certifications required by Appendix C and cost information, is limited to 15 pages). Each side of a sheet of paper containing text or figures is considered a page. Use type font 12 point or larger, minimum one-inch margins and standard 8.5 x 11 inch paper. **Proposals exceeding the page limit of 15 pages may be truncated to 15 pages prior to evaluation or returned to the proposer unevaluated at the discretion of the review panel.**

The proposer shall submit one paper copy of the complete proposal (technical proposal as defined above, plus the cover sheet, abstract, certifications required by Appendix C and cost information) to

the address shown in the main body of this solicitation. This copy will serve as the archival version of the proposal.

In addition, the technical proposal and monthly cost plan (described Appendix A.II.F) shall be submitted by uploading electronic files to the ESTO electronic handbook (EHB) located at the WWW address http://esto.gsfc.nasa.gov.

Acceptable electronic format for the technical proposal is a document composed using Microsoft Word (version 6.0 or later), WordPerfect (version 6.x or later), or Portable Document Format (PDF) (version 3 or later). Acceptable electronic format for the monthly cost plan is a document composed using Microsoft Word (version 6.0 or later), Microsoft Excel (version 4.0 or later), or Portable Document Format (PDF) (version 3 or later). In order to facilitate efficient document distribution during the review process, every effort should be made to keep document file sizes to less than 2Mbytes. Consequently, proposers are cautioned against using high-resolution, color graphics, since this can dramatically increase the size of the electronic file. The technical proposal that is uploaded to the EHB should not include the cover page, abstract, budget or certifications required by Appendix C. The EHB contains online forms for the cover page, budget sheet, abstract and current and pending research support that are to be filled in by the proposer. The proposer will receive an acknowledgement from the EHB when all the forms have been submitted and the files have been uploaded. The EHB will not attempt to validate the information submitted. **Detailed instructions for proposal submission will be available on the EHB.** The EHB forms (cover page, abstract, budget and certifications) should be printed and combined with the technical proposal and monthly cost plan and then delivered to the address shown in the main body of this announcement by the closing date in order to be considered for review. **Proposals will not be reviewed unless both the electronic files/forms and signed original proposal have been received.**

IV. Reporting Requirements

The following deliverables will be required of awarded proposals. In cases where subcontract arrangements exist, consolidated project reports, including financial reports, are the responsibility of the PI. The proposed budget should allow for these reporting requirements. In this context "phase" refers to the basic and contract periods established with the PI at contract award. Phases should be 9 to 15 months long and end with a significant milestone in the technology development effort.

A. Monthly Reports:

The initial monthly report should include a plan for technical, schedule and resource activities for the phase. Reports should be submitted monthly on a schedule to be determined by the Earth Science Technology Office (ESTO). A teleconference may be conducted between the ESTO and the awardee to review and discuss each report. These reports must include:

1. Technical status: The awardee must summarize accomplishments for the preceding month, including technical accomplishments (trade study results, requirements analysis, design, etc.), technology development results, and results of lab tests or demonstrations.

2. Schedule status: The awardee must address the status of major tasks and the variance from planned versus actual, 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.

3. Financial status: The financial status should be monthly and cumulative planned and actual cost. The awardee must address:

(a) the variance of planned versus actual costs, and include work that has been completed and cost incurred from the project (should be traceable to the schedule),

(b) the status of major procurements that have been incurred to date, and

(c) the amounts obligated to suppliers and subcontractors, including open purchase orders against which materials have not been received nor services rendered.

An initial assessment should be provided of the Technology Readiness Level (TRL) and the basis for that assessment for the critical technology developments of the activity. The first TRL assessment is to be provided with the first report. An updated TRL assessment must be provided with each mid or end-of-phase review.

B. Mid-Phase Review:

The awardee must provide a presentation summarizing the work accomplished and results leading up to this mid-phase milestone review and must:

1. Describe the primary findings, technology development results, and technical status, e.g., status of elements, construction of breadboards or prototype implementations, results of tests and/or proof-of-concept demonstrations, etc. The PI may provide a laboratory demonstration, if appropriate, to show technical results and status.

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

3. Summarize the cost and schedule status of the project, including any schedule slippage/acceleration.

4. Summarize the status of project reserve (if applicable) and planned use to meet critical milestones remaining in the phase.

The ESTO will conduct a two hour (approximately) review at the PI's facility, or at a mutually agreed upon location.

