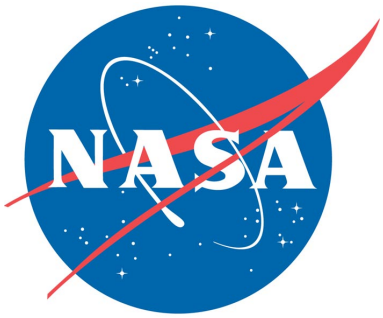

National Aeronautics and
Space Administration
Headquarters
Office of Earth Science
300 E Street SW
Washington, DC 20546

Earth Science Enterprise
NNH04ZYS004N

NASA RESEARCH ANNOUNCEMENT

MEASUREMENTS, MODELING, AND ANALYSES IN SUPPORT OF AURA AND OTHER NASA SATELLITE OBSERVATIONS OF THE EARTH'S ATMOSPHERE

Including contributions from:
Atmospheric Composition Focus Area

CATALOG OF FEDERAL DOMESTIC ASSISTANCE (CFDA) NUMBER: 00.000
ISSUED: June 14, 2004

DUE DATES:
Notice of Intent – July 14, 2004
Proposals – August 30, 2004
INTEX-B Proposals – September 30, 2004

OMB Approval No. 2700-0087

MEASUREMENTS, MODELING, AND ANALYSES IN SUPPORT OF AURA AND OTHER SATELLITE OBSERVATIONS OF THE EARTH'S ATMOSPHERE

NASA Research Announcement
Soliciting Research Proposals
For Research Commencing
On or After
November 1, 2004

NN-H-04-Z-YS-004-N

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

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NASA RESEARCH ANNOUNCEMENT

MEASUREMENTS, MODELING, AND ANALYSES IN SUPPORT OF AURA AND OTHER SATELLITE OBSERVATIONS OF THE EARTH'S ATMOSPHERE

1. FUNDING OPPORTUNITY DESCRIPTION

A. Overview

The NASA vision is

To improve life here,
To extend life to there,
To find life beyond.

The NASA mission is

To understand and protect our home planet
To explore the universe and search for life
To inspire the next generation of explorers
…as only NASA can.

The NASA Earth Science Enterprise:

The goal of NASA's Earth Science Enterprise (ESE) is to develop a scientific understanding of the Earth system and its response to natural and human-induced changes, thereby improving predictive capabilities for climate, stratospheric ozone, weather, global air quality, 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, leveraging the unique observation vantage point from space. The Earth system components interact on a continuum of spatial scales ranging from local and regional to global, and on temporal scales from short-term daily weather to long-term, multi-decadal climate cycles. The Enterprise 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 Earth Science Enterprise has defined its Research Strategy around a hierarchy of scientific questions. At the highest level, the Enterprise is attempting to provide an answer to the one overarching question **"How is the Earth changing and what are the consequences for life on Earth?"** The magnitude and scope of this question are too large to allow a simple answer.

Hence, a next tier of questions provides a structure for the conceptual approach that ESE is taking to improve our knowledge of the Earth system.

- *How is the global Earth system changing?*
- *What are the primary causes of changes in 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 will the Earth system change in the future?*

These five questions define a pathway of "variability, forcing, response, consequence, and prediction" that is taken to further enumerate more specific questions, which provide direction and focus to the program. This structure highlights one of the most important and intellectually demanding challenges of the study of the Earth system – most responses that the Earth system makes to a forcing (either natural or human-induced) can become forcing factors themselves. Thus, the understanding of such feedback processes is central to NASA's study of the Earth system.

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 Enterprise Strategy, http://www.earth.nasa.gov/visions/ESE_Strategy2003.pdf, recognizes the need for close linkages 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. 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 President's Climate Change Science Program Plan, http://www.climatescience.gov/.
The frontier of Earth system science is to: (1) explore interactions among the major components of the Earth system – continents, oceans, atmosphere, ice, and life, (2) distinguish natural from human-induced causes of change, and (3) understand and predict the consequences of change. NASA has established six scientific focus areas for these complex processes. These scientific focus areas are: Atmospheric Composition, Carbon Cycle and Ecosystems, Climate Variability and Change, Earth Surface and Interior, Water and Energy Cycle, and Weather. Roadmaps have been developed to summarize the technology, observations, modeling, field campaigns, basic research, and partnerships needed over time to achieve the long-term goals for each of these focus areas (http://earth.nasa.gov/roadmaps/). The roadmap for Atmospheric Composition focus area provides the strategic framework for research under this NRA. ESE focus areas are interrelated and their integration will eventually lead to a fully interactive and realistic Earth system representation.

The opportunities for research offered in this NRA fall primarily within the Atmospheric Composition Focus Area, but there are strong interrelationships with other focus areas that must not be overlooked in research plans. For example, there is strong linkage between the Atmospheric Composition focus area and the Climate focus area through the measurement of radiatively active trace gases and the impact of aerosols on the earth radiation budget either

directly or through the modification of clouds and ice sheet albedo. *Successful proposals responding to this NRA will identify how the research will contribute to the aforementioned focus areas.* Furthermore, ESE focus areas are interrelated and proposers are encouraged to illustrate how their research integrates or builds linkages among them. This is consistent with NASA's role in supporting development of a fully interactive and realistic Earth system representation.

B. Introduction

With the planned launch of the Aura spacecraft in mid-CY 2004, NASA will be providing the research community with significant new capability that will provide products of use to a broad range of policy and decision-makers, including NASA's domestic and international partners. The full range of Aura's capability may be found on the EOS Project Science web site (http://eos-aura.gsfc.nasa.gov/). New capabilities include:

- First global measurements of the vertical profiles of tropospheric ozone and several key precursors
- Global measurements of column amounts of ozone, nitrogen dioxide, and other constituents that can be used to assess tropospheric and stratospheric composition
- Highest horizontal resolution global measurements of vertical profiles of ozone, water vapor, and related chemical constituents in the upper troposphere and lower stratosphere
- First-ever global observation of profiles of several important trace gases in the stratosphere, most notably the hydroxyl radical
- A comprehensive measurement of aerosol and cloud properties making use of a combination of wavelengths not available on any other space-based platform

This capability will contribute directly to the development of long-term "climate data records" for a limited number of atmospheric parameters, provide new climatological information about the distribution and variation of other atmospheric parameters, and investigation of atmospheric chemical and dynamical processes on a global scale. It is the Earth Science Enterprise view that one of the most important contributions of the Aura Mission to Earth System Science will come from the synergistic use of satellite observations, sub-orbital observations, and models that can assure the accuracy of the new Aura observations, provide ways of looking at atmospheric composition not possible with suborbital data alone. This combination of assets will synthesize Aura observations into data sets for scientific research and use by others for policy and/or decision-making.

C. Project Goals and Proposal Classification

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 either alone or in conjunction with other kinds of data or models. The goals of this research are to answer the key science questions listed below. Whereas 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 atmospheric composition changing?*
- *What trends in atmospheric constituents and solar radiation are driving global climate?*
- *How do atmospheric trace constituents respond to and affect global environmental change?*
- *What are the effects of global atmospheric chemical and climate changes on regional air quality?*
- *How will future changes in atmospheric composition affect ozone, climate, and global air quality?*

The questions that have been defined by the CCSP in the area of atmospheric composition are:

- What are the climate-relevant chemical, microphysical, and optical properties, and spatial and temporal distributions, of human-caused and naturally occurring aerosols?

- What are the atmospheric sources and sinks of the greenhouse gases other than CO_2 and the implications for the Earth's energy balance?

- What are the effects of regional pollution on the global atmosphere and the effects of global climate and chemical change on regional air quality and atmospheric chemical inputs to ecosystems?

- What are the characteristics of the recovery of the stratospheric ozone layer in response to declining abundances of ozone-depleting gases and increasing abundances of greenhouse gases?

- What are the couplings and feedback mechanisms among climate change, air pollution, and ozone layer depletion, and their relationship to the health of humans and ecosystems?

These CCSP questions are reproduced here so that proposers can focus their research efforts on NASA's unique contributions toward these national priorities. 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. Priority will be given to proposals that illustrate the value of space-based remotely sensed observations, either alone or in conjunction with suborbital observations and models that contribute to our understanding of chemistry-climate interactions on the global and continental scale.

Question 1: How is atmospheric composition changing?

Congress, through the 1976 NASA Authorization Act, mandated NASA to document the variability and long-term changes in stratospheric ozone and the atmospheric halogen abundance. In order to document and understand the sources of variability and change, a scientifically robust understanding of these changes and their transient variations and longer-term changes requires the analysis and modeling of accurate and consistent long-term observations of ozone distribution (both total column and vertical profiles), together with a suite of ozone-related and climate-related parameters and atmospheric constituents. Aura observations will play a major role in recording such atmospheric variability and change together with data sets from other

satellite instruments (see list in appendix Q) and the ground based networks (Dobson/Umkehr, NDSC/AGAGE). Aura's unique contribution to this question comes from the satellite's capability to measure ozone in the lower stratosphere where trends have a large uncertainty and have not been explained.

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, especially on the aerosols that can 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 their optical and physical properties. Global profile measurements of the distribution and properties of aerosols in the stratosphere and troposphere are needed to define this important climate forcing.

Aura will continue global measurements of total aerosol abundance as well as provide information on aerosol chemical composition. Hence, desired research in this category includes the analysis of stratospheric and tropospheric aerosol products, including comparisons of derived information on aerosol size and surface area among surface-, airborne-, balloon-, and space-based instruments.

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, aircraft and from the ground in order to provide a better understanding of its distribution, long-term variation, and trends. The ozone measurements on Aura will play a critical role in continuing this long-term essential database. Important studies are those directed at the intercomparison of Aura (and other satellite) ozone measurements with data from ground-based, balloon, and airborne platforms. Studies making use of multi-dimensional atmospheric chemistry/transport models together with various measurements of the spatial and temporal variations of tropospheric ozone are also encouraged.

Measurements of various source gases and their degradation products (such as those in the halogen and nitrogen families, H_2O, CH_4, etc.) play a strong role in chemistry-climate coupling and information on their atmospheric abundances, distributions, and trends will be enhanced by Aura observations. Proposals for comparative measurement studies and modeling analyses of such species are solicited.

Question 3: How do atmospheric trace constituents respond to and affect global environmental 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.

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. Issues of particular interest include potential changes in the stability of the wintertime polar vortices, effects of temperature changes on reactions that occur on aerosol and/or cloud particle surfaces, effects of changes in stratospheric water vapor that may result from changes in trace gas distributions or cross-tropopause fluxes, and radiative feedback of stratospheric ozone changes.

