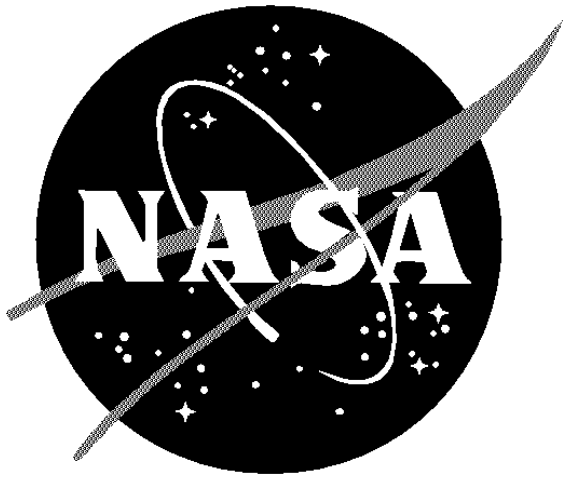

National Aeronautics and Space Administration

April 1, 2002

NRA-02-OES-02

RESEARCH ANNOUNCEMENT

INVESTIGATIONS THAT CONTRIBUTE TO THE NASA EARTH SCIENCE ENTERPRISE'S ATMOSPHERIC CHEMISTRY MODELING, MEASUREMENTS AND DATA ANALYSIS RESEARCH

Proposals in response to Appendix A, Section C due April 30, 2002
All other proposals due May 30, 2002

OMB Approval No. 2700-0087

INVESTIGATIONS THAT CONTRIBUTE TO THE NASA EARTH SCIENCE ENTERPRISE'S ATMOSPHERIC CHEMISTRY MODELING, MEASUREMENTS, AND DATA ANALYSIS RESEARCH

NASA Research Announcement
Soliciting Research Proposals
for
Periods Ending
April 30 and May 30, 2002

NRA 02-OES-02
Issued April 1, 2002

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

NASA RESEARCH ANNOUNCEMENT

INVESTIGATIONS THAT CONTRIBUTE TO THE NASA EARTH SCIENCE ENTERPRISE'S ATMOSPHERIC CHEMISTRY MODELING, MEASUREMENTS, AND DATA ANALYSIS RESEARCH

The NASA 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, thereby improving the predictive capabilities for climate, stratospheric ozone, weather, and natural hazards. Through its science research programs, the ESE aims to acquire a deeper understanding of the components of the Earth system and their interactions. These interactions occur on a continuum of spatial scales ranging from local and regional to global, and on temporal scales from short-term weather to long-term climate. The Enterprise also seeks to provide accurate assessments of changes in the chemical composition and physical state of the atmosphere; in the extent and health of the world's forest, grassland, and agricultural resources; and in geologic phenomena that lead to natural hazards.

The key research topics studied by NASA's Earth Science Enterprise (ESE) fall largely into five categories: variability, forcings, responses, consequences and prediction. This conceptual approach applies to all research areas of NASA's Earth Science program. 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 future changes to the Earth system?*

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. For this purpose, more specific research questions need to be formulated and prioritized.

The strength of NASA's Earth science program is derived from the synergy between different classes of observations, basic research, modeling, and data analysis, as well as field and laboratory studies. In particular, NASA's Earth Science Research Strategy

(http://www.earth.nasa.gov/visions/researchstrat/Research_Strategy.htm) recognizes the need for close linkage between the observation programs and the data analysis and predictive Earth system modeling programs at all relevant spatial and temporal scales. Developing the means for full utilization of global observational data (e.g. through systematic data assimilation) and for analysis of discrepancies between observed and modeled fields is considered an essential component of the program. In this respect, NASA's research strategy fully subscribes to the recommendation of the National Research Council's Board on Atmospheric Sciences and Climate to: "Apply the discipline of forecasting… in order to advance knowledge, capabilities for prediction, and service to society". The synergy between global Earth observation, analysis, and modeling is perceived as an essential means to answer these scientific questions and as NASA's specific contribution to the U. S. Global Change Research Program (http://www.usgcrp.gov/) and the President's Climate Change Research Initiative.

The intellectual capital for both the planning and exploitation of Earth system observations is vested in a robust research and analysis program. Research and analysis forms the conceptual source of Earth system science questions, and strategies to address them. The research program supports the early development of innovative observing techniques (including both instruments and the linkage of instruments with platforms) and processing algorithms, organizes field tests, and generally charts the path for scientific and engineering developments that enable future advances. It assures the linkage between global satellite observations, *in situ* process-oriented observations, and the computational models used to provide both a framework for interpretation of observations and a tool for prediction. It helps assure the development of consistent, integrated, and well calibrated data sets, especially those that involve multiple instruments, observational platforms, and observing techniques. Altogether, the research and analysis program brings fundamental research to bear on key Earth Science issues, and lays the interdisciplinary groundwork for linking these research efforts, and ultimately providing the Earth system predictive capabilities in support of economic and policy decision making.

This NASA Research Announcement:

NASA is presently soliciting proposals for investigations that will contribute to atmospheric chemistry modeling, measurements and data analysis research supported by its Earth Science Enterprise. This NRA specifically solicits proposals in three research categories (see appendix A, sections a, b and c). It solicts proposals pertinent to the interests of disciplinary research and analysis for the Atmospheric Chemistry Modeling and Analysis Program (ACMAP) that includes global and regional modeling activities and large-scale data analysis, especially model-driven analysis. It also solicits proposals for the Solar Occultation Satellite Science Team (SOSST) that will replace what formerly were the SAGE II and SAGE III science teams. SOSST will focus on global and regional modeling and/or model-driven data analysis in the area of atmospheric chemistry and chemistry-climate interactions. And finally, it solicits proposals for measurement participation in the validation of the Stratospheric Aerosol and Gases Experiment (SAGE) III satellite instrument.

In keeping with overall NASA ESE goals, research supported by this NRA will be directed toward demonstrating successful use of data from satellite observing systems, in conjunction with other kinds of data. The goals of this research are to improve models and data assimilations for the Earth system or one or more of its components in order to answer the key science questions listed below. The five fundamental questions presented above are based on the importance of variability, forcing, response, consequences and prediction in Earth science. For the purposes of this NRA, more specific scientific questions within these categories have been identified as priorities:

- *How is stratospheric ozone changing as the abundance of ozone-destroying chemicals decreases?*
- *What trends in atmospheric constituents and solar radiation are driving global climate?*
- *How do stratospheric trace constituents respond to climate and chemical change?*
- *What are the effects of regional pollution on the global atmosphere, and the effects of global chemical and climate changes on regional air quality?*
- *To what extent can future atmospheric chemical impacts be assessed?*

Proposals that address one or more of these questions and help make the connection among variability, forcing, response, consequences, and prediction through the joint use of models and data are of particular interest. Where appropriate, priority will be given to proposals that illustrate the value of space-based remotely-sensed observations that contribute to our understanding of chemistry-climate interactions on the global and continental scale. Research topics that accomplish this integration and are programmatically desirable at this time include: (See Appendix A for more information and details)

Question 1: How is stratospheric ozone changing as the abundance of ozone-destroying chemicals decreases?