C. End-of-Phase Review:

The awardee must provide a presentation summarizing the work accomplished and anticipated results at the end of phase. This review must include:

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

2. A summary of the primary findings, technology development results, and technical status, e.g., status of elements, construction of breadboards or prototype implementations, results of tests and/or demonstrations, etc. The PI may provide a laboratory demonstration, if appropriate, to show technical results and status.

3. A recommendation on whether to continue the effort, if applicable, and the rationale for that recommendation.

D. Final Report:

The final report should be submitted by the end of the final contract period, and should include the following:

1. Background and description of the measurement concept. Description of the earth science questions addressed by the measurement system.

2. Results of all analyses, measurement system designs, breadboards and/or prototype implementations and designs.

3. Performance analysis results of tests and/or demonstrations; estimation of reduction of size, mass, power, volume, cost, improved performance, or description of enabled capability not previously possible; and documentation of technology dependencies.

4. Tables, graphs, diagrams, curves, sketches, photographs and drawings in sufficient detail to explain, comprehensively, the results achieved.

5. An updated TRL assessment, with a description of technology work remaining and an estimate of the required technology investment.

6. A rough order of magnitude cost and schedule estimate to build a flight model and a conceptual description of that system.

E. Annual Workshop:

If held, the awardee is encouraged, and may be required, to attend an annual workshop. The purpose of the workshop, which will be open to the public, is to widely advertise the technology developments invested by the ESE Technology. In the workshop, the awardee should be prepared to make a presentation, provide a paper, or create a poster providing a description of the project, the objectives, approach, technical status, and schedule information. These annual workshops will be held at or near NASA Field Centers. Costs for attending these workshops shall be itemized separately and will be funded as options. As guidance for pricing, the workshops will be one day in length and the 2001 workshop will be held in the greater Washington, D.C. area. The 2002 workshop will be held in the Pasadena, California area, and the 2003 workshop will be held in the Cleveland, Ohio area. The location of subsequent workshops will be determined later.

APPENDIX B

INSTRUCTIONS FOR RESPONDING TO
NASA RESEARCH ANNOUNCEMENTS

NASA Federal Acquisition Regulation (FAR), Supplement (NFS)
Part 1852.235-72, Effective JANUARY 2000 (Modified)

(a) General.

(1) Proposals received in response to a NASA Research Announcement (NRA) will be used only for evaluation purposes. NASA does not allow a proposal, the contents of which are not available without restriction from another source, or any unique ideas submitted in response to an NRA to be used as the basis of a solicitation or in negotiation with other organizations, nor is a pre-award synopsis published for individual proposals.

(2) A solicited proposal that results in a NASA award becomes part of the record of that transaction and may be available to the public on specific request; however, information or material that NASA and the awardee mutually agree to be of a privileged nature will be held in confidence to the extent permitted by law, including the Freedom of Information Act.

(3) NRAs contain programmatic information and certain requirements which apply only to proposals prepared in response to that particular announcement. These instructions contain the general proposal preparation information which applies to responses to all NRAs.

(4) A contract, grant, cooperative agreement, or other agreement may be used to accomplish an effort funded in response to an NRA. NASA will determine the appropriate instrument. Contracts resulting from NRAs are subject to the Federal Acquisition Regulation and the NASA FAR Supplement. Any resultant grants or cooperative agreements will be awarded and administered in accordance with the NASA Grant and Cooperative Agreement Handbook (NPG 5800.1).

(5) NASA does not have mandatory forms or formats for responses to NRAs; however, it is requested that proposals conform to the guidelines in these instructions. NASA may accept proposals without discussion; hence, proposals should initially be as complete as possible and be submitted on the proposers' most favorable terms.

(6) To be considered for award, a submission must, at a minimum, present a specific project within the areas delineated by the NRA; contain sufficient technical and cost information to permit a meaningful evaluation; be signed by an official authorized to legally bind the submitting organization; not merely offer to perform standard services or to just provide computer facilities or services; and not significantly duplicate a more specific current or pending NASA solicitation.

(b) **NRA Specific Items.** Several proposal submission items appear in the NRA itself: the unique NRA identifier; when to submit proposals; where to send proposals; number of copies required; and sources for more information. Items included in these instructions may be supplemented by the NRA.

(c) The following information is needed to permit consideration in an objective manner. NRAs will generally specify topics for which additional information or greater detail is desirable. Each proposal copy shall contain all submitted material, including a copy of the transmittal letter if it contains substantive information.