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. Particular interest is given to integrated studies of radiative/dynamical/chemical couplings at high latitudes and to combined studies of satellite data with higher vertical resolution data (e.g., lidar) for the tropopause regions.

Question 4: What are the effects of global atmospheric 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 ozone precursors, as well as aerosol particles and their precursors.

Satellite observations provide evidence of the large-scale effects of such emissions on the troposphere. There are currently few space-based global observations of tropospheric ozone, key trace gases, or aerosol particles and none provide the vertical resolution required to adequately address this question. Aura measurements are expected to provide significant improvements to these databases. Proposals addressing the determination and critical evaluation of tropospheric ozone, aerosol, ozone precursor species and water vapor distributions using Aura and other satellite data either independently or together with other satellite and/or suborbital data sets, will be considered here. The analysis 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. Proposals are solicited for the analysis of existing field experiment data sets, improvement and/or intercomparison of existing instrumentation. Proposals that focus on the analysis of satellite only or integrated satellite-suborbital data will be favored. Proposals for instrument development should document how the new capability can enhance NASA's ability to improve our knowledge of tropospheric chemistry and transport in the context of integrated suborbital and satellite studies and respond to the measurement requirements in the Aura Validation Plan. Instrumentation should be compatible with existing suborbital platforms and preference will be given to instruments that can operate on both existing and the new evolving suborbital platforms.

***Question 5: How will future changes in atmospheric composition affect ozone, climate, and global air quality*?**

Prediction of the evolution of atmospheric composition is intimately linked to that of the meteorological conditions under which chemical and transport processes occur. Accurate modeling of atmospheric composition requires knowing or forecasting the future evolution of chemical forcings as well as relevant changes in climatic conditions. 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. The integration of Aura data, together with those from other space-based and sub-orbital measurements, is expected to enhance this predictive ability.

Investigations in the following categories are being solicited:

A) **Validation of Aura observations** Radiance level validation of Aura observations – this most basic and lowest level comparison would typically involve either vicarious calibrations made by comparing Aura observations to surface sites with well-measured properties during satellite overflights, or suborbital (typically aircraft) measurements in which radiometers of known calibration are flown to enable coincident measurements with those obtained by the Aura instruments

1) Assessment of smaller-scale variability in Aura observations – this involves the use of suborbital platforms to make measurements that can remove the need for assumptions about the nature of the horizontal or vertical variability within an Aura observational footprint about the nature of the distribution of a parameter of interest and/or interfering species (including effects associated with variability along the long path length of limb-viewing instruments as well as heterogeneity within the observing scene for nadir-viewing instruments)
2) Comparison of Aura measurements with coincident or near-coincident measurements, emphasizing retrieved geophysical quantities – this involves comparison of Aura observations with comparable ones made from the ground, from suborbital platforms, or from other satellites

B) **Extension of Aura observations** These may be broken into two categories:

1) Comprehensive coincident observation of parameters not measured by Aura – this includes the extension of Aura observations by measuring species not measurable by Aura (e.g., gas phase precursors for aerosols measured by Aura, free radicals not measured that are produced from reservoir and/or source gases measured by Aura)
2) Coincident or near-coincident measurement of Aura-observed species at greater resolution than allowed by Aura – these observations are not so much important for Aura validation (although they may contribute to that) but that they provide a more

useful data set (albeit one for which there will be much less geographic and/or temporal coverage) for process study than can be obtained from Aura

C) **Models that use, predict, and/or assimilate Aura observations** These may be broken into several categories:

1) Models that inter-relate Aura observations or those of Aura with measurements from other observing platforms, including those that can assist in identifying near-coincident measurement opportunities, and those that are used to test for consistency between related observations under a broad range of conditions
2) Models that may be used to provide assimilated data sets for observations made with Aura instruments, either independently or in concert with observations from other platforms
3) Models that may be used to improve Aura retrievals, including those that are used for assimilation of radiances as part of retrieval efforts or determinations of meteorological or other parameters obtained through inclusion of Aura data in data assimilation systems
4) Predictive models for which Aura observations may be used for initialization and/or quantitative evaluation

D) **Laboratory and related theoretical observations that are needed to improve the accuracy of Aura retrievals.** These may be broken into two categories:

1) Laboratory measurements of the spectral properties of Aura-observed quantities or those of any interfering quantity, emphasizing the temperature and pressure conditions needed to assure accuracy of retrievals over the full range of atmospheric conditions sampled by Aura
2) Theoretical and/or modeling approaches that may be used to help extend laboratory observations made under a more limited set of temperature/pressure conditions to the fuller range of such conditions sampled by Aura instruments in the atmosphere

This NRA reflects significant work carried out over the past several years by the Aura team to define those observations that are most important for its validation (http://aura.gsfc.nasa.gov/mission/validation.html). It also builds on significant effort by the atmospheric composition research community to demonstrate how synergistic use of different types of atmospheric observations and/or models can lead to improvements in understanding and/or quality of products made available for research and/or application.

E) **Investigations that will contribute to measurements, modeling, and data analysis research supported under the Earth Science Enterprise's Atmospheric Composition focus area**. This NRA specifically addresses the activities summarized above and described in more detail described in Appendix A. These include ground-based, balloon-borne, and aircraft-borne (hereafter referred to as sub-orbital) measurements of atmospheric parameters and constituents that are pertinent to the validation and scientific use of data products from satellite platforms. Proposals that address the ongoing improvement, maturation, and operations of existing measurement systems (such as those traditionally supported by the Upper Atmosphere Research Program, the Radiation Science Program, and the Tropospheric Chemistry Program) are included

in this category. However, priority will be given to those measurements that address the science questions discussed above as well as enhance, supplement and/or complement activities planned jointly by the EOS Aura Instrument Science Teams and the ESE Research and Analysis Programs to characterize and validate the accuracy of remotely-sensed atmospheric geophysical parameters derived by the instruments on Aura and other remote sensing satellites. The participation of instruments and investigators in several satellite validation and associated science field measurement campaigns (as detailed in Appendix A) is also solicited. Further, this NRA solicits 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 (with an emphasis on satellite data validation and and use of this data to answer scientific questions). Proposals are also solicited for additional basic laboratory spectroscopic studies not funded under previous NRA's covering this time period that contribute directly to the improved retrieval of atmospheric geophysical parameters from the EOS Aura instruments, specifically the Tropospheric Emission Spectrometer (TES), the Microwave Limb Sounder (MLS), the Ozone Monitoring Instrument (OMI), and the High Resolution Dynamics Limb Sounder (HIRDLS).

Proposal Standards

Participation is open to all categories of domestic and foreign organizations, including educational institutions, industry, non-profit institutions, NASA Centers, and other US 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 directly by NASA

All policies and procedures for the preparation and submission of proposals, as well as those for NASA's review and selection of proposals for funding, are now presented in a separate document entitled "Guidebook for Proposers Responding to NASA Research Announcements" that is located at http://www.hq.nasa.gov/office/procurement/nraguidebook/.

By reference, the newest edition of this "Guidebook for Proposers Responding to a NASA Research Announcement, Edition 2004 (January 2004)" is hereby incorporated into this NRA, and proposers to this NRA are responsible for understanding and complying with its procedures before preparing and submitting their proposals. Proposal that do not conform to its standard may be declared noncompliant and returned without review.

The other chapters and appendices of this "Guidebook for Proposers Responding to a NASA Research Announcement" provide supplemental information about the entire NRA process, including NASA policies for the solicitation of proposal, guidelines for writing complete and effective proposals, the NASA policies and procedures for the review and selection of proposals as well as for issuing and managing the awards to the institutions that submitted selected proposals, and Frequently Asked Questions (FAQ's) about a variety of the NASA proposal and award processes and procedures. Note that the NASA policy for proposals involving non-U.S. participants is given in Section (1) of Appendix B of this Guidebook.

Safety is a top priority for all of NASA's programs. As such, all proposers should regard the following statement:

> Safety is the freedom from those conditions that can cause death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment. NASA's safety priority is to protect: (1) the public, (2) astronauts and pilots, (3) the NASA workforce (including employees working under NASA award instruments), and (4) high-value equipment and property."

2. AWARD INFORMATION

A. Terms and Level of Funding Available

Funds are not currently available for awards under this NRA. The Government's obligation to make award(s) is contingent upon the availability of appropriated funds from which payment can be made and the receipt of proposals that NASA determines are acceptable for award under this NRA. The anticipated levels of available funding and the guidance for project sizes for the various components of this NRA are summarized below. Approximately $ 20 million per year is expected to support proposals selected under this announcement. NASA will consider a wide range of study sizes. The typical annual budget for a project is expected to be $100,000 - $350,000. Proposed projects with budgets exceeding the suggested maximum project funding may be accepted, but must clearly demonstrate exceptional programmatic and technical merit that warrants the elevated funding level. Only the most critical projects with broad scope may propose an annual budget not to exceed $600,000. Continuation of support of selected proposals beyond the first year is contingent upon satisfactory performance, continued relevance, and the availability of funds.

B. Commercially Available Data Sets

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 they meet scientific requirements and are cost-effective. When responding to this NRA, the proposer should identify the commercial data sources intended for use and the associated cost. Costs for any other types of required data should also be identified in the budget request.

3. ELIGIBILITY INFORMATION

A. Eligible Applicants

Participation in this program is open to all categories of U.S. and non-U.S. organizations, including educational institutions, industry, nonprofit institutions, as well as NASA centers, and other U.S. Government agencies. Historically Black Colleges and Universities, other minority educational institutions, and small businesses and organizations owned and controlled by socially and economically disadvantaged individuals or women are particularly encouraged to apply. Participation by non-U.S. organizations in this program is encouraged subject to NASA's policy

of no-exchange-of-funds. Participation by non-U.S. institutions must be proposed within the specific guidelines described in Appendix C, sections (l) and (m), which include a no-exchange-of-funds provision. Further information on foreign participation is provided in Section §1260.12(e), "Choice of award instrument" of the NASA Grant and Cooperative Agreement Handbook. This Handbook is located at: http://ec.msfc.nasa.gov/hq/grcover.htm.

B. Cost Sharing or Matching

If an institution of higher education, hospital, or other non-profit organization wants to receive a grant or cooperative agreement, cost sharing is not required: however, NASA can accept cost sharing if it is voluntarily offered. Section B, Provision §1260.123, "Cost sharing or matching" describes the acceptable forms of cost sharing. If a commercial organization wants to receive a grant or cooperative agreement, cost sharing is required, unless the commercial organization can demonstrate that they will not receive substantial compensating benefits for performance of the work. If no substantial compensating benefits will be received, then cost sharing is not required, but can be accepted. Section D, Provision §1274.204, "Costs and Payments" of the NASA Grant and Cooperative Agreement Handbook describes the acceptable forms of cost sharing.