NASA has been mandated by Congress to document the variability and long-term changes in stratospheric ozone. A scientifically robust understanding of stratospheric ozone change and transient variations in ozone requires the analysis and modeling of accurate and consistent long-term observations of ozone distribution (both total column and vertical profiles), together with the key parameters governing its abundance. At this time, data sets of particular interest are from the Stratospheric Aerosol and Gas Experiment (SAGE), the Polar Ozone and Aerosol Measurement (POAM) and the Halogen Occultation Experiment (HALOE) satellite instruments, including comparison with appropriate ground- and balloon-based measurement networks (Dobson/Umkehr, ozonesondes, etc), and examinations of interconsistency with ozone measurements provided by various other space-based instruments, such as the Ultraviolet Visible Imagers and Spectrographic Imagers/Midcourse Space Experiment (UVISI/MSX), Total Ozone Mapping Spectrometer (TOMS), the Global Ozone Monitoring Experiment (GOME), Solar Backscatter Ultraviolet 2 (SBUV2), Atmospheric Chemistry Experiment (ACE) and Measurements of Aerosol Extinction in the Stratosphere and Troposphere

Retrieved by Occultation (MAESTRO) on SCISAT and instruments on the Upper Atmosphere Research Satellite (UARS), ENVISAT, ADEOS II, etc. platforms.

Question 2: What trends in atmospheric constituents and solar radiation are driving global climate?

This NRA focuses on the atmospheric composition portion of this question. A subsequent NRA, to be released later this year, will solicit proposals focusing on the solar radiation portion of this question.

Aerosols affect climate by altering the amount of solar radiation received at the Earth's surface and the amount of terrestrial infrared radiation emitted to space. Their radiative impact is highly dependent upon their abundance, vertical and geographical distribution, and optical and physical properties. In the stratosphere, aerosols that result from volcanic eruptions can cause significant cooling at the surface and warming in the lower stratosphere. In the troposphere, aerosols have natural and anthropogenic sources and can either cool or warm the atmosphere depending on their properties. Global vertical profile measurements of aerosols in the stratosphere and troposphere are needed to define this important climate forcing.

Solar occultation satellite experiments have been very successful at providing accurate profile measurements of aerosol extinction that track the dispersion of aerosols produced in the stratosphere by volcanically injected SO_2 and their radiative effects. These instruments have also been successful at observing the seasonal behavior of aerosols in the upper troposphere, as evident from an examination of the SAGE aerosol products. Hence, desired research in this category includes the analysis of the SAGE stratospheric and tropospheric aerosol products, including comparisons of derived information on aerosol size and surface area with that from surface-, airborne-, balloon-, and other space-based instruments. Studies which combine SAGE data with data from other space-based instruments such as the POAM, SAM II, TOMS, ACE and instruments on UARS, ENVISAT and ADEOS II are encouraged, as is the systematic comparison of aerosol products with models.

Changes in the abundance of ozone in the troposphere also act as an important forcing of climate, as ozone can trap terrestrial radiation and thus contribute to global warming. Measurements of the vertical profile of tropospheric ozone by satellites are needed globally to complement ozone observations made by balloons in order to provide a better understanding of its distribution, long-term variation, and trend. Important studies are those directed at intercomparison studies between ozone measurements utilizing solar occultation techniques and those from ground-based, balloon, and airborne platforms and those making use of multi-dimensional atmospheric chemistry/transport models together with surface and, where available, space-based measurements of the spatial and temporal variations of tropospheric ozone.

Question 3: How do stratospheric trace constituents respond to climate and chemical change?

Climate change associated with increasing concentrations of trace gases will affect the distribution of ozone in the stratosphere, and vice versa. The connection between atmospheric temperatures and stratospheric composition is equally well established. A striking example is the enormous interannual variations in winter/spring ozone concentration over the Arctic, highly correlated with changes in stratospheric circulation and temperature driven by the troposphere. Long, cold winters, such as occurred in 1996-1997, enhance ozone destruction and make Arctic conditions more similar to those in the Antarctic that enable the large annual springtime depletion of ozone.

It has been suggested that climate change will affect the way in which the troposphere influences the stratosphere, and would thus indirectly affect stratospheric ozone. The impact would be particularly strong if the wintertime polar vortex became more stable. Similarly, chemical reactions that occur on the surface of stratospheric aerosol and/or cloud particles are temperature dependent; even a small decrease in temperature could cause a significant increase in the rates of these reactions. Changes in stratospheric water vapor, associated with changes in its fluxes through the tropopause, could also enhance the formation of aerosol and cloud particles that facilitate ozone destruction. Furthermore, since ozone absorption of solar UV radiation causes stratospheric heating, a decrease in ozone amount would result in further cooling, and further accelerate ozone losses. There is already strong evidence of cooling in the lower stratosphere, which constitutes one of the largest temperature signals measured in the atmosphere over the past 20 years.

Improving our understanding of this highly interactive system calls for detailed investigation of the relationship between the distributions of ozone, water vapor, aerosols, temperature, and relevant trace constituents, notably chlorine and bromine compounds and nitrogen oxides. Therefore, joint modeling and data analysis studies of the dynamical, radiative, and chemical processes that couple the troposphere and the stratosphere, including those processes responsible for stratosphere-troposphere exchange, are considered a programmatic priority. High latitude observations, such as those provided by SAGE III, POAM, GOME and later the SCanning Imaging Absorption SpectroMeter for Atmospheric CHartographY (SCIAMACHY) on the European ENVISAT, and the Improved Limb Atmospheric Spectrometer (ILAS) on Japan's Advanced Earth Observing Satellite (ADEOS) II, can be used to understand important radiative, dynamical, and chemical processes. The analysis of higher resolution data, obtained from ground-based (e.g., lidar), aircraft, and balloons is critical for some investigations, especially in the tropopause region.

Question 4: What are the effects of regional pollution on the global atmosphere, and the effects of global chemical and climate changes on regional air quality?

The continued growth of the world's population and increasing industrial development suggest that there will be increasing human impacts on the global atmosphere. As fossil fuel combustion increases, emissions of trace gases other than carbon dioxide will also rise, notably nitrogen oxides, carbon monoxide, hydrocarbons, and other precursors of ozone, as well as aerosol particles and their precursors.