(1) **Transmittal Letter or Prefatory Material.**

(i) The legal name and address of the organization and specific division or campus identification if part of a larger organization;
(ii) A brief, scientifically valid project title intelligible to a scientifically literate reader and suitable for use in the public press;
(iii) Type of organization: e.g., profit, nonprofit, educational, small business, minority, women-owned, etc.;
(iv) Name and telephone number of the principal investigator and business personnel who may be contacted during evaluation or negotiation;
(v) Identification of other organizations that are currently evaluating a proposal for the same efforts;
(vi) Identification of the NRA, by number and title, to which the proposal is responding;
(vii) Dollar amount requested, desired starting date, and duration of project;
(viii) Date of submission; and
(ix) Signature of a responsible official or authorized representative of the organization, or any other person authorized to legally bind the organization (unless the signature appears on the proposal itself).

(2) **Restriction on Use and Disclosure of Proposal Information.** Information contained in proposals is used for evaluation purposes only. Offerors or quoters should, in order to maximize protection of trade secrets or other information that is confidential or privileged, place the following notice on the title page of the proposal and specify the information subject to the notice by inserting an appropriate identification in the notice. In any event, information contained in proposals will be protected to the extent permitted by law, but NASA assumes no liability for use and 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 offeror, be used or disclosed other than for evaluation purposes; provided, however, that in the event a contract (or other 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 contract (or other 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) **Abstract.** Include a concise (200-300 word if not otherwise specified in the NRA) abstract describing the objective and the method of approach.

(4) **Project Description.**
(i) The main body of the proposal shall be a detailed statement of the work to be undertaken and should include objectives and expected significance; relation to the present state of knowledge; and relation to previous work done on the project and to related work in progress elsewhere. The statement should outline the plan of work, including the broad design of experiments to be undertaken and a description of experimental methods and procedures. The project description should address the evaluation factors in these instructions and any specific factors in the NRA. Any substantial collaboration with individuals not referred to in the budget or use of consultants should be described. Subcontracting significant portions of a research project is discouraged.
(ii) When it is expected that the effort will require more than one year, the proposal should cover the complete project to the extent that it can be reasonably anticipated. Principal

emphasis should be on the first year of work, and the description should distinguish clearly between the first year's work and work planned for subsequent years.

(5) **Management Approach.** For large or complex efforts involving interactions among numerous individuals or other organizations, plans for distribution of responsibilities and arrangements for ensuring a coordinated effort should be described.

(6) **Personnel.** The principal investigator is responsible for supervision of the work and participates in the conduct of the research regardless of whether or not compensated under the award. A short biographical sketch of the principal investigator, a list of principal publications and any exceptional qualifications should be included. 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, together with information as to their level of academic attainment. Any special industry-university cooperative arrangements should be described.

(7) **Facilities and Equipment.**

(i) 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. Include evidence of its availability and the cognizant Government points of contact.

(ii) Before requesting a major item of capital equipment, the proposer should determine if sharing or loan of equipment already within the organization is a feasible alternative. Where such arrangements cannot be made, the proposal should so state. The need for items that typically can be used for research and non-research purposes should be explained.

(8) **Proposed Costs (U.S. Proposals Only).**

(i) Proposals should contain cost and technical parts in one volume: do not use separate "confidential" salary pages. As applicable, include separate cost estimates for salaries and wages; fringe benefits; equipment; expendable materials and supplies; services; domestic and foreign travel; ADP expenses; publication or page charges; consultants; subcontracts; other miscellaneous identifiable direct costs; and indirect costs. List salaries and wages in appropriate organizational categories (e.g., principal investigator, other scientific and engineering professionals, graduate students, research assistants, and technicians and other non-professional personnel). Estimate all staffing data in terms of staff-months or fractions of full-time.

(ii) Explanatory notes should accompany the cost proposal to provide identification and estimated cost of major capital equipment items to be acquired; purpose and estimated number and lengths of trips planned; basis for indirect cost computation (including date of most recent negotiation and cognizant agency); and clarification of other items in the cost proposal that are not self-evident. List estimated expenses as yearly requirements by major work phases.

(iii) Allowable costs are governed by FAR Part 31 and the NASA FAR Supplement Part 1831 (and OMB Circulars A-21 for educational institutions and A-122 for nonprofit organizations).

(iv) Use of NASA funds--NASA funding may not be used for foreign research efforts at any level, whether as a collaborator or a subcontract. The direct purchase of supplies and/or services, which do not constitute research, from non-U.S. sources by U.S. award recipients is permitted. Additionally, in accordance with the National Space Transportation Policy,

use of a non-U.S. manufactured launch vehicle is permitted only on a no-exchange-of-funds basis.