4. PROPOSAL AND SUBMISSION INFORMATION

A. Source of Application Materials

All applicants must provide the Dun and Bradsteet (D&B) data Universal Numbering System (DUNS) number for their organization in the Cover Page of their proposal. Responses to this NRA are all considered prospective new awards but note that for other NASA announcements requests for renewals of awards will also require a DUNS number. The DUNS number is a unique nine-character identification number provided by the commercial company Dun & Bradstreet (D&B). Applicants may call D&B at 1-866-705-5711 to register and obtain a DUNS number, or access the D&B website at: http://www.dnb.com/us/. The process to request a DUNS number by telephone take about 10 minutes and is free of charge. The process to obtain a DUNS number through the website takes about fourteen days, and is also free of charge. Organizations will use the same DUNS number with every proposal submitted for a Federal grant and cooperative agreement. Note that the DUNS number is site-specific.

NASA also requires the applicant's organization to be registered in the Central Contractor Registration (CCR) database and obtain a Commercial and Government Entity (CAGE) code prior to submitting a proposal. The purpose of this requirement is to help centralize information about grant recipients and provide a central location for grant recipients to change organizational information. Information for registering in the CCR and online documents can be found at http://www.ccr.gov. Before registering applicants and recipients should review the Central Contractor Registration Handbook, which is also located at http://www.ccr.gov. The process for obtaining a CAGE code is incorporated into the CCR registration.

B. Content and Form of the Application Submission

Appendices B through E contain NASA general guidelines and requirements 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. Awards will be made

for periods of up to three years for projects that are approved under the terms of this announcement, although NASA reserves the option of extending the duration of some of the selected investigations as necessary. 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 available.

Technical information contained in Appendix A applies to this Research Announcement only. This appendix has several components under which a proposer may apply. Thus, proposers should identify the component under which they are seeking support. Separate budgets must be provided in cases where activities are proposed under more than one component. The budget for each component should identify both baseline and mission-specific-deployment costs. Selections for the various components may not be made and announced at the same time, but may be made sequentially. All investigators selected as a result of this announcement are expected to make available, to NASA, all developed techniques, methods of analysis, results, and data over the course of their investigation, in agreement with the NASA Earth Science Enterprise Data Policy http://www.earth.nasa.gov/visions/data-policy.html.

All prospective proposers are strongly encouraged to submit a letter of intent to propose in response to this announcement by the close of business on **July 14, 2004**. This letter will help to expedite planning for the proposal review process. The letter of intent may be submitted electronically through the Internet by completing the forms at URL http://www.earth.nasa.gov/LOI. You are urged to use these electronic letter of intent forms unless you do not have access to the Internet. In that case, we will accept a FAX copy sent to 202-554-3024 with the following information:

- PI and CoI names and addresses, (including Zip + 4)
- NRA Identifier
- Title of proposal
- Telephone number
- Fax number
- Email address

A brief summary of your proposal including any plans for aircraft usage. (Please limit this summary to no more than 3000 characters).

C. Proposal Submission Dates, Time, and Location

Proposals whose primary focus is on the support of the INTEX-B component of the AURA validation Plan will be due by the close of business on **September 30, 2004**. All other proposals submitted in response to this announcement are due by the close of business on **August 30, 2004**. Late proposals will not be considered for review and funding unless it is judged to be in the interest of the US Government. A complete proposal schedule is given below:

Release Date	June 14, 2004
Notice of Intent Due	July 14, 2004
First Round of Proposals Due	4:00 p.m., EST, August 30, 2004
INTEX-B Proposals Due	4:00 p.m., EST, September 30, 2004

All due dates and times refer to the deadline by which the agency must have received the proposals, regardless of submission method (e.g. mail, electronic, or personal/courier delivery).

The following items apply only to this announcement.

Identifier: NN-H-04-Z-YS-004-N

Submit Proposals to: Aura 2004 NRA
NASA Peer Review Services, Code Y
500 E Street, SW
Suite 200
Washington, DC 20024-2760

For overnight mail delivery purposes, the recipient telephone number is (202) 479-9030.

Number of Copies Required: 20

D. Proposal Funding Restrictions

The information in section II.A. Terms and Level of Funding Available provides an estimate of the funds expected to be available for competition through this NRA, as well as the approximate number of awards these funds are expected to support.

- Construction of facilities is not an allowed activity.
- Travel, including foreign travel, is allowed as may be necessary for the meaningful completion of the proposed investigation, as well as for the publicizing its results at an appropriate professional meeting.
- U.S. research award recipients may directly purchase supplies and/or services that do not constitute research from non-U.S. sources, but award funds may not be used to fund research carried out by non-U.S. organizations. However, subject to possible export control restrictions, foreign nationals may conduct research while employed by a U.S. organization.
- Regardless of whether function as a team lead or as a team member, personnel from NASA Centers must propose budgets based on Full Cost Accounting (FCA). Non-NASA U.S. Government organizations should propose based on FCA unless no such standards are in effect; in that case such proposers should follow the Managerial Cost Accounting Standards for the Federal Government as recommended by the Federal Accounting Standards Advisory Board (for further information, see http://www.hq.nasa.gov/fullcost/).

E. Additional Information

Appendix B provides amendatory guidance to the general guidelines for responding to NASA Research Announcements, contained in Appendix C, specific to this interdisciplinary research program, information on required proposal format and content, and the proposal evaluation criteria. Appendix C contains instructions for foreign participation in this opportunity.

Appendices D and E contain information about and a sample proposal cover sheet with required institutional declarations in Appendix D. Appendix F contains the budget summary form. If electronic access is not available to prospective proposers, a hard copy of relevant reference(s) can be requested by calling (202) 358-3552 and leaving a voice mail message. Please leave your full name and address, including zip code, and your telephone number, including area code. Appendix A provides instructions for submitting Step-1 proposals electronically. *Prospective investigators are urged to read the information in all of the appendices carefully and to follow completely the specific guidelines therein.*

For proposals responding to this NRA the NASA Selecting Official is Dr. Jack A. Kaye, Director, Research Division, Office of Earth Science.

5. PROPOSAL REVIEW INFORMATION

A. Evaluation Criteria

The Evaluation Criteria for proposals will be intrinsic scientific and technical merit, its relevance to NASA's stated objectives, and its cost realism and reasonableness.

B. Review and Selection Processes

All proposals will be subjected to a full peer review including external reviewers, which may involve a mail review, a panel review, or both. This will be followed by a programmatic review in which NASA managers will evaluate any logistical, implementation, cost, and/or management concerns and assess program balance among competing proposals.

C. Selection Announcement and Award Dates

NASA's stated goal is to announce selections within 150 days of the proposal due date. Proposers may contact the responsible Program Officer listed in section 7. Contacts, if communication has not occurred.

Those proposers not selected for award will be notified by mail and offered a debriefing consistent with the policy in Section C.6 of the NASA *Guidebook for Proposers*.

6. AWARD ADMINISTRATION INFORMATION

A. Award Notices

All proposers submitting a proposal will receive a response from NASA either informing them their proposal has been rejected or selected to receive an award. Letters indicating acceptance should NOT be used as authorization to begin performance. Accepted proposers will then be contacted by NASA, either by phone, mail, or electronically to discuss the type of award to be issued, as well as the suggested budget for the project. It is anticipated that most selected awards to this announcement will be research grants. As an exception, agreements with investigators from some institutions may take the form of a more common agreement mechanism used between NASA and these institutions, such as interagency agreements between NASA and other federal agencies or contracts with private institutions.

B. Administrative and National Policy Requirements

This solicitation does not invoke any special administrative or National policy requirements, nor do the awards that will be made involve any special terms and conditions that differ from NASA's general terms and conditions as given in the Handbook.

C. Reporting

At the time proposers are contacted regarding their successful proposals, NASA will discuss the required reporting for the award. It is anticipated that most research grants issued will require annual reports, most likely submitted electronically, similar to former ESE research grants. The Handbook, located at http://ec.msfc.nasa.gov/hq/grcover.htm, references the standard required reports for grants and cooperative agreements in Exhibit G.

7. NASA CONTACTS

Obtain Additional Information From:

Dr. Philip L. DeCola
NASA Headquarters, Code YS
Washington, DC 20546
Tel: (202) 358-0768
Fax: (202) 358-2770
Email: pdecola@nasa.gov

Additional information about any of the specific technical areas described in Appendix A may be obtained by referencing the points of contact identified therein.

8. Concluding Statement

Your interest and cooperation in participating in this opportunity are appreciated.

Ghassem R. Asrar
Associate Administrator for Earth Science

Appendices:

Appendix A – Technical Description
Appendix B – Instructions for Responding to NASA Research Announcements
Appendix C – Proposal Cover Page
Appendix D – Budget Summary
Appendix E – Notice of Intent
Appendix F – Acronyms
Appendix G – Current and Pending Research Support from all other Sources
Appendix H – Suggested Contents

Appendix A

Technical Description

I. General Background

Proposals are solicited for investigations that will contribute to measurements, modeling and data analysis research supported under the Earth Science Enterprise's Atmospheric Composition focus area. These include sub-orbital measurements of atmospheric parameters and constituents that are pertinent to the validation and scientific use of data products from satellite platforms with priority being given for activities that support, enhance, supplement, or complement data product validation for the instruments on the EOS Aura Satellite (scheduled for launch mid-2004). The ESSP missions, CALIPSO and CloudSat, and other elements of the EOS afternoon constellation plan to participate in parts of this validation effort although this NRA does not solicit proposals focused on validation of these missions since their validation is covered under their science team support.

The overall goal of the EOS Validation Program is to quantify the accuracy and provide validation for remote sensing observations and retrieved geophysical parameters used for determining and understanding regional and interseasonal to interannual changes and trends in atmospheric constituents. Validation activities seek to characterize and/or improve the accuracy of such data products. Studies that seek to quantify the geographical, seasonal, and environmental sensitivities of the accuracy characteristics of EOS data products are also desired.