Satellite observations provide evidence of the large-scale effects of such emissions on the troposphere. The highest tropospheric ozone concentrations observed in this way were found in summertime over mid-latitude regions of the northern hemisphere, and also over the tropics in regions affected by biomass burning. Aircraft observations have demonstrated that plumes of pollution produced by fires can be transported thousands of kilometers to otherwise pristine regions of the atmosphere (e. g., over the Pacific Ocean). Surface level trace gas measurements made on the west coast of the United States show enhanced levels of ozone precursors during periods of rapid and direct transport of air from East Asia.

There are currently few space-based global observations of tropospheric ozone, key trace gases or aerosol particles and none provide nearly the required vertical resolution. Observations from SAGE II, however, have provided the first climatological distribution of aerosols in the upper troposphere. Total column observations of absorbing tropospheric aerosols have been accomplished through the analysis of TOMS data. New insight into the distribution of ozone and water vapor in the upper troposphere may also be garnered from the revised SAGE II data set or SAGE III observations. Support for determination of tropospheric ozone, aerosol, and water vapor distributions using SAGE, either independently or together with other data sets will be considered here. Critical evaluation of SAGE tropospheric ozone, water vapor, and aerosol distributions based on profiles from ozonesondes, lidars, etc. is desired. Other satellite data sets such as from UARS, ENVISAT, Measurements of Pollution in the Troposphere (MOPITT), GOME and Atmospheric Trace Molecule Spectroscopy Experiment (ATMOS), along with data obtained from ground, balloon and aircraft observations, will also be considered. The consideration of the effects of global atmospheric change on the chemistry of the troposphere through the use of multi-dimensional atmospheric chemistry/transport models and the systematic comparison of models with observations of tropospheric ozone and its precursors are also a priority.

Question 5: To what extent can future atmospheric chemical impacts be assessed?

Prediction of the evolution of atmospheric trace constituent and aerosol composition is intimately linked to that of the meteorological conditions under which chemical and transport processes occur. The chemical constituent of greatest interest is ozone, which both protects the Earth from biologically damaging solar ultraviolet radiation, and is an active chemical pollutant that affects both plant and animal life. Ozone responds (for both production and destruction) to the concentration of many precursor species coming from

both natural and anthropogenic sources. Accurate modeling of atmospheric composition requires knowing or forecasting the future evolution of these chemical forcings as well as relevant changes in climatic conditions. In the case of sufficiently large changes in atmospheric composition, interactions with resulting changes in atmospheric circulation and physical properties cannot be ignored (the chemistry of the polar stratosphere is an important case in point). Processes of particular importance for model assessments of potential atmospheric chemical composition impacts include the transport of material between the troposphere and stratosphere; the formation of aerosols and cloud particles and of their interactions with gas phase species; the natural and human-induced variability in biological sources and sinks; and the balance between chemical removal and long-range tropospheric transport.

Proposals should meet the other requirements that are listed in Appendices B through D. Awards will be made for periods of up to three years to projects that are approved under the terms of this announcement. Funding for this NRA has not yet been appropriated and NASA reserves the right to cancel this NRA in the event that adequate funds are not appropriated.

Participation is open to all categories of domestic and foreign organizations, including educational institutions, industry, non-profit institutions, NASA Centers, and other U.S. Government Agencies. In accordance with NASA Policy as described in Appendix B, all investigations by foreign participants will be conducted on a no-exchange-of-funds basis, i.e., investigators whose home institution is outside of the United States cannot be funded by NASA.

NASA's Earth Science Enterprise has adopted commercial data purchases as a mainstream way of acquiring research-quality data, as these commercial capabilities become available. NASA encourages the use of commercially available data sets by Principal Investigators as long as it meets the scientific requirements and is cost-effective. When responding to a NASA Research Announcement the proposer should identify the commercial data sources intended for use and the associated cost.

For the SAGE III validation campaign portion of this NRA (appendix A, section c), proposals may be submitted at any time before April 30, 2002, 4:30 PM EDT. For all other parts of this NRA (appendix A, sections a and b) proposals may be submitted at any time before May 30, 2002, 4:30 PM. NASA reserves the optional right to consider proposals received after that date in accordance with Appendix B, i.e., "the selecting official deems the late proposal to offer significant technical advantage or cost reduction". Proposals will be submitted to a peer and/or Program Office review and evaluation. Selected proposals for the SAGE III validation campaign will be announced during June, 2002. The remainder of the announcements will be made before August 30, 2002.

Approximately $12 million over three years is available from NASA to address the research for the ACMAP and SOSST parts of this NRA (appendix A, sections A and B). The value of these awards is expected to be in the range of about $100-150K per year. An

additional amount of approximately $2 million is available to fund the selected investigations as part of the SAGE III validation campaign (appendix A, section C). The investigations selected to be part of the SAGE III validation campaign will mostly be selected as one-year investigations with very limited support available beyond the time frame of the campaign.

Technical information contained in Appendix A applies to this Research Announcement only. Appendices B through D contain NASA general guidelines for the preparation of proposals solicited by this Research Announcement. New information and changes to this NRA will be posted at the following web address http://research.hq.nasa.gov/code_y/code_y.cfm, and we suggest that you periodically visit this site to check for changes.

Identifier **NRA-02-OES- 02**

Submit proposals to:
NASA Peer Review Services
500 E Street SW, Suite 200
Washington, DC 20024, USA
Phone: 202-479-9030

Number of Copies Required: 20

Selecting Official:
Director, Research Division
Office of Earth Science
NASA Headquarters

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Please use identifier number NRA-02-OES-02 when making an inquiry regarding this Announcement. Your interest and cooperation in participating in this opportunity are appreciated.

Ghassem R. Asrar
Associate Administrator
Office of Earth Science

APPENDIX A

Technical Description for this NRA

NASA Programmatic Areas Included in this NRA

A. Atmospheric Chemistry Modeling and Analysis Program (ACMAP):

The primary objective of the ACMAP is to study the distribution of trace constituents in the global troposphere and stratosphere through the use of computational models and through the analysis of spatially and temporally extended data sets. The ACMAP also supports the bulk of NASA's studies of stratospheric meteorology and of the dynamical, chemical, and radiative couplings between the Earth's stratosphere and troposphere, as well as between the stratosphere and upper atmosphere (mesosphere/thermosphere). Efforts within the ACMAP emphasize the global atmosphere, although some consideration is given to the large regional (continental and hemispheric) scales; the ACMAP does not support studies at local scales. Note that this program only supports proposals in the areas of data analysis, interpretation, and modeling; it does not support proposals for laboratory work or field measurements.

Current research in the ACMAP may be broken down into several categories as follows:

- *Stratospheric Dynamics and Related Data Analysis:* This includes modeling and data analysis studies of temperature and wind distributions in the stratosphere, transport processes in the stratosphere and their long-term evolution, dynamical couplings between the stratosphere and regions below (troposphere) and above (mesosphere), as well as studies of the stratospheres influence in the climate system and tropospheric weather patterns.