(9) **Security.** Proposals should not contain security classified material. If the research requires access to or may generate security classified information, the submitter will be required to comply with Government security regulations.

(10) **Current Support.** For other current projects being conducted by the principal investigator, provide title of project, sponsoring agency, and ending date.

(11) **Special Matters.**

(i) Include any required statements of environmental impact of the research, 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.

(ii) Proposers 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.

(d) **Renewal Proposals.**

(1) Renewal proposals for existing awards will be considered in the same manner as proposals for new endeavors. A renewal proposal should not repeat all of the information that was in the original proposal. The renewal proposal should refer to its predecessor, update the parts that are no longer current, and indicate what elements of the research are expected to be covered during the period for which support is desired. A description of any significant findings since the most recent progress report should be included. The renewal proposal should treat, in reasonable detail, the plans for the next period, contain a cost estimate, and otherwise adhere to these instructions.

(2) NASA may renew an effort either through amendment of an existing contract or by a new award.

(e) **Length.** Unless otherwise specified in the NRA, effort should be made to keep proposals as brief as possible, concentrating on substantive material. Few proposals need exceed 15-20 pages. Necessary detailed information, such as reprints, should be included as attachments. A complete set of attachments is necessary for each copy of the proposal. As proposals are not returned, avoid use of "one-of-a-kind" attachments.

(f) **Joint Proposals.**

(1) Where multiple organizations are involved, the proposal may be submitted by only one of them. It should clearly describe the role to be played by the other organizations and indicate the legal and managerial arrangements contemplated. In other instances, simultaneous submission of related proposals from each organization might be appropriate, in which case parallel awards would be made.

(2) Where a project of a cooperative nature with NASA is contemplated, describe the contributions expected from any participating NASA investigator and agency facilities or equipment which may be required. The proposal must be confined only to that which the proposing organization can commit itself. "Joint" proposals which specify the internal arrangements NASA will actually make are not acceptable as a means of establishing an agency commitment.

(g) **Late Proposals.** Proposals or proposal modifications received after the latest date specified for receipt may be considered if a significant reduction in cost to the Government is probable or if there are significant technical advantages, as compared with proposals previously received.

(h) **Withdrawal.** Proposals may be withdrawn by the proposer at any time before award. Offerors are requested to notify NASA if the proposal is funded by another organization or of other changed circumstances which dictate termination of evaluation.

(i) **Evaluation Factors.**

(1) Unless otherwise specified in the NRA, the principal elements (of approximately equal weight) considered in evaluating a proposal are its relevance to NASA's objectives, intrinsic merit, and cost.

(2) Evaluation of a proposal's relevance to NASA's objectives includes the consideration of the potential contribution of the effort to NASA's mission.

(3) Evaluation of its intrinsic merit includes the consideration of the following factors of equal importance:

(i) Overall scientific or technical merit of the proposal or unique and innovative methods, approaches, or concepts demonstrated by the proposal.
(ii) Offeror's capabilities, related experience, facilities, techniques, or unique combinations of these which are integral factors for achieving the proposal objectives.
(iii) The qualifications, capabilities, and experience of the proposed principal investigator, team leader, or key personnel critical in achieving the proposal objectives.
(iv) Overall standing among similar proposals and/or evaluation against the state-of-the-art.

(4) Evaluation of the cost of a proposed effort may include the realism and reasonableness of the proposed cost and available funds.

(j) **Evaluation Techniques.** Selection decisions will be made following peer and/or scientific review of the proposals. Several evaluation techniques are regularly used within NASA. In all cases proposals are subject to scientific review by discipline specialists in the area of the proposal. Some proposals are reviewed entirely in-house, others are evaluated by a combination of in-house and selected external reviewers, while yet others are subject to the full external peer review technique (with due regard for conflict-of-interest and protection of proposal information), such as by mail or through assembled panels. The final decisions are made by a NASA selecting official. A proposal which is scientifically and programmatically meritorious, but not selected for award during its initial review, may be included in subsequent reviews unless the proposer requests otherwise.

(k) **Selection for Award.**

(1) When a proposal is not selected for award, the proposer will be notified. NASA will explain generally why the proposal was not selected. Proposers desiring additional information may contact the selecting official who will arrange a debriefing.

(2) When a proposal is selected for award, negotiation and award will be handled by the procurement office in the funding installation. The proposal is used as the basis for negotiation. The contracting officer may request certain business data and may forward a model award instrument and other information pertinent to negotiation.