Investigations are solicited that consider EOS data products in the following categories:

Level 1 - Instrument level data products, i.e., calibrated and geo-located radiance data

Level 2 - Fundamental geophysical parameters (derived from Level 1 products) retrieved at the space and time scales of the individual satellite measurements, i.e., instantaneous observations for the instrument field of view that can be directly related to in situ and remote measurements made by other satellite, airborne, balloon-borne, and ground-based systems

Level 3 - Higher order data products produced by combining satellite remote sensing measurements of fundamental geophysical parameters often on uniform space and time grids (derived from Level 2 and 3 products), may incorporate model calculations and/or other observations or analyses

Priorities for scientific data product validation are based on the sequential and dependent nature of the EOS data production chain. Given the limited available resources, higher priority will be given to studies of the more fundamental data products on which the accuracy of higher order products inherently depend. The highest priority for EOS science data validation will be given to Level 1 and Level 2 products, called fundamental remote sensing products, with emphasis on products that have multi-product impacts (e.g. radiance). Comparative studies of similar remote sensing products are encouraged, especially with data products from the Aqua platform, which will be

flying 15 minutes ahead of Aura (e.g., AIRS products compared to TES products). Studies of EOS data products from operational or other research and commercial satellites will also be considered.

The EOS Validation Program presently includes some activities to be conducted by the EOS Instrument Science Teams. It is not the intention here to support investigations that duplicate or compete with those activities. In particular, investigations that propose to develop competing algorithms for the analysis of Aura data will not be supported via this NRA. Rather, investigations that support, enhance, supplement and/or complement the planned data validation activities are solicited.

Unlike previous EOS missions, the Aura Science Team has developed a platform wide validation plan that combines the validation needs of all the instruments and establishes platform wide priorities for validation. The Aura validation requirements can be downloaded at http://aura.gsfc.nasa.gov/mission/validation.html.

Activities appropriate for the validation and scientific use of atmospheric data products from satellite platforms include the following: balloon measurements of upper tropospheric and stratospheric trace gases and parameters at mid and high latitudes; augmentation of ozone and water vapor sonde measurements at current network locations and/or in conjunction with one or more field campaigns discussed below; in situ and remote airborne measurements (using both manned and remotely-controlled aircraft) of atmospheric trace gases and the radiation field; and ground-based measurements conducted at permanent fixed locations or utilizing mobile facilities to obtain data in different environments. For example, it is expected that data from existing measurement networks like the Network for Detection of Stratospheric Change (NDSC) the ozonesonde network will play important roles in addressing the validation / science objectives. Likewise fixed instrumented sites such as the ARM sites will provide valuable validation data.

The Aura validation plan components are indicated in Table A.I.1. The validation program includes six components: high altitude balloons, ground based measurements including existing sites and a mobile facility, additional ozone and water vapor sondes, aircraft validation, and non-coincident validation approaches. Each one of these components makes a unique contribution to the Aura validation requirements as discussed below. For example, we anticipate that OH profiles for the validation of the MLS OH measurement validation will be obtained using high altitude balloons. Likewise, assessment of the satellite retrieval of the complex chemical structure of the lower stratosphere will require lidar measurements from aircraft.

Proposals must address a specific component. Proposers with interest in more than one component must submit clearly identified sections for each component along with corresponding budgets pages for each component. Proposals for targeted spectroscopy investigation outlined in Section VII will also be considered under this NRA.

Table A.I.1 Components of Aura validation plan. Activity type references the discussion of the validation approach given in main body of the announcement.

Component	Goal	Activity Type	Comment
Ground based and Sonde **Section III**	Long-term data base for statistical validation	A1A3, B1, B2	Augmentation of existing networks, mobile facility
High Altitude Balloon **Section IV**	Mid-stratospheric measurements	A1, A3, B2	
Aura Validation Experiment (AVE) Aircraft Validation **Section V**	Frequent profiling flights into validation regions of interest	A1, A2, A3, B1, B2	Multiple components, proposers need to specify which deployments
UAV Aircraft Validation **Section V**	Along the satellite track long range sampling	A1, A2, A3, B1, B2	Multiple flights
Scientific Mission Combined with Aircraft Validation **Section V**	North American tropospheric pollution inflow	A1, A2, A3, B1, B2	INTEX B
	Tropical stratosphere –troposphere exchange	A1, A2, A3, B1, B2	TC4 - multiple deployments, proposers need to specify which deployments
Modeling and Analysis including non-coincidental approaches to validation **Section VII**	Reconciling non-coincident measurements using models	C1, C2, C3, C4	This includes satellite, aircraft and ground based measurement intercomparisons.
Spectroscopy **Section VIII**	Improvement of retrievals	D	

An Aura Data Validation Center (AVDC) has been established to host relevant validation data and to provide pointers to data not held at the AVDC. All data gathered under this NRA will be made available to AVDC in order to facilitate data exchange. The AVDC will also provide information on the Aura instrument footprints for each of the instruments and will provide access to Aura data for validation investigators. The AVDC protocol is available at (http://aura.gsfc.nasa.gov/mission/validation.html).

Some of the planned airborne missions participating in Aura and other satellite validation/science will be jointly coordinated with, and substantially benefit from, field measurements supported by various NASA Research and Analysis (R&A) Programs and/or other agencies. While not precluded, proposals for additional flight programs utilizing NASA sub-orbital resources to validate the EOS data products will be evaluated in the context of the existing planned flight

program. Thus, it is highly recommended that proposals requiring NASA sub-orbital resources be coordinated with the field campaign plans described below.

Proposers must be knowledgeable about the specific satellite instrument data products and corresponding validation needs. Brief synopses of the EOS Aura validation priorities, including planned and desired components, are given in this Appendix along with points of contact for the validation/science activities. The Aura Data Validation Plans and detailed summaries, as well as other information about the EOS Validation Program and related national and international resources and facilities, may be found at: http://aura.gsfc.nasa.gov/mission/validation.html

Additional information on EOS, the Instrument Science Teams and the data products may also be obtained from the EOS Project Science Office home page at: http://eospso.gsfc.nasa.gov/. The ESE Reference Handbook, the EOS Data Products Handbook, and the Algorithm Theoretical Basis Documents (ATBDs) produced by the Instrument Science Teams will be of particular utility: http://eospso.gsfc.nasa.gov/eos_homepage/for_scientists/atbd/index.php (look under MLS, TES, HIRDLS and OMI).

From an EOS Aura perspective, a strong collaborative working relationship is sought between validation/science investigations funded through this solicitation and the appropriate EOS Instrument Science Teams. Contact between prospective investigators and the Instrument Science Teams is highly encouraged to assist in the formulation of appropriate proposals. While members of the Instrument and Interdisciplinary Science Teams may respond to this solicitation, a principal motivation of this solicitation is to bring new resources, especially human resources and expertise, to bear on the task of validating and using the EOS Aura data products. The intention to forge an integrated EOS science data validation and science effort, as noted above, should not be construed as discouraging proposals that seek to apply independent, innovative, cost-effective approaches other than those detailed below.

Proposals to provide specific correlative data products in support of the validation and scientific use of satellite data will be considered. Proposals to provide data management functions with respect to such data will also be considered; however the need for such a function must be clearly justified. As discussed below, strong preference will be given to proposals that augment and leverage existing networks, capabilities, or facilities, as opposed to those seeking to develop new observing networks, capabilities, or facilities. Proposals involving collection of correlative measurements must commit to providing their data in a timely manner with appropriate quality control and documentation to the AVDC. Likewise, the AVDC will provide sub-sets of Aura data sets from either the Science Computing Facility (SCF) or from an appropriate EOS Distributed Active Archive Center (DAAC). Complete Aura data sets will be available from the DAACs. In addition, investigators are expected to participate in activities to define appropriate measurement and calibration protocols for field measurements, adhere to those protocols, and participate in calibration activities for field measurement sensors. It is expected that the EOS Calibration Scientist, Instrument Science Teams, and EOS project science office will help organize such community activities with respect to field measurements. Budgets should account for travel to participate in such community activities, i.e., meetings and travel to calibration facilities.

It is expected that all validation or correlative measurements obtained by investigators funded here, or obtained by the EOS Instrument Science Teams, will be publicly accessible though the AVDC, an SCF, or DAAC validation home page for each specific instrument or EOS data product. The purpose of this policy is to further the scientific benefit derived from EOS validation/science activities by providing data access to the broadest scientific community.

II. Aura Validation Plan Overview

Aura Data Products

Table A.II.1 (below) summarizes the Aura data products. Detailed descriptions of each standard data product, and the methods by which it is derived, may be found in the corresponding Algorithm Theoretical Basis Document (ATBD) available on the EOS Project Science Office home page: http://eospso.gsfc.nasa.gov/eos_homepage/for_scientists/atbd/index.php (look under MLS, TES, HIRDLS and OMI).

Table A.II.1: Aura Instruments, Principal Investigators and Measurements

Acronym	Name	Instrument PI	Measurement	Instrument Description
HIRDLS	High Resolution Dynamics Limb Sounder	John Gille, National Center for Atmospheric Research & U. of Colorado; John Barnett, Oxford University	Profiles of T, O_3, H_2O, CH_4, N_2O, NO_2, HNO_3, N_2O_5, $CFCl_3$, CF_2Cl_2, $ClONO_2$, Aerosol extinction	Limb IR filter radiometer from 6.2μ to 17.76μ 1.2 km vertical resolution up to 80 km.
MLS	Microwave Limb Sounder	Joe Waters, Jet Propulsion Laboratory	Profiles of T, H_2O, O_3, ClO, BrO, HCl, OH, HO_2, HNO_3, HCN, N_2O, CO, HOCl, CH_3CN, Cloud ice.	Microwave limb sounder 118 GHz to 2.5 THz 1.5-3 km vertical resolution
OMI	Ozone Monitoring Instrument	Pieternel Levelt, KNMI, Netherlands	Column O_3, SO_2, aerosols properties, NO_2, BrO, OClO. HCHO, UV-B, cloud top pressure, O_3 profiles.	Hyperspectral nadir imager, 114º FOV, 270-500 nm, 13x24 km footprint for ozone and aerosols
TES	Tropospheric Emission Spectrometer	Reinhard Beer, Mike Gunson, Jet Propulsion Laboratory	Profiles of T, O_3, NO_2, CO, HNO_3, CH_4, H_2O.	Limb (to 34 km) and nadir IR Fourier transform spectrometer 3.2-15.4μ Nadir footprint 5.3x8.5 km, limb 2.3 km

There are two types of measurements needed for validation: Level-1b and Level-2. Level-1b products, radiance measurements, are a high priority for TES (nadir) and OMI. Radiance measurements for MLS and HIRDLS are lower priority because of the strong instrument heritage. Aura measurement priorities are shown in Table A.II.2 with Priority 3 being the lowest.