- *Atmospheric Chemistry Data Analysis:* This research area includes the analysis/re-analysis of new/existing satellite and other field measurement data on the trace constituent composition of the troposphere and stratosphere, including both short- and long-term variations. Data sets of greatest interest are NASA satellite missions and atmospherically-oriented aircraft missions (such as the stratospheric and upper tropospheric oriented, the tropospheric oriented GTE series of campaigns, as well as missions supported by NASA's Atmospheric Effects of Aviation Project, such as SUCCESS and SONEX, many of which are described in detail at http://cloud1.arc.nasa.gov). Investigations utilizing other space-based data, such as those from GOME, Polar Ozone and Aerosol Measurement (POAM), Ultraviolet Visible Imagers and Spectrographic Imagers/Midcourse Space Experiment (UVISI/MSX), and the instruments on ENVISAT, ADEOS II, etc., are of interest as well.

- *Aerosols, Stratospheric Clouds, and Radiation:* Studies of the combined physical and chemical processes by which aerosols and polar stratospheric clouds form in the atmosphere are a principal focus in this area, although some consideration will be given to studies of tropical and subvisible cirrus as well. Also included are studies of the optical and chemical effects such aerosols have on radiative transfer in the troposphere-stratosphere system, including ultraviolet radiation at the Earth's surface

- *Multi-Dimensional Atmospheric Modeling:* This area highlights studies of tropospheric and stratospheric chemistry using two- and three-dimensional models, emphasizing the simulation of the combined effects of chemical and transport properties on atmospheric chemistry. The evaluation of models using ground-, aircraft-, balloon-, and space-based data forms an important part of these efforts. Increasing emphasis has recently been placed on the improved representation of the chemical effects of aerosols on tropospheric trace constituents. Consideration is especially given to the combined effects of atmospheric chemical and climate change on stratospheric ozone production and loss and formation and transport of tropospheric ozone and its precursors.

The ACMAP is one of several NASA programs supporting modeling and analysis of atmospheric trace constituents. Other NASA programs active in this area include the Interdisciplinary Science Program of the Earth Observing System (EOS), Total Ozone Mapping Spectrometer (TOMS) science teams and the newly constituted Solar Occultation Science Team (formerly SAGE II and SAGE III, see section b). Some process scale modeling activities are also carried out under the Upper Atmosphere Research Program and the Tropospheric Chemistry Program of OES. The research supported by the ACMAP contributes significantly to several elements of the Stratospheric Processes and their Role in Climate (SPARC) program of the World Climate Research Program described at http://www.aero.jussieu.fr/~sparc/ and http://www.wmo.ch/web/wcrp/wcrp-home.html, respectively, and the International Global Atmospheric Chemistry (IGAC) program of the International Geosphere-Biosphere Programme (IGBP) described at http://www.igac.unh.edu/ and http://www.igbp.kva.se/cgi-bin/php/frameset.php, respectively.

The full range of NASA's research in the area of atmospheric ozone, including plans for the future evolution of this research, is described in the Atmospheric Chemistry, Aerosols, and Solar Radiation section of the NASA ESE *Science Implementation Plan*. This document is available electronically at http://www.earth.nasa.gov/. The broader context of NASA's Earth Science Enterprise program may be found in the *Earth Science Strategic Enterprise Plan*, which is available at http://www.earth.nasa.gov/visions/stratplan/index.html.

B. Solar Occultation Satellite Science Team:

Individuals responding to this component of the NRA should propose data analysis and/or theoretical studies to be conducted as an Investigator for the Solar Occultation Satellite Science Team (SOSST) program. The SOSST will replace what formerly were

the SAGE II and SAGE III science teams. Over the past 20 or more years, solar occultation satellite instruments have played an important role in NASA's systematic observations program by providing accurate and stable measurements of aerosols, ozone, and other trace constituents in the middle atmosphere and upper troposphere. Previous solar occultation satellite missions that have provided important contributions to our understanding of atmospheric processes include Stratospheric Aerosol Measurement (SAM) II from 1978-1993; Stratospheric Aerosols and Gas Experiment (SAGE) I from 1979-81 and SAGE II from 1984-present; Atmospheric Trace Molecule Spectroscopy Experiment (ATMOS) flown on the Space Shuttle in 1985, 1992, 1993, and 1994; Polar Ozone Aerosol Measurement (POAM) II from 1993-96 and POAM III from 1998-present; and Halogen Occultation Experiment (HALOE) from1984-present. The SAGE III instrument is a new and advanced instrument from the SAGE instrument family and was launched on board the Russian Meteor-3M spacecraft in December 2001. This NRA places some emphasis on the validation and utilization of data from the SAGE III/Meteor-3M satellite mission, although data from other missions with similar satellite occultation measurement characteristics will be considered such as those previously listed. Emphasis will be placed on preparing data sets that can be connected to those of predecessor instruments, and to proposals that use unique capability of the SAGE III instrument.

Proposals seeking to support field measurement investigations for the validation of the SAGE III/Meteor-3M mission should refer to section C for the second SAGE III Ozone Loss and Validation Experiment (SOLVE-2) field campaign. This NRA does not solicit proposals for model development or proposals to acquire data handling facilities or computers. Investigators should utilize existing data analysis techniques and theoretical models in their proposed work and should have on hand the computing and communications facilities necessary for performing the proposed work. Flight Operations for satellite platforms, instrument operations, algorithm maintenance, and program management are not included under the scope of this NRA and will be funded separately.

Technical Description

SAGE III is a fourth generation instrument designed to measure atmospheric aerosols and gases. It is an important component of NASA's Earth Observing System (EOS) aimed at improving our knowledge and understanding of atmospheric processes in the upper troposphere and middle atmosphere in order to better predict the response of this sensitive part of the Earth system to natural changes and to changes resulting from human activities. The SAGE III/Meteor-3M mission is a collaboration between NASA and the Russian Aviation and Space Agency.

The SAGE III instrument incorporates a charge-coupled device (CCD) to permit continuous spectral coverage at wavelengths between 280 to 1030 nm at a resolution of approximately 1-nm. A discrete photodiode is also used to made additional aerosol measurements at 1550 nm. During solar occultation events, these measurements provide information on the vertical structure of aerosol, ozone, water vapor, nitrogen dioxide,

temperature, pressure, and clouds with a vertical resolution of about 0.5 km. The improved SAGE III instrument design also permits lunar occultation measurements of O_3, NO_2, and the nighttime species of NO_3 and OClO and the exploration of new limb-scattering retrieval techniques. Further information on the SAGE III instrument, retrieval algorithms, and data products is available from the SAGE III Algorithm Theoretical Basis Documents (ATBD) and the EOS Data Products Handbook Volume 2 (Parkinson and Greenstone, 2000). General information on the SAGE III mission is available at the SAGE III website (http://www-sage3.larc.nasa.gov/).