(l) **Additional Guidelines Applicable to Foreign Proposals and Proposals Including Foreign Participation.**

(1) NASA welcomes proposals from outside the U.S. However, foreign entities are generally not eligible for funding from NASA. Therefore, unless otherwise noted in the NRA, proposals from foreign entities should not include a cost plan unless the proposal involves collaboration with a U.S. institution, in which case a cost plan for only the participation of the U.S. entity must be included. Proposals from foreign entities and proposals from U.S. entities that include foreign participation must be endorsed by the respective government agency or

funding/sponsoring institution in the country from which the foreign entity is proposing. Such endorsement should indicate that the proposal merits careful consideration by NASA and, if the proposal is selected, sufficient funds will be made available to undertake the activity as proposed.

(2) All foreign proposals must be typewritten in English and comply with all other submission requirements stated in the NRA. All foreign proposals will undergo the same evaluation and selection process as those originating in the U.S. All proposals must be received before the established closing date. Those received after the closing date will be treated in accordance with paragraph (g) of this provision. Sponsoring foreign government agencies or funding institutions may, in exceptional situations, forward a proposal without endorsement if endorsement is not possible before the announced closing date. In such cases, the NASA sponsoring office should be advised when a decision on endorsement can be expected.

(3) Successful and unsuccessful foreign entities will be contacted directly by the NASA sponsoring office. Copies of these letters will be sent to the foreign sponsor. Should a foreign proposal or a U.S. proposal with foreign participation be selected, NASA's Office of External Relations will arrange with the foreign sponsor for the proposed participation on a no-exchange-of-funds basis, in which NASA and the non-U.S. sponsoring agency or funding institution will each bear the cost of discharging their respective responsibilities.

(4) Depending on the nature and extent of the proposed cooperation, these arrangements may entail:

(i) An exchange of letters between NASA and the foreign sponsor; or
(ii) A formal Agency-to-Agency Memorandum of Understanding (MOU).

(m) **Export Control Guidelines Applicable to Foreign Proposals and Proposals Including Foreign Participation.**

(1) Foreign proposals and proposals including foreign participation must include a section discussing compliance with U.S. export laws and regulations, e.g., 22 CFR Parts 120-130 and 15 CFR Parts 730-774, as applicable to the circumstances surrounding the particular foreign participation. The discussion must describe in detail the proposed foreign participation and is to include, but not limited to, whether or not the foreign participation may require the prospective proposer to obtain the prior approval of the Department of State or the Department of Commerce via a technical assistance agreement or an export license, or whether a license exemption/exception may apply. If prior approvals via licenses are necessary, discuss whether the license has been applied for or if not, the projected timing of the application and any implications for the schedule. Information regarding U.S. export regulations is available at http://www.pmdtc.org and http://www.bxa.doc.gov. Proposers are advised that under U.S. law and regulations, spacecraft and their specifically designed, modified, or configured systems, components, and parts are generally considered " Defense Articles" on the United States Munitions List and subject to the provisions of the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120-130.

(n) **Cancellation of NRA.**

(1) NASA reserves the right to make no awards under this NRA and to cancel this NRA. NASA assumes no liability for canceling the NRA or for anyone's failure to receive actual notice of cancellation.

(End of provision)

APPENDIX D

PROPOSAL COVER SHEET AND REQUIRED DECLARATIONS AND ASSURANCES

FOR REFERENCE ONLY - MUST BE ENTERED AT THE ELECTRONIC HANDBOOK WWW ADDRESS

NASA Research Announcement 01-OES-XX
Proposal No. _____ (Leave Blank for NASA Use)

Title: _____

Principal Investigator: _____

Department: _____

Institution: _____

Street/PO Box: _____

City: _____ State: _____ Zip: _____

Country: _____ Congressional District: _____
(used for database sorting purposes only)

E-mail: _____

Telephone: _____ Fax: _____

Co-Investigators:

Name	Institution & Email Address	Address & Telephone
_____	_____	_____
_____	_____	_____
_____	_____	_____

Budget:	Full Cost Accounting	Non-Full Cost Accounting (NASA only)
Year 1		
Year 2		
Year 3		

Development Type (check all that apply):	
Instrument Design	
Engineering Model Construction	
Laboratory Demonstration	
Field Demonstration	

Science Area (check at least one):	
Atmospheric Chemistry	
Solid Earth	
Global Carbon Cycle	
Global Water and Energy Cycle	
Climate Variability and Prediction	

Certification of Compliance with Applicable Executive Orders and U.S. 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 NRA [namely, (i*) Certification 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).