Table A.II.2: Aura Validation Measurement Priorities

Measurement	Priority 1	Priority 2	Priority 3
Level 1: Radiance	5-15μ (TES) 280-500 nm (OMI) [polluted and clean locations]		
Level 2: Profiles: Troposphere (and into LS)	H_2O, O_3, CO, HNO_3, NO_2, T [polluted & clean regions]	CH_4 UT/LS: N_2O, CFC-11, CFC-12, CH_3CN, HCN	UT: GPH
Level 2: Profiles: Stratosphere	H_2O, O_3, N_2O, CH_4, HCl, OH, HNO_3, BrO, SO_2, T	ClO, $ClONO_2$, CFC-11, CFC-12, HOCl, HO_2, NO, NO_2, N_2O_5, CO	CH_3CN, HCN, SO_2, GPH
Level 2: Column Densities	NO_2, NO_2 (trop.), O_3 (total), O_3 (trop.), SO_2 [polluted & clean regions]	HCHO, OClO, BrO	SO_2
Level 2: Aerosols, Clouds, UV	Clouds, Aerosols, PSCs (location, properties, statistics)	UV flux	

Aura validation activities occur in two main phases.

Instrument Checkout and Simple Validation, the Commissioning Phase (to L+6 months)

During this phase, instrument outgassing, checkout, and operations testing will occur. No specific validation activities will take place during this phase but data gathered after instrument operations begin will be used for later comparison with instrument measurements. Intra-platform comparisons will be made (e.g. HIRDLS O_3 and MLS O_3). Inter-platform measurements may also be used (e.g. Aura TES and Aqua AIRS radiances).

Validation of Level 1b and Level 2 Data Products (after L+6 months)

Level 1 data are radiance measurements. Level 1b are radiances measurements with reference to a geo-located source. Level 2 data are geophysical data products with reference to a geo-located source. (Level 3 data are geophysical data mapped to a standard grid.) Validation of the Aura Level 1b and 2 standard data products will involve a mix of activities including sustaining and intermittent activities as noted above. Inter-platform satellite data will include non-EOS satellites.

Field campaigns have been developed for the purpose of fulfilling the validation needs of Aura and other satellites while addressing outstanding questions in atmospheric science through the synergistic use of Aura and suborbital (ground-based, balloon-borne, and aircraft-borne) data. Frequent flights of one or more sub-orbital platforms are envisioned to fulfill specific validation needs under the general heading of AVE (Aura Validation Experiment). Uninhabited Aerial Vehicles (UAV) will be used to perform some validation activities. The Tropical Composition, Cloud and Climate Coupling (TC^4) and Intercontinental Chemical Experiment-North America (INTEX) have been developed to address science questions while at the same time fulfilling validation requirements, and are described in more detail in the following sections.

To facilitate validation during the various field campaigns, Aura instrument investigators will provide near real time data through their SIPS or through the AVDC. It should be noted that resources associated with this NRA are insufficient for supporting major new instrument development activities and field campaign resources are constrained as well. Hence, it is expected that instruments proposed for validation use will have demonstrated measurement heritage, validation utility, and will require only limited modification for either measurement improvement or for integrating on the appropriate aircraft. All components of the validation activity may be subject to re-planning based upon budget availability, Aura instrument performance and the success of prior validation activities.

Each of the Aura validation components is detailed in the following sections. The next section describes ground based / sonde network validation activities. High altitude balloon flights validation requirements are described in Section IV. Aircraft validation flights including mission type deployments are described in Section V. The ***Timeline*** for these activities is given in Section VI. Section VII describes non-coincidental and model based validation needs, and Section VIII describes spectroscopic requirements.

III. Ground Based Instruments And Balloon Sondes

Measurements from ground-based stations, such as NDSC and SHADOZ represent important components in the ESE Research Strategy for addressing issues of variability, forcing, response, consequences, and prediction within the Atmospheric Composition focus area. In addition, such measurements will play an essential role in Aura validation, in continuing the data sets needed for analyses of trends, and in providing information on interannual variability of key species in tropospheric and stratospheric chemistry. Some examples of the types of measurements being solicited follow.

Ozone Profile and Column Measurements

Ozonesonde measurements, co-located with well-calibrated ground-based ozone column instruments, will play a key role in Aura validation and science in both the troposphere and stratosphere. They are also required for investigating trends and interannual variability, and to provide a link with other satellite data sets, all of which have used sonde data in their validation. Timed overpasses will be essential for Aura validation in the tropics; ozonesondes will also be needed at both high and mid-latitudes. Profiles obtained in cloud-free conditions over the ocean are required in the commissioning phase, as well as profiles at sites equipped with atmospheric radiation measurements, for TES validation in particular.

Sonde profiles are needed at tropical sites that range from relatively clean to highly polluted. The latter will test retrievals under high-aerosol conditions. Measurements throughout the Aura lifetime are required for long-term validation and calibration monitoring. Sonde launches coincident with the satellite overpasses will be needed in the longer term in the tropics. In mid- and high latitudes, long-term validation can be provided by NDSC stations and by regularly scheduled launches at existing ozonesonde stations. Concurrent temperature and water vapor measurements should be obtained coincident with such ozone measurements.

Lidar profiles of ozone throughout the atmosphere will be valuable for Aura validation. Measurements from the boundary layer through the lower stratosphere will be particularly useful in showing the short-term variability of tropospheric ozone at a given location, and useful for TES validation. Ozone profile measurements may also be obtained using microwave radiometers and high-resolution FTIR spectrometers. Concurrent lidar measurements of temperature and aerosol are also of value.

Ground-based column measurements of ozone will be essential for OMI validation, as they have been in the past for TOMS data.

Water Vapor

High quality water vapor data are required because water vapor is not only an important climate greenhouse gas but can also interfere with the retrieval of standard satellite data products such as temperature, ozone, and methane. Validation measurements obtained using different techniques (ground-based column and profile, and balloon borne) are required in the Aura commissioning phase at selected sites (such as those within the DoE ARM network).

Measurements are also needed to validate upper tropospheric and stratospheric water measurements at both mid- and high latitudes as well as in the tropics (with concurrent measurements of ozone). Ideally, the tropical sites should include the tropical western Pacific where the tropopause temperatures are coldest, and a location with a large annual cycle such as the Asian Monsoon. These measurements can also be used to investigate tropical tropopause layer issues outlined in the TC^4 section below. As with ozone, the water profile measurements should be timed with satellite overpasses.

Accuracies of better than 10% are required for H_2O measurements. Thus any suborbital observations proposed for Aura validation should be able to demonstrate absolute accuracy at this level through documented heritage.

Other Ground-Based Data

A primary goal of the Aura platform is to track regional pollution episodes and to quantify sources of pollution. These measurements include the amount and type of aerosols, the height of the aerosol layer, the shapes of the O_3 and NO_2 profiles. All of these may differ for different pollution episodes. Column measurements of NO_2, BrO, SO_2, and HCHO are needed for OMI validation. Column measurements of CO will be useful for the validation of TES nadir products. Validation measurements are required in clean and polluted sites; pollution episodes with differing pollution characteristics must be explored. Continuation of current measurements at NDSC sites (generally clean atmosphere) or other permanent sites can meet some of these needs. For typical continental situations, continuous statistics for pollutants (ozone, CO, NO_2, particle size / number density) are required. OMI, as a back-scattered UV instrument, needs concurrent aerosol data for accurate ozone retrieval. Hence, total aerosol column optical properties and vertical profiles (as from lidar) are needed.

Profile data are also required to validate tropospheric data from TES (CO) and column data from OMI (NO_2). Measurements are needed for a range of conditions for both. Profiles of CO are needed throughout the troposphere because TES measurements are best between 6 and 14 km. For NO_2, better characterization of the polluted boundary layer is required for the OMI retrieval algorithm. Timed overpasses are necessary. A mobile facility (discussed below) may be needed to make measurements covering a range of pollution characteristics and different combinations of aerosol type and trace gases.

Ground Based Measurements from a Mobile Laboratory

Ground-based instruments operate under the auspices of existing networks like the NDSC, but these measurements systems have not been widely used in field campaigns nor have they focused on measurements in polluted environments. The requirement for Aura validation that measurements be made in a range of polluted conditions led to the development of a plan for assembling a portable container system with a flexible "payload" and associated data acquisition and communication hardware and software. The needs for the system are specified by: (1) instrumentation oriented towards aerosol and ozone pollution; (2) capabilities for routine operation to build up statistics for validation during pollution episodes; and (3) mobility for easy comparison with other validation instruments as well as the ability to participate in campaigns.

The mobile ground-based system will consist of a transportable laboratory that can be readily deployed in field campaigns and to sites of opportunity (e.g. downwind of forest fires and locations of extreme pollution). The container system will be provided as a facility to be used by the investigators. System design features include:

- Standard shipping containers that allow easy shipping and rapid-response operations
- The containers will be outfitted with a standard suite of commercially available instruments and selected, *existing*, specialized instruments for specific trace gas and particle measurements (see Table A.III.1).

Table A.III.1 Ground-based AURA Validation Requirements with Pollution Emphasis.

- Total column ozone
- Ozone vertical profiles
- Aerosol parameters (e.g. aerosol optical thickness)
- Aerosol vertical profile
- In situ trace gas and particle data - CO, ozone, NOx, SO_2, PM2.5, PM10
- Column ozone, HCHO, BrO, OClO, SO_2, NO_2

Ground-based system Contact – Dr. Michael Kurylo 202-358-0237

IV. High Altitude Balloon Measurements

Validation of the Aura measurements, particularly in the stratosphere above aircraft altitudes, is the primary objective of the balloon measurements. In addition, it is highly desirable to extend those profiles into the troposphere. Refer to Table A.II.2 for Aura validation measurement priorities. Measurements are most useful if they are performed up to a minimum of 35 km in altitude. These high altitude balloon measurements are a key component for validation of several Aura products, particularly the radical gases OH, HO_2, BrO and ClO and also the reservoir gases N_2O_5 and $ClONO_2$. The MLS instrument will measure profiles of OH globally for the first time, and profiles measured by a balloon borne instrument are the only possibility for correlative OH measurements other than ground-based columns. Heavy and/or medium lift balloon measurements will be needed at mid-latitudes and polar latitudes during 2005-7 for both remote sensing and in situ measurements as indicated in the ***Timeline***. The polar flights are expected to be conducted from the Esrange rocket and balloon facility near Kiruna, Sweden to facilitate sampling stratospheric winter vortex air, which is highly chemically perturbed. Mid-latitude flights will likely be conducted from Ft. Sumner, NM.

Although the Timeline describes two polar and two mid-latitude balloon campaigns, the actual number of campaigns may be fewer and will depend on Aura instrument performance and the success of the earlier campaigns.