The SAGE III/Meteor-3M spacecraft was placed into a sun synchronous orbit with at an altitude of 1020 km and a 9:15 am equatorial crossing time. Approximately15 satellite sunrise and 15 satellite sunset events will occur each day. Lunar occultation events will be limited to only periods when the moon is illuminated by 50% or more. For this mission, solar occultation measurements will occur mostly at high latitudes in the Northern Hemisphere and mid latitudes in the Southern Hemisphere. This coverage will allow measurements to be made within the arctic polar vortex where polar stratospheric clouds form and rapid ozone loss occurs locally in winter and early spring. Greater latitudinal coverage is available from lunar occultation events.

The SAGE III data can be ordered from the Atmospheric Science Data Center at Langley Research Center via their online browse system. The contact information for inquiries is

NASA Langley Atmospheric Sciences Data Center
User Services
Mail Stop 157D
Hampton, VA 23681-2199 USA
Phone 757 864-8656
Web address: http://eosweb.larc.nasa.gov/

Possible Proposal Areas

Investigations are solicited by this Research Announcement in all areas within the scientific scope of the Solar Occultation Satellite Science Team (SOSST) program, with particular emphasis on the extended mission goals. Examples of the kinds of studies that could be supported within the SOSST program are given below.

- Validation – Proposals in this research area should address the validation of satellite occultation and limb-scattering data sets utilizing intercomparison studies with measurements from ground-based, balloon-borne, aircraft, and satellite platforms. Responses in this area should provide a description of the accuracy and precision of correlative data sets and approach to be used. Emphasis will be placed on supporting the validation of SAGE III standard and research data products. Proposals seeking to conduct measurement experiments in support of the second SAGE III Ozone Loss

and Validation Experiment (SOLVE-2) should respond to Appendix C. A smaller number of proposals will also be considered for the validation of observations from other solar occultation data sets such as SAGE II (version 6.1), MSX, POAM III. ACE and the instruments on ENVISAT and ADEOS II.

- Ozone – Support for the analysis of ozone profile measurements obtained by satellite occultation instruments is considered here. These satellite instruments also provide measurements on long-lived, reservoir, and radical gases that are important in controlling ozone. Satellite occultation measurements, either independently or combined with other observational or modeled data sets, can be used to test the general theoretical understanding of the production, loss and transport of ozone in the middle atmosphere and upper troposphere. Studies providing estimates of the diurnal variation of the measured species, examination of ozone changes in the lower stratosphere, and information on the distribution of ozone in the upper troposphere are encouraged.

- Aerosols – Included in this category is the analysis of stratospheric and tropospheric aerosol profiles obtained from satellite occultation instruments, including comparisons on aerosol extinction and derived information on surface area with that from surface-, balloon-, airborne-, and space-based instruments. Investigations on the evolution and distribution of aerosol and clouds and their impact on the radiation balance are also included here. Studies that combine satellite occultation data with data from other space-based or in situ instruments and models are encouraged.

- Trend Studies – This research area focuses on the analyses of long-term solar occultation data sets of vertical profiles of ozone, aerosol, water vapor, air density, and other trace species, including comparison with appropriate ground- and balloon-based measurement networks (Dobson/Umkehr, ozonesondes, dustsondes, frost-point hygrometers, lidars, etc). A major focus of such research should include cross-instrument studies, and examinations of interconsistency between measurements provided by various space-based instruments.

Proposals in other areas will also be considered, including: (i) the development of retrieval techniques to improve existing satellite occultation products and, (ii) the development of new products, such as ozone retrievals from limb-scattering measurements. Proposals in other areas of the SOSST program science are also welcome, although priority will be given to those investigations dealing with the stratosphere and upper troposphere. All proposals should provide an indication of how the proposed work will improve our ability to answer the scientific questions called out in this NRA.

C. The Second SAGE III Ozone Loss and Validation Experiment (SOLVE-2)

Technical Description of the
Second SAGE III Ozone Loss and Validation Experiment (SOLVE-2):
An Aircraft and Balloon Measurement Campaign for SAGE III Validation

Objectives

The second **S**AGE III **O**zone **L**oss and **V**alidation **E**xperiment (SOLVE-2) is a DC-8 aircraft and small balloon measurement campaign plan for January-April 2003, that will focus on acquiring correlative data needed to validate measurements from the Meteor-3M/Stratospheric Aerosol and Gas Experiment (SAGE) III satellite mission. The field campaign will also acquire correlative measurement with the atmospheric chemistry instruments onboard the ADEOS-II and ENVISAT satellite missions to enhance comparison and science activities utilizing these data sets. While complementary science objectives will not be primary factors in the mission design and implementation, it is recognized that validation of these satellite measurements will foster an improved quantitative understanding of polar stratospheric ozone levels and the relationship between the stratospheric temperature, aerosols/clouds and other gas phase species that drive ozone chemistry.

SOLVE-2 is a follow-up to the original SOLVE campaign conducted in the Arctic during the 1999-2000 winter in which direct SAGE III intercomparison activities were not accomplished because the satellite had not launched. This earlier mission had several detailed science objectives in addition to the satellite measurement validation goals. These process scale science objectives became the primary focus of the mission when the SAGE III launch was delayed, although SOLVE data are being used extensively in conjunction with measurements from several other satellite instruments for validation studies. Thus, these SOLVE comparisons will provide a level of indirect validation of SAGE III, ILAS-II, and SCIAMACHY using existing satellite instruments that bridge the SAGE III mission timeframe. Full details regarding the scope of SOLVE can be found at http://cloud1.arc.nasa.gov/solve/index.html. SOLVE-2 will focus on obtaining direct coincident correlative data with SAGE III and, as opportunities become available, with ILAS-II and SCIAMACHY. SOLVE-2 is co-sponsored by the Upper Atmosphere Research Program (UARP), the Atmospheric Chemistry Modeling and Analysis Program (ACMAP), and the Earth Observing System (EOS) of NASA's Earth Science Enterprise (ESE). This type of international partnership fits well within the Integrated Global Observing Strategy (IGOS, http://www.unep.ch/earthw/igos.htm).

SAGE III Validation

SAGE III is the latest in a family of solar occultation satellite instruments designed to monitor distributions of stratospheric and upper tropospheric aerosol, ozone, water vapor, and other important chemically-active trace species with very high vertical resolution of

~0.5 km. Measurements from SAGE III will extend the ~17 year data record collected by SAGE II (1984-present) and provide a valuable data resource that will enable an examination of long-term climate variations and trend analysis.