Title of Authorizing Institutional Official: _____

Signature: _____ Date: _____

Name of Proposing Institution: _____

Telephone: _____ E-mail: _____ Facsimile: _____

PROPOSAL SUMMARY (1-PAGE ONLY)

NASA Research Announcement 01-OES-XX

FOR REFERENCE ONLY - MUST BE ENTERED AT THE ELECTRONIC HANDBOOK WWW ADDRESS

ABSTRACT: (Single-space, typed, about 200-300 words). Include: (a) Objectives and justification for work; (b) Accomplishments of prior work; (c) Outline of proposed work and methodology; (d) One or two relevant recent publications authored by the PI or Co-I.

CURRENT AND PENDING RESEARCH SUPPORT FROM ALL OTHER SOURCES

FOR REFERENCE ONLY - MUST BE ENTERED AT THE ELECTRONIC HANDBOOK WWW ADDRESS

All proposals must include this information. This list should include all current and pending research support from the following sources:

1. Any proposal for which the PI of this proposal is also the Principal Investigator.

2. Any proposal, regardless of the PI, which accounts for more than 20% of the time of the Principal Investigator of this proposal and other personnel essential to this proposal.

Please provide this information in the following format:

I. Principal Investigator

A. Current Fiscal Year Support

1. Source of Support and Principal Investigator
2. Award Amount and Period of Performance
3. Person-Months and Level of Effort
4. Project Title and Short Abstract (50 words or less)

B. Pending Proposals (Excluding this proposal but including other proposals).

1. Source of Support and Principal Investigator
2. Award Amount and Period of Performance
3. Person-Months and Level of Effort
4. Project Title and Short Abstract (50 words or less)

For both current and pending support provide information on:

II. Co-Investigators

As outlined above, provide information on all Current and Pending Support. Disclosure of current and pending research support is not required for collaborators.

III. Other agencies to which this proposal, or parts thereof, has been submitted.

CERTIFICATION 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 1962 (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 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 recognized 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 below are authorized to sign on behalf of the Applicant.

NASA FORM 1206

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 D

BUDGET SUMMARY

FOR REFERENCE ONLY - MUST BE ENTERED AT THE ELECTRONIC HANDBOOK WWW ADDRESS

For period from _____ to _____

- Provide a complete Budget Summary for year one and separate estimate 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. Facilities and Administrative Costs	_____	_____	_____
4. Other Applicable Costs:	_____	_____	_____
5. SUBTOTAL--Estimated Costs	_____	_____	_____
6. Less Proposed Cost Sharing (if any)	_____	_____	_____
7. Carryover Funds (if any)			
a. Anticipated amount : _____			
b. Amount used to reduce budget	_____	_____	_____
8. Total Estimated Costs	_____	_____	XXXXXXX
9. APPROVED BUDGET	XXXXXX	XXXXXXX	_____

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. Facilities and Administrative (F&A) 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. Carryover Funds (if any): Enter the dollar amount of any funds expected to be available for carryover from the prior budget period Identify how the funds will be used if they are not used to reduce the budget. NASA officials will decide whether to use all or part of the anticipated carryover to reduce the budget (not applicable to 2nd-year and subsequent-year budgets submitted for award of a multiple year award).

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

APPENDIX E

DEFINITION OF TECHNOLOGY READINESS LEVELS

TRL 1 Basic principles observed and reported

TRL 2 Technology concept and/or application formulated

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

TRL 4 Component and/or breadboard validation in laboratory environment

TRL 5 Component and/or breadboard validation in relevant environment

TRL 6 System/subsystem model or prototype demonstration in a relevant environment (ground or space)

TRL 7 System prototype demonstration in a space environment

TRL 8 Actual system completed and "flight qualified" through test and demonstration (ground or space)

TRL 9 Actual system "flight proven" through successful mission operations

APPENDIX F

LIST OF ACRONYMS USED IN THIS RESEARCH ANNOUNCEMENT

AO	Announcement of Opportunity
CETDP	Cross-Enterprise Technology Development Program
EHB	Electronic Handbook
EOS	Earth Observing System
ESE	Earth Science Enterprise
FAR	Federal Acquisition Regulation
FY	Fiscal Year
GSFC	Goddard Space Flight Center
IIP	Instrument Incubator Program
NASA	National Aeronautics and Space Administration
NFS	NASA FAR Supplement
NRA	NASA Research Announcement
OES	Office of Earth Science
OMB	Office of Management and Budget
PI	Principal Investigator
URL	Uniform Resource Locator
WWW	World Wide Web