Proposers should describe how their remote sensing or *in situ* balloon measurements would contribute to Aura validation and to the science questions posed earlier. Measurements close to the local times of Aura overpasses are most desirable, especially in cases where rapid changes in atmospheric concentrations occur within a day (e.g., NO, ClO, OH, HO_2). For instruments which must make measurements at other times of day, (e. g., solar occultation), proposers should discuss, quantitatively, how their measured values will be converted into values appropriate to the Aura measurements. Accuracy of better than 5-10% is typically necessary to be useful for Aura validation. Proposers should discuss the heritage and demonstrated performance of their instruments including previous examples of such performance. This NRA does not solicit significant instrument modification or the development of new instruments.

Proposers should discuss how simultaneous measurements of other atmospheric parameters would augment the science return from their instrument. However, proposers should limit their proposals (and budgets) to their particular instruments. Proposals for pre-arranged teams, or joint proposals, are not encouraged. Multiple instrument gondolas will be assembled from the selected investigations. To

facilitate planning for balloon operations, proposers should include the following information about their instrument: weight of instrument and all flight hardware, peak and average power requirements, desired and minimum required balloon altitude and flight duration, and other special requirements, e. g., an azimuth-pointed gondola.

Proposers should budget for the field costs associated with their team, including travel, per diem, and shipping. The multi-instrument balloon flights are most likely to be conducted by the National Scientific Balloon Facility (NSBF). The balloon program cost of the those balloon flights, including balloon, helium, batteries, range fees, flight operations personnel, etc., will be covered separately and proposers need not include any estimate for such. For other (non-NASA) flights specific to an individual proposal, a cost estimate for those flights should be included in a way that can be easily identified and separated from the cost of the rest of the proposal.

Balloon Contact – Dr. Michael Kurylo 202-358-0237 (michael.j.kurylo@nasa.gov)

V. Airborne Validation/Science Experiments

Validation missions described below solicit instrument investigators and theory teams. Preference will be given to theory teams that plan to be present in the field in order to guide flight planning as well as perform data analysis. This participation by the theory team during the deployment can also help insure data quality and early identification of problems.

Given the extended timeframe over which the various validation/science experiments are planned, it is expected that the later missions will undergo some degree of further evolution based on the results from earlier ones. Thus, the budgets proposed for participation in these out-year missions are understood to be best estimates based on current mission formulations. They will be used as such for budget planning purposes, with science team/payload selections and associated budgets being finalized in the year preceding each mission.

Priority Airborne measurements

Priority constituent measurements for Aura validation are listed in Table A.II.2. In addition, the Aura MLS and HIRDLS instruments will be using multiple-scan retrieval algorithms, which will allow greater horizontal resolution than normal limb soundings. To validate these measurements the Aura instrument teams are interested in long North-South transects of profiling instruments (e.g. curtain type measurements of priority trace gases). Aura validation will also benefit from high-resolution infrared spectrometric measurements that can target the TES nadir footprint, and from UV-Vis spectrometric measurements capable of targeting the OMI footprint.

High Altitude Platforms (HA) – the Aura Validation Experiment (AVE)

High altitude platforms provide useful validation of satellite measurements via in situ and remote sensing measurements of the stratosphere and upper troposphere. These platforms will be a central components for most of the comprehensive validation / science missions listed in the Timeline. The AVE concept is to use a high altitude platform with a standard payload for

sampling different atmospheric environments. AVE will provide measurements not available through the listed field campaigns. AVE flights will typically originate from Ellington AFB or Dryden FRC and will target specific meteorological and chemical conditions that provide validation information for the sensors. The AVE payload will include a core set of instruments that address the Level 1b and Level 2 validation requirements. Additional instruments may be added to the payload to augment the science. The specific science and validation objectives for the various AVE missions are discussed below.

Medium Altitude Platforms (MA)

The needs for remote sensing measurements in satellite validation cannot be fully addressed using existing high altitude aircraft due to the lack of a sufficient suite of lightweight instruments having established measurement heritage. Hence, Aura expects to use medium altitude aircraft to support lidar, microwave, infrared, and/or UV/visible measurement of ozone, temperature, aerosols, and other constituents to provide "curtain" type measurements for validation of limb retrievals. Medium altitude aircraft may also support tropospheric in situ measurements relevant to the Aura mission (e.g. HNO_3, O_3, NO_y, HCOH).

Low Altitude Platforms (LA)

In situ measurement capabilities of the high and medium altitude aircraft cannot entirely meet the needs for measurements in the atmospheric boundary layer. Measuring atmospheric species in the boundary layer provides a significant remote sensing challenge to the Aura instruments. Boundary layer measurements are required for both direct validation of measurements (i.e. O_3 and CO) as well as the measurements of interfering species (i.e., water vapor and aerosols.) Thus this validation NRA also requests instruments for low altitude aircraft. Aura expects to use low altitude aircraft in the TC^4 (Costa Rica, Guam and Darwin) and INTEX. These aircraft may be NASA aircraft, aircraft provided by NASA or aircraft provided by our mission partners.

Uninhabited Platforms (UAV)

Aura validation and science missions will be among the first NASA missions to use UAVs for such purposes. UAV's provide the capability for long duration flights with the possibility for new science. For example, the Altair has a round trip range of ~5300 km while the ER-2 has a range of ~2400 km. NASA's long-range plans involve shifting emphasis to UAVs. Thus the UAV activity under this proposal will be given a high priority.

Current plans focus on the NASA Altair or the Global Hawk with up to three flights per year from NASA Dryden FRC during FY06 and FY07. The Altair capability can be found at the NASA Dryden web site (http://www.dfrc.nasa.gov/airsci/UAV_Specs/altair_specs.html). The Altair or the Global Hawk would fly long North-South transects providing a unique validation capability. Proposals for UAV instrumentation should carefully consider the available size, weight and power resources of the UAV. We envision that most of the proposed UAV instruments will provide remote-sensing measurements of high priority constituents (Table A.II.2) with some in situ capability on board as well. It is expected that instruments proposed for use on the UAV will have demonstrated measurement heritage and will require only limited

modification for either measurement improvement or for integrating on the aircraft. Suggested payload for UAV is given in Table A.V.3.

A. Airborne Campaigns

AVE Flight Series

Aura instruments will make atmospheric observations under a wide variety of conditions. Constituent profiles are needed for a range of conditions to demonstrate that retrieval algorithms are valid for a realistic dynamic range. Table 5.4 in V1.0 of the Aura Validation Document provides an estimate of the number and type of coincident constituent profiles needed for validation of TES nadir measurements. The named aircraft campaigns will not entirely meet the validation needs for Aura because each campaign concentrates on a single scientific environment. To provide a range of validation opportunities, NASA will sponsor the Aura Validation Experiment (AVE), a series of short mini airborne campaigns targeting Aura validation needs. The primary goal of these flights is validation. There will also be opportunities to make complementary suborbital measurements that in combination with the validated satellite measurements can answer scientific questions. Each of the AVE campaigns will have both validation goals and specific scientific questions that are being addressed. There will be up to two AVE campaigns per year. The ***Timeline*** below indicates the nominal AVE schedule. Although AVE will mainly use a high altitude aircraft, the need for transects of ozone, aerosols and temperature by remote sensors (microwave and lidar) implies that a larger, medium altitude aircraft may also be needed for some deployments. Thus AVE deployments may include both aircraft or a single aircraft as the validation and science needs evolve.

The AVE payload will have two components, a base payload, planned to be flown for each deployment, and an augmented payload which will be chosen based on the specific additional validation and/or scientific needs, cost and platform payload capacity. The augmented payload may vary from deployment to deployment. The AVE base payload (Table A.V.1) will also be the standard payload for the named campaigns above. The (*) in the table indicates probable base measurements while the (x) indicates desired measurements that may be part of the augmented payload.

Proposers are encouraged to propose both for the base AVE payload, and for specific TC^4 campaigns (see timeline) which have specific scientific purposes. For example, cloud instruments will be needed on the high altitude platform for the AVE/TC^4 deployments and proposers should refer to Table A.II.2 and the ***Timeline*** for additional augmentations.

Table A.V.1 AVE Payload.

Observation	Platform	
	HA	MA
Temperature, pressure, winds	*	*
O_3	*	*
H_2O vapor and total water	*	*
CO, CH_4, N_2O	*	*

NO_2		*
NO_y	*	*
UV-vis radiances (O3, NO_2,BrO-HCHO column)	*	*
IR Nadir Radiance spectrum 5-15μ $0.01cm^{-1}$ resolution	*	
Clouds and Aerosol particle size	x	*
Cloud Particle habit and Aerosol Composition	x	
HNO_3	x	*
HCl	x	x
CFCs	x	x
BrO, ClO	x	x
$ClONO_2$	x	
Ozone profiles above and below the aircraft up to 40km		*
Temperature profile	x	*
Aerosol profiles	x	*

AVE Contact – Dr. Mike Kurylo NASA/HQ (michael.j.kurylo@nasa.gov) 202-358-0237

INTEX-B

Intercontinental Chemical Transport Experiment - North America (INTEX) Mission
INTEX is an integrated atmospheric field experiment to be performed over North America. The goals are to understand the transport and transformation of gases and aerosols on transcontinental / intercontinental scales and their impact on air quality and climate.

INTEX will combine satellite, surface and aircraft based measurements to quantify and characterize the inflow and outflow of pollution over North America. The main constituents of interest are ozone and ozone precursors, aerosols and aerosol precursors, and the long-lived greenhouse gases. INTEX is part of a larger international ITCT (Intercontinental Transport and Chemical Transformation) initiative (http://www.al.noaa.gov/WWWHD/pubdocs/ITCT/). The INTEX mission description is available at:
http://www.espo.nasa.gov/intex-na/overview/white_paper.pdf.

INTEX will take place in two phases using the NASA sub-orbital research platforms. Phase A (INTEX-A) will take place during the summer (July/August) of 2004 and Phase B during the spring (April/May) of 2006. Phase A is in summer when photochemistry is most intense, and Phase B is in spring when Asian transport to North America is at its peak. The experiment will be supported by forecasts from meteorological and chemical models, satellite observations, surface networks, and additional ozonesonde launches. It is anticipated that the INTEX-B deployment will be 4-6 weeks in the spring of 2006, plus an additional 2 weeks of instrument integration/de-integration. For budgetary purposes, proposers should assume 2 weeks of science flight from Dryden FRC and 4 weeks of science flights from Seattle, WA.