The first of two SAGE III instruments was launched on December 10, 2001 in a sun-synchronous orbit onboard the Russian Meteor-3M spacecraft. There is a plan to place a second SAGE III instrument on the International Space Station in a mid-inclined orbit sometime in the future. For the Meteor 3M/SAGE III mission, solar occultation measurements will occur mostly at high latitudes in the Northern Hemisphere and mid latitudes in the Southern Hemisphere. This coverage will allow measurements to be made within the Arctic polar vortex where polar stratospheric clouds form and rapid ozone loss occurs locally in winter and early spring. Greater latitudinal coverage is available from lunar occultation events. Figure 1 shows the expected latitudinal coverage of SAGE III measurement locations throughout the year.

Validation of SAGE III science products requires airborne and balloon correlative measurements that are in close temporal and spatial coincidence in order to reduce uncertainties in representative sampling. Added correlative measurements are also needed along the line-of-sight between the satellite and the sun (or moon) to assess the impact of constituent inhomogeneity on the retrieval algorithm. This is especially true in the presence of polar stratospheric clouds or cirrus. The measurement requirements specified below are discussed further in the SAGE III Validation Plan 2000, which can be accessed at http://eospso.gsfc.nasa.gov/validation/sageval.html.

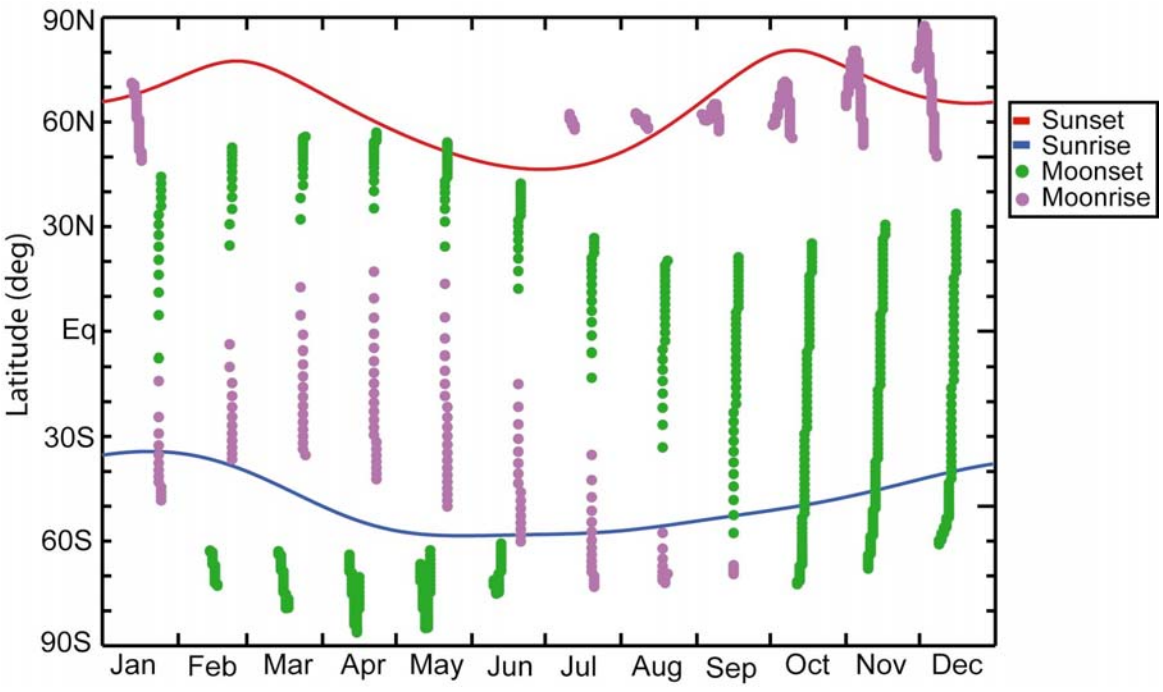

Figure 1: Predicted coverage of the SAGE III measurement locations for solar and lunar occultation events for 2003.

Complementary Science

As indicated above, the primary focus of this mission is on obtaining direct, coincident correlative data for SAGE III validation. Hence, the measurement / instrument requirements are less comprehensive than were included in the original SOLVE mission. Nevertheless, opportunities will exist during SOLVE-2 for addressing complementary science issues. For example, measurements during this short campaign could provide better insight on the initial stages of nitric acid trihydrate (NAT) particle growth in mountain lee waves through the possible identification of the temperature and aerosol backscatter/ depolarization signatures during this critical stage. Within the measurement priorities listed below, the address of other complementary science issues may be equally possible.

Mission Design and Implementation

The validation of the SAGE III science products relies heavily upon comparisons with correlative measurements to assess their relative accuracy and precision (SAGE III Validation Plan, 2000). The SOLVE-2 campaign is designed to acquire such correlative data from the NASA DC-8 aircraft at the tangent measurement locations for solar and lunar occultation events under different meteorological settings. DC-8 underflights with other satellite missions such as POAM III, ENVISAT, or ADEOS II may also be considered during the mission. The aircraft field campaign is scheduled to take place over a 3-4 week period between January 1, 2003 and February 15, 2003, with integration of the aircraft occurring in December 2002. Flights may originate from several sites such as Kiruna, Sweden or Fairbanks, Alaska for validating high latitude solar occultation measurements; and one or more locations at mid-latitudes for validating the lunar occultation measurements.

The SOLVE-2 mission will also include profile measurements of ozone, water vapor, nitrogen dioxide, temperature, pressure, and aerosol size distribution from small balloons. These measurements will provide linkage to previous satellite validation activities and a valuable cross-reference to other long-term records. It is envisioned that such balloon payloads will be launched from the Esrange facility near Kiruna, Sweden, which will be at approximately the same latitude of measurement for SAGE III sunset occultation events during the campaign. It is anticipated that ~ 6-8 balloon launches will be achieved during the campaign. It is also possible that one or two heavy lift balloons carrying remote –sensing instrumentation will be launched during the January-March, 2002 timeframe.

Aircraft Measurements

An important aspect of the aircraft payload is the ability to obtain vertical profile measurements to maximize the range of overlap with SAGE III profile data. This will also permit measurements to be obtained along the satellite sun (moon) slant path to gain

better understanding on the impact that clouds or inhomogeneities in the constituent distributions may have on the algorithm retrieval. These measurements will also serve to verify the altitude registration of the SAGE III profile measurements.

Measurement Priorities

A. Ozone

SAGE III will measure ozone concentration from cloud top to 85 km with an accuracy of about 6% at the peak and a vertical resolution of 0.5 km. Validation of this product over this height range is beyond the scope of this mission. Instead, this mission will focus on obtaining correlative ozone measurements in the upper troposphere and lower to mid-stratosphere. Accurate knowledge of ozone trends in this region near the tropopause is critical for assessing radiative forcing. Historically, this is the same altitude regime in which SAGE II has had its greatest uncertainties in ozone trend assessments.