To expand the temporal and spatial scale of airborne measurements and to maximize scientific output, INTEX-B will be closely coordinated with field activities by several national and international partners. INTEX-B will primarily use medium altitude aircraft. It is anticipated that some low altitude aircraft flights will be available. The INTEX-B payload will validate all Aura Priority 1 and 2 measurements in the troposphere. Salient among these are H_2O, O_3, NO_2, NO, HNO_3, CO, CH_4 and HCN. Validation will involve vertical profiling from the boundary layer to the aircraft ceiling (12 km) at the precise locations and times of satellite overpass, as was previously done for MOPITT validation in TRACE-P (*J. Geophys. Res.*, 108 (D24), 4804, doi:10.1029/2003JD003507, 2003). The task of large-scale chemical characterization will be done by a long-range medium altitude aircraft and the lower tropospheric and boundary layer studies including processes of exchange with the free troposphere will be done with a low altitude aircraft. Observations of trace gases from convective outflow may be made from a high altitude platform in coordination with other aircraft.

INTEX-B expects to coordinate activities with Asian colleagues to assess the impact of Asian emissions on North American air quality. The primary stratospheric INTEX objective will be to address critical questions about the chemistry and dynamics of the lower stratosphere ozone loss and the exchange of pollution across the tropopause boundary. Table A.V.3 provides an overview of the general INTEX-B instrument payload. More detail on the desired INTEX measurements is provided in the INTEX whitepaper (see above).

INTEX Contact – Dr. Jim Gleason NASA Headquarters 202-358-0743 & 301-614-6036

Tropical Composition, Cloud and Climate Coupling (TC^4)

TC^4 Overview

Three closely related field programs have been proposed for Aura validation and to investigate the tropical tropopause region in the 2004 to 2007 time frame. These combined programs are called Tropical Composition, Cloud and Climate Coupling (TC^4).

Many aspects of the chemical, dynamical, and physical processes occurring in the tropical upper troposphere and in the layer surrounding the tropical tropopause are not well understood. Elucidating the key processes in this region is essential for progress on issues involving global climate change, stratospheric ozone depletion, and global tropospheric chemistry. TC^4 grew from the planning activities associated with the Aura satellite validation program. Aura observations will provide crucial information on the spatial and temporal variations of a number of important properties of this region. Carefully planned and executed airborne observations will be used both to validate Aura data and to provide critical observations not available from satellite.

Another goal of TC^4 is to better understand the Tropical Tropopause Layer (TTL) over a broad range of the tropics. The focus is to better understand the ozone chemistry in this region of the atmosphere as it is impacted by convective transport, as well as to better understand the mechanisms that control the entry of water into the stratosphere.

The TC^4 science working-group identified three separate regions in which to investigate cloud-climate coupling. Those three regions are close to Costa Rica, the southern hemisphere western Pacific region near Darwin, Australia, and the Western Pacific near Guam. Aura will contribute to missions to Costa Rica and Darwin, Australia, which are focused mainly on convection as discussed below. Aircraft deployed from Costa Rica have access to regions of deep tropical maritime convection. Costa Rica has very low tropopause temperatures relative to most of the world but this is not the part of the world thought to make a dominant contribution to cross-tropopause transport. Aircraft missions from Northern Australia will sample the outflow of air after it has been dehydrated and the opportunity to follow air mass trajectories towards the dehydration region. Guam is in the region of the lowest tropopause temperature, which is thought to make the dominant contribution to transport into the stratosphere. Thus both satellite and aircraft measurements in this region are key towards understanding processes through which air in the tropical transition layer enters the stratosphere and is dehydrated. Measurements of temperature and trace gases including water vapor and ozone made during these missions provide critical information for Aura validation as they represent extreme conditions that are difficult for the retrieval algorithms.

In addition to improving our understanding of the chemical, dynamical, and physical processes occurring in the tropical upper troposphere and in the layer surrounding the tropical tropopause, TC^4 seeks to better understand the roles that the anvils of deep convective clouds, and tropical cirrus in general, play in humidifying the upper troposphere and lower stratosphere, and in the Earth's radiation balance. Changes in the radiation balance impact deep convection via stability, impact large-scale circulation via horizontal gradients and stability, which in turn impacts deep convection and large-scale UT transport processes. Thus TC^4 also seeks to understand cumulus physics, and its link to precipitation efficiency. In addition to Aura, TC^4 data will be useful for validation of other satellite observations, including those of Aqua, CloudSat, CALIPSO, and PARASOL (LRD 2005). However, this does not relieve the individual science teams for these missions from their validation responsibilities. The observations from these satellites will, like Aura, play a key role in addressing the TC^4 science goals.

Table A.V.2 lists the major questions that TC^4 seek to answer. Much of the focus of TC^4 is on the region referred to as the Tropical Tropopause Layer (TTL). However, it is recognized that an understanding of the flux of material into the TTL requires constituent measurements in the troposphere, including convectively disturbed regions. An understanding of the role of water vapor and ozone in the climate system requires observations below the lower boundary of the TTL in the free troposphere. Similarly, measurements in the lower stratosphere are required to understand how processes in the TTL influence humidity and other properties of the stratosphere. Aura's MLS instrument has already shown the capability of retrieving ozone and water vapor in the presence of high cloud systems, and these measurements combined with HIRDLS high-resolution limb sounding will provide a significant improvement to our current understanding of this region.

Major Scientific questions to be addressed by TC^4

1. What mechanisms maintain the humidity of the stratosphere? What are the relative roles of

large-scale transport and convective transport and how are these processes coupled?

2. What are the physical mechanisms that control (and cause) long-term changes in the humidity of the upper troposphere and lower stratosphere in the tropics and subtropics?

3. What controls the formation and distribution of thin cirrus in the Tropical Tropopause Layer, and what is the influence of thin cirrus on radiative heating and cooling rates, and on vertical transport?

4. What are the chemical fates of short-lived compounds transported from the tropical boundary layer into the Tropical Tropopause Layer? (i.e., what is the chemical boundary condition for the stratosphere?)

The TC^4 mission description can be found at the Aura validation web site http://aura.gsfc.nasa.gov/mission/validation.html. For information on TC^4 contact Dr. Hal Maring (hal.maring@nasa.gov) 202-358-2770.

TC^4-Summer – Joint with TCSP

TCSP proposers should respond to the TCSP NRA while those wishing to participate in other TC^4 and Aura validation activities should respond to this NRA.

The NASA ESE anticipates the release of an NRA titled Tropical Cloud Systems and Processes (TCSP). TCSP will call for investigations of tropical cloud systems and their environmental feedbacks that contribute to a unified approach to study variations in the Earth's climate system. The TCSP NRA seeks innovative investigations that use remote sensing, suborbital and *in situ* data for investigations of hurricanes, the impact of cirrus clouds on atmospheric cycles of water and energy, and related feedbacks on the radiative, compositional and structural attributes of the upper troposphere/lower stratosphere. It also seeks proposals that use this knowledge to develop and evaluate models and data assimilation systems that include representations of tropical cloud processes and their impact on the Earth's climate system.

The major goal of Aura participation in TCSP through TC^4 is to obtain validation measurements for the cold, dry conditions of the upper tropical tropopause. This extreme environment, with temperatures below 190 K will test retrieval algorithms for HIRDLS, MLS and TES. In addition, lidar measurements of ozone and temperature from medium altitude aircraft will provide tropical upper troposphere and lower stratosphere profiles and structure.

One focus of the TCSP campaign will be the study of chemical, dynamical and physical processes occurring in the tropical upper troposphere and in the layer surrounding the tropical tropopause, as well as the roles that the anvils of deep convective clouds and tropical cirrus play in humidifying and altering the radiative balance of the upper troposphere and lower stratosphere. TC^4 will focus on their upper-level cirrus outflows and associated radiative, compositional, and structural attributes of the surrounding upper troposphere/lower stratosphere. Combining the resources of the TCSP and TC^4 communities offers the benefits of shared scientific goals, logistics requirements and the cross-disciplinary expertise of the two teams, as well as providing for a significant cost savings.

From Costa Rica, aircraft have access to deep tropical maritime convection. This Eastern Pacific summer mission will serve as a contrast to the later missions in the Western Pacific both in season and location.

Tables A.V.3 provides the desired measurements on the different platforms required to address the science questions.

TC^4-Northern Hemisphere Winter – Darwin

The Darwin deployment provides another important opportunity to obtain Aura validation measurements in an environment very different from the eastern Pacific. The western Pacific upper troposphere processes air before it enters the stratosphere. Measurements from UARS show that amount of water vapor entering the stratosphere has a strong seasonal cycle, but the mechanism behind this cycle is not well understood. The primary goal of the Darwin deployment is to provide validation for Aura instruments in a mixed oceanic/continental environment. Data obtained during this mission are also of interest for validation of CALIPSO and CloudSat, however validation of these instruments is the responsibility of the individual science teams for these missions. The NASA science goals are summarized above in Table A.V.2.

Through TC^4, NASA plans to collaborate with scientists from the U.S. Department of Energy, Australia and the European SCOUT-O3 project in a field program based in Darwin, Australia, during January and February of 2006. It is anticipated that a research ship, several instrumented ground sites, and several aircraft will be provided by the collaborators. NASA proposes to provide an instrumented high altitude aircraft, ozone and water vapor sondes, and possibly some instruments for a low altitude platform provided by one of the mission partners. This mission will address radiation science program goals concerning intense monsoonal convection that occurs over the ocean North of Australia during the months of January and February. Air passes through the lowest temperatures in the vicinity of Guam and then flows southward and past Australia. Aircraft should sample the outflow of that has been dehydrated locally and fly up the air parcel trajectories toward the dehydration region.

Table A.V.3 provides an overview of the general Darwin instrument payload being planned. Sonde launches are also planned.

TC^4-Northern Hemisphere Winter, Guam

Through TC^4, NASA plans a Tropical Western Pacific field program to be based in Guam during January and February of 2007. This mission is focused on understanding the Tropical Transition Layer. The Guam deployment provides a third important opportunity to obtain Aura validation measurements in an environment very different from the eastern Pacific and the winter Western Pacific. Guam is near the region of deepest convection, which controls the composition of the TTL, as well as near the region of coldest tropopause temperatures and lowest stratospheric humidity. This is a key location for identifying the mechanisms that maintain the low humidity of the stratosphere, and for investigating the importance of convection to stratospheric humidity. Long-range flights from Guam also offer the opportunity to sample the tropics and mid-latitudes

near Asia, regions with very different properties, sampling of which is necessary for Aura validation. Table A.V.3 provides an overview of the general Guam instrument payload.