To address the vertical extent of the SAGE III and other ozone measurement variability over the slant path (line-of-sight) of approximately 200 km for a given altitude, we hope to include zenith and nadir viewing lidar measurements of ozone concentrations on the DC-8 instrument payload. Lidar measurements provide high precision, but have lower accuracy; thus, an *in situ* ozone concentration measurement should also be included. Lidar profile measurements should extend to an altitude of at least 10 km above flight altitude. *In situ* observations should cover the operational altitude range of the aircraft.

B. Aerosols

SAGE III will measure aerosol extinction at seven wavelengths ranging from 385 to 1550 nm in the troposphere and stratosphere. Validation of these measurements as well as inferred products such as aerosol surface area will be based on intercomparisons with different instruments. We anticipate that a number of aerosol instruments identified in the SAGE III validation plan will be included in SOLVE-2.

Lidar aerosol and cloud measurements

Vertical lidar backscatter measurements provide an excellent method for examining the vertical and horizontal variability of aerosol and optically thin cloud along the SAGE slant path. Because the aerosol lidar retrieval is strongly affected by the normalization procedure, measurements should reach heights above 30 km, where Rayleigh scattering dominates the backscatter return. Measurements must have 0.5 km vertical resolution or better. Depolarization measurements are further required to discriminate between spherical and non-spherical particles.

In situ particle samplers

The multi-wavelength SAGE III aerosol measurements provide estimates of aerosol surface area. Well-calibrated instruments are needed to validate these estimates over

aerosol particle size distributions in the sub-micron size range. Aerosol composition in the stratosphere and upper troposphere is needed to examine variability of the backscatter-to-extinction conversion factor. Instruments should be able to measure particle optical surface area to better than a factor of two.

Solar radiometer

Radiometers can provide slant-path optical depth measurements at many of the same wavelengths measured by SAGE III. Such measurements can further be differentiated during aircraft ascents or descents to yield vertical extinction profiles for intercomparison. These data will also enable profiles of aerosol extinction to be compared with those derived from *in situ* particle samplers or inferred from lidar backscatter observations.

C. Water vapor

Although water vapor measurements of the upper troposphere and lower stratosphere have been conducted since the late 1940's, considerable disagreement remains between different measurement techniques. Consequently, SAGE III validation will include a series of water vapor measurement intercomparisons to bracket its accuracy against other aircraft and balloon instruments. In situ water vapor measurements will be needed with an accuracy of ~10% for the upper troposphere and <25% for the stratosphere. Lidar profile measurements will also be needed to examine its variability in the troposphere along the SAGE III slant path. Measurements are also desired in the stratosphere, where variations near PSCs could provide insight on cloud formation. Such profile measurements should extend at least 10 km above and 5 km below flight altitude in clear sky conditions.

D. Temperature, Pressure and Altitude Registry

SAGE III will make temperature profile measurements, a capability not realized by either of its predecessors. Temperature profiles also will be used to help interpret PSC measurements and to calculate the altitude of the tropopause. Profile measurements are needed from a point several kilometers below the aircraft to a height of about 35 km.

The accurate determination of the transmission profile is fundamental to the retrieval of all species. For SAGE I, altitude registration errors of about 200 to 400 m resulted in biases in ozone mixing ratio and other species. For SAGE III, altitude registration with an uncertainty of < 100 m is desired. Validation may be achieved by measuring the altitude of the top of an optically thick cloud that lies along the slant path. It may also be achieved by matching profiles of aerosol, ozone, and water vapor, especially near the tropopause where strong vertical gradients exist. A combination of upward and downward viewing lidar profiles acquired along aircraft survey and staircase flights should provide this information.

E. Nitrogen Dioxide and Chlorine Dioxide

Correlative observations of NO_2 and OClO are needed to compare with SAGE III measurement profiles. Nitrogen dioxide will be observed during both solar and lunar occultation events and are needed over the altitude range of about 20 km to 35 km. OClO will only be observed during lunar occultation events. Techniques that can provide either profile or column coincident measurements are desired.

F. Facility Measurements

DC-8 facility measurements of time, position (latitude, longitude, and both radar and pressure altitude), attitude angles, and *in situ* temperature will be available to investigators.

G. Balloon-borne Measurements

Balloon-borne *in situ* or remotely sensed observations of O_3, NO_2, and H_2O will provide valuable profile data at latitudes near coincident with SAGE III sunset occultation measurements of these same species. *In situ* measurements of aerosol size distribution and surface area will similarly provide validation for SAGE III estimates of these parameters. Concurrent temperature and pressure measurements are also required to determine altitude and aid in scientific analysis. Additional measurements HNO_3, BrO, ClO, CO, CO_2, CH_4, CFC-11, CFC-12, N_2O, $ClONO_2$, HCl, and HF will aid validation efforts for ILAS-II and SCIAMACHY, other atmospheric chemistry instruments, as well as enhance the interpretation of SAGE III observations.

Mission Requirements / Instrumentation: DC-8 Payload

Table 1 lists a set of candidate DC-8 instruments. Priority 1 instruments are those that are thought to meet the basic SAGE III validation requirements and some validation requirements for ILAS-II and SCIAMACHY. Priority 2 instruments complement the basic validation objectives with additional comparison support for SAGE III, ILAS-II and SCIAMACHY. Proposers are reminded that the following are intended to represent a class of instrument capabilities and other techniques of equal or superior capability would certainly be considered. Unless specified otherwise, measurements should have adequate instrument response to support the validation of SAGE III products in the stratosphere and upper troposphere (the expected sensitivity of SAGE III measurements are listed on the web site). If needed, a combination of instrument proposals may be selected to provide the needed measurement data set.

Desired Measurements	Candidate Instrumentation	Priority
O_3 Concentration (troposphere and stratosphere)	lidar, microwave radiometer, *in situ* techniques	1
Aerosol Extinction (wavelengths 385 nm - 1550 nm); Size Distribution; Depolarization	lidar, solar radiometer, particle samplers	1
H_2O Concentration (troposphere and stratosphere)	lidar, diode laser hygrometer, photofragment fluorescent hygrometer, and other in situ techniques	1
Temperature / Pressure	lidar, microwave radiometer, in situ probe	1
NO_2	solar radiometer, FTIR, UV/Vis spectrometer	2
OClO	inferred from microwave radiometer	2
Solar Imager	CCD imager	2
Long-lived Tracers N_2O, CO_2, CO, CH_4	*in situ* techniques	2
HNO_3	Mass spectrometry, Microwave radiometer	2
ClO, BrO	Microwave radiometer	2
Reservoir Compounds $ClONO_2$, HCl	Remote-sensing Techniques	2

Table 1. Measurement requirements and candidate instrumentation for the DC-8

Instrument selection will be based upon a combination of cost, measurement priority, heritage of the measurements / instruments proposed, and available space on the DC-8. At the end of each flight, each investigator will be required to produce a preliminary data set for exchange with other measurement investigators and SOLVE-2 managers for use in subsequent flight planning. These data will also be made available to members of the SAGE III Science Team for their validation studies. A final submission of data, with supporting documentation, to a central data facility is required approximately six months following completion of the mission.

Mission Requirements / Instrumentation: Balloon Payload

The desired balloon-borne measurements include *in situ* and/or remotely-sensed O_3, H_2O, NO_2, NO_3, HNO_3, BrO, ClO, CO, CO_2, CH_4, CFC-11, CFC-12, N_2O, $ClONO_2$, HCl, HF aerosol characteristics, pressure and temperature. These measurements may be made by combining instruments on a single gondola or on free-flying balloons launched simultaneously.

Theoretical Investigations

Given the validation focus of SOLVE-2, extensive in-the-field theoretical, analytical, modeling, and observational analysis support is not being solicited for this mission. The data from SOLVE-2 will be available to the international scientific community as soon as possible following completion of the mission, as has been done for past field experiments. However, meteorological forecasts of ground conditions and stratospheric fields will be required for directing DC-8 and balloon operations. Hence, proposals for providing such meteorological forecasting as well as flight planning are encouraged. Such investigators are expected to actively participate in mission development activities and in-field operations.

Mission Logistics

An initial science team meeting for selected investigators and program/project management will be held in late 2002 at a location yet to be determined. The overall mission has the following tentative schedule.

DC-8 Deployment Schedule

The DC-8 activities are as follows:

- DC-8 integration and test flights will occur in December 2002.
- DC-8 mission flights will be staged over a 3-4 week period between January1, 2003 and February 15, 2003.

Staging locations for the DC-8 are under consideration and will be finalized in 2002. Being evaluated for the high latitude base of operations are Kiruna, Sweden or Fairbanks, Alaska. For the mid-latitude flights, it is expected that the either the Azores or Hawaii will provide a suitable base of operations. Experimenters can expect heated hanger space, but limited telecommunications and ground lab facilities. Internet connections are not guaranteed except through commercial analog telephone service.

Balloon Launch Schedule

It is expected that balloon operations for other than free-flying sondes will be conducted by the National Scientific Balloon Facility which will provide the balloon-launching

capability, telemetry, and recovery as they have done for past operations in New Mexico, Texas, Alaska, Canada, Brazil, and Sweden. Investigators will be responsible for the launches of any free-flying, hand-launched balloons for water vapor, nitrogen dioxide, aerosols, and/or ozone.

As indicated above, the Esrange balloon and rocket launch facility near Kiruna, Sweden (67.8˚N, 20.4˚E) is being considered as the primary SOLVE-2 balloon launch location due to its proximity to the latitude of SAGE III sunset occultations. Launches will be centered on the 3-4 week DC-8 deployment period in January / February 2003. However, the launches could occur as early as late November 2002 and as late as April 2003 to maximize satellite comparison opportunities.

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 that apply only to proposals prepared in response to that particular announcement. These instructions contain the general proposal preparation information that 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 C

Required Proposal Cover Pages

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

The second proposal cover page (Appendix D) must be submitted **electronically** to the SYS-EYFUS Web site located at **http://proposals.hq.nasa.gov/**.

If the proposer obtained a User ID and password in the process of submitting a proposal for a previous research opportunity announcement, the same user UserID and password can be used to complete the electronic proposal cover page in response to this research opportunity announcement. Be sure to click on "Edit Personal Information" if any of your correspondence information in the SYS-EYFUS is not current.

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

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

Once you receive your User ID and Password, **login** to the SYS-EYFUS Web site and follow the instructions for **New Proposal Cover Page.**

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

Appendix D

Proposal Cover Page

Proposal Number: _____

Date: __/___/_____

Name of Submitting Institution: **Congressional District:**

Proposal Title:			
Name of Submitting Institution:		**Congressional Distinct:**	

Certification of Compliance with Applicable Executive Orders and US Code

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

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

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

NASA PROCEDURE FOR HANDLING PROPOSALS

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

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

Co-Investigator:

Name	Telephone	Email	Institution	Address

Budget:

Year	
1	
2	
3	
Total	

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

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

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

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

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

1. LOBBYING

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

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

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

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

2. GOVERNMENTWIDE DEBARMENT AND SUSPENSION

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

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

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

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

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

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

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

APPENDIX E

BUDGET SUMMARY

For period from _____ to _____

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

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

***Facilities and Administrative Costs.**

INSTRUCTIONS FOR BUDGET SUMMARY

1. Direct Labor (salaries, wages, and fringe benefits): Attachments should list the number and titles of personnel, amounts of time to be devoted to the grant, and rates of pay.
2. Other Direct Costs:
   a. Subcontracts: Attachments should describe the work to be subcontracted, estimated amount, recipient (if known), and the reason for subcontracting.
   b. Consultants: Identify consultants to be used, why they are necessary, the time they will spend on the project, and rates of pay (not to exceed the equivalent of the daily rate for Level IV of the Executive Schedule, exclusive of expenses and indirect costs).
   c. Equipment: List separately. Explain the need for items costing more than $5,000. Describe basis for estimated cost. General purpose equipment is not allowable as a direct cost unless specifically approved by the NASA Grant Officer. Any equipment purchase requested to be made as a direct charge under this award must include the equipment description, how it will be used in the conduct of the basic research proposed and why it cannot be purchased with indirect funds.
   d. Supplies: Provide general categories of needed supplies, the method of acquisition, and the estimated cost.
   e. Travel: Describe the purpose of the proposed travel in relation to the grant and provide the basis of estimate, including information on destination and number of travelers where known.
   f. Other: Enter the total of direct costs not covered by 2a through 2e. Attach an itemized list explaining the need for each item and the basis for the estimate.
3. Indirect Costs*: Identify F&A cost rate(s) and base(s) as approved by the cognizant Federal agency, including the effective period of the rate. Provide the name, address, and telephone number of the Federal agency official having cognizance. If unapproved rates are used, explain why, and include the computational basis for the indirect expense pool and corresponding allocation base for each rate.
4. Other Applicable Costs: Enter total explaining the need for each item.
5. Subtotal-Estimated Costs: Enter the sum of items 1 through 4.
6. Less Proposed Cost Sharing (if any): Enter any amount proposed. If cost sharing is based on specific cost items, identify each item and amount in an attachment.
7. 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.

* Facilities and Administrative (F&A) Costs