1 Table A.V.3 TC[4], INTEX and UAV Payloads. Large X indicates a priority validation measurement.

Observation	Costa Rica	Darwin	Guam	Costa Rica	Guam	INTEX	Costa Rica	Darwin	Guam	INTEX	UAV
Aircraft	HA	HA	HA	MA	MA	MA	LA	LA	LA	LA	
Temperature, pressure, winds, turbulence	X	X	X	X	X	X	X	X	X	X	X
Temperature, pressure, winds, turbulence	X	X	X	X	X	X	X	X	X	X	X
Temperature profile	X	X	X	X	X	X				X	
GPS downlink	X	X	X	X	X	X	X	X	X	X	X
Aerosol size dist	X	X	X	X	X	X	X		X	X	X
Aerosol composition	X	X	X		X	X	X		X	X	
CCN					X	X	X		X	X	
Ice nuclei			X	X	X						
Ice water content			X	X	X						
Ice size distribution	X	X	X	X	X						
Ice crystal habit	X	X	X	X	X						
Cloud extinction	X	X	X	X	X						
H_2O vapor	X	X	X	X	X	X	X	X	X	X	X
H_2O total	X	X	X	X	X						
H_2O isotopes	X	X	X		X						
O_3	X	X	X	X	X	X	X	X	X	X	X
CO	X	X	X	X	X	X	X	X	X	X	X
CH_4, CO_2, N_2O-high time resolution	X	X	X	X	X	X			X	X	
NO_2 column, BrO column, HCHO column	X	X	X					X			X
HNO_3	X	X	X	X	X	X			X	X	
NO_x (NO &NO_2)	X		X	X	X	X		X	X	X	

HO_x	X	X	X		X	X	X					
HCl	X	X	X									
Acetone			X		X	X					X	
N_2O, CFCs, CH_4, CH_3Br, CH_3I	X	X	X		X	X	X		X	X	X	X	X
BrO ClO	X	X	X									
HCHO, HOOH, CH_3OOH			X		X	X	X		X	X	X	X	
IO			X									
Observation	Costa Rica	Darwin	Guam		Costa Rica	Guam	INTEX		Costa Rica	Darwin	Guam	INTEX	UAV
Aircraft	HA	HA	HA		MA	MA	MA		LA	LA	LA	LA	
NO_y, PAN			X		X		X				X	X	
Short lived Organics and CFC's			X			X	X				X	X	
$ClONO_3$			X										
SO_2			X				X					X	
SF_6			X								X		
94 Ghz radar	X		X			X			X				
Precipitation Doppler radar	X		X		X	X					X		
Visible/IR spectral radiometers, imagers, scanners	X		X						X				
Microwave radiometers (10–350 GHz)	X		X		X	X							
Submillimeter radiometer	X		X										
Solar spectral Flux	X	X	X			X	X		X		X	X	
Longwave Radiation	X	X	X			X			X		X		
FTIR		X	X										
Dropsonde	X		X		X								
Lightning Inst.	X				X								

Cloud/aerosol lidar	X	X	X		X	X						X
Ozone lidar (nadir)			X		X	X						
Ozone lidar (zenith)					X	X						
Ozone lidar (zenith)					X	X						
H_2O lidar (nadir)			X		X	X						
H_2O lidar (nadir)			X		X	X						
H_2O lidar (zenith)					X	X						
H_2O lidar (zenith)					X	X						
Temperature lidar			X			X	X					
Temperature lidar			X			X	X					
Forward scanning cloud lidar			X									
Aerosol optical depth								X	X			
CO Lidar							X					

2

Airborne Science Points-of-Contact and Cost Estimates

The following is guidance provided by NASA to potential users of NASA aircraft for Earth science measurements. Mission peculiar costs are additional expenses to the investigator associated with the mission, such as travel for investigators, shipping of special support equipment, etc. Investigators should include deployment and travel costs for field missions including instrument upload, test flights and download.

The following summarize the airborne program elements relevant to Aura validation:

1. The core NASA Airborne Science fleet consists of the DC-8 and 2 ER-2s at Dryden Flight Research Center, and a P-3B at Wallops Flight Facility. Candidate UAV platforms will also be stationed at Dryden FRC

2. Other cooperative aircraft are available for Earth Science Enterprise supported missions. A NASA WB-57 at NASA's Johnson Space Center (JSC), is expected to be available. A universal instrument interface was completed and effectively made the instrument electrical interface transparent to the user.

For budget planning, further information on aircraft experimenter configurations, approaches to estimating mission peculiar costs, etc. can be obtained from the following individuals:

ER-2, DC-8, Proteus, Altair,Global Hawk:
Tom Mace/Dryden Flight Research Center 661-276-7453

P-3B, Aerosonde, low altitude aircraft:
George Postell/Wallops Flight Facility 757-824-1031

WB-57: Andy Roberts/Johnson Space Center 281-244-9543

VI. Time Line for Aura Validation/Science Experiments

It should be understood that the reality of satellite launches involves unexpected delays. Thus the timeline listed below represents an ideal situation under the assumption of an Aura launch by July 1, 2004. The various missions are discussed in further detail later in this Appendix.

2004: October - AVE from Ellington AFB or Dryden FRC. Objective: Level 1b radiance validation and in situ measurements in upper troposphere and lower stratosphere. Field deployment – two weeks. These measurements may be rescheduled depending on actual Aura launch date.

2005: January - AVE from NASA Dryden FRC. Objectives: mid tropospheric high vertical resolution measurements of tropospheric and stratospheric ozone, aerosols and temperature across the subtropical edge and polar vortex boundaries. Field deployment – 2-3 weeks. High latitude, high resolution balloon profiles of stratospheric constituents. These measurements may be rescheduled depending on actual Aura launch date.

2005: UAV instrument development and payload construction, test flights.

2005: July – AVE/TC^4 Summer, joint measurements with TCSP from San Jose, Costa Rica. Objectives: water vapor and trace gas measurements in the tropical East Pacific near the tropopause, high vertical resolution measurements of ozone, aerosols and temperature profiles in the troposphere and lower stratosphere. Field deployment – four weeks.

2005: September – Mid-latitude, high resolution balloon profiles of stratospheric constituents.

2006: January –AVE/TC4 Winter Southern Hemisphere, joint measurements with DoE mission in Darwin, Australia. Objectives: water vapor and trace gas measurements in the tropical East Pacific near the tropopause. Field deployment – four weeks.

2006: January - High latitude, high resolution balloon profiles of stratospheric constituents.

2006: April – AVE/ INTEX NA-W from NASA Dryden. Objectives: troposphere and lower stratosphere profiles and in situ measurements of tropospheric trace gases in polluted and unpolluted environments to assess inflow into the West Coast of the US. Two to three long duration North south mid-tropospheric UAV flights from Dryden FRC. Field deployment – 4-6 weeks.

2006: September - AVE from Ellington AFB or Dryden FRC. Objective: radiance validation and in situ measurements in polluted environments throughout the troposphere and lower stratosphere. Field deployment – two weeks. Mid-latitude, high resolution balloon profiles of stratospheric constituents if needed based on assessment of usefulness of the prior balloon observations and knowledge of Aura instrument performance.

2007: January – AVE/TC^4 Winter Northern Hemisphere from Guam. Objectives: water vapor and trace gas measurements in the tropical East Pacific near the tropopause. Field deployment - 4-6 weeks.

2007: June – AVE from Ellington AFB. Objectives: radiance validation and in situ measurements in upper troposphere and lower stratosphere. May include joint flights with a UAV for mid troposphere in situ measurements. Field deployment – two weeks.

2007: October – AVE from Ellington AFB. Objectives: radiance validation and in situ measurements in upper troposphere and lower stratosphere. Mid-latitude, high resolution balloon profiles of stratospheric constituents if needed. Field deployment – two weeks.

Ozone and water vapor sonde launches will support appropriate field campaigns and provide augmented measurements during satellite overpasses.

VII. Non-coincident and Other Approaches to Validation

Aura validation efforts will also include efforts to provide validation through coincident and non-coincident techniques. Coincident techniques are those where non-Aura data are compared with Aura data taken within the same time-space envelope. Non-coincident

techniques use models to compare relevant observations from non-Aura data sources to Aura measurements. Examples of this later type of effort include trajectory mapping, assimilation systems, flow coordinate chemical models, etc. This NRA seeks proposals that use any of these approaches to validation. We expect proposers will take advantage of satellite measurements such as being made by the list of space-based atmospheric composition observations summarized in Appendix E. While satellite data sets provide experimenters with the largest data resources for both types of studies, other data sources such as chemical sondes and radiosondes, NDSC ground based data and other non-NASA mission data may be used as well. This NRA does not solicit new development of non-coincident modeling approaches.

Under this NRA, we will also consider proposals to study distributions of trace constituents in the global atmosphere through the use of computational models and through the analysis of constituent data sets. Efforts that emphasize the global atmosphere, as well as those investigating the large regional (continental and hemispheric) scales will be considered. Such research may be further described as follows:

- *Dynamics and Related Data Analysis:* This includes modeling and data analysis studies of temperature and wind distributions, transport processes and their long-term evolution, dynamical couplings between the stratosphere and troposphere, as well as studies of the stratosphere's 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 field measurement data on the trace constituent composition of the atmosphere, including both short- and long-term variations. Data sets of greatest interest are NASA satellite missions and atmospherically-oriented aircraft missions. Investigations utilizing other space-based data, such as those from GOME, POAM, Ultraviolet Visible Imagers and Spectrographic Imagers/Midcourse Space Experiment (UVISI/MSX), and the instruments on ENVISAT, ADEOS II, ACE/SCISAT, 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.

These areas of interest are a subset of those historically funded by ACMAP with an emphasis for this announcement on better understanding of tropospheric constituent distributions and the controlling processes. The research supported here 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 Program (IGBP) described at http://www.igac.unh.edu/ and http://www.igbp.kva.se/cgi-bin/php/frameset.php, respectively. Another useful guide toward science priorities can be found in Chapter 3 of the CCSP Research Plan, located at (http://www.climatescience.gov).

VIII. Laboratory Spectroscopy Investigations

The Aura mission will measure the abundance of numerous chemical species, as well as aerosols, clouds properties and temperatures. Improved spectroscopic information may be required for algorithm refinement and validation of the retrievals and correlative observations. Further details of spectroscopic requirements may be found in the Aura Validation Plan. Proposers are encouraged to work with instrument teams to demonstrate the likely improvement in retrievals and the importance of the improvement. Proposals are solicited that directly address these requirements as well as for improved retrievals of atmospheric geophysical parameters from other satellite observations. These improvements are needed to provide answers to questions identified in the ESE research strategy. In addition to active interaction with the Aura Science Teams, a key requirement of spectroscopic studies supported via this NRA is an explicit commitment to enter the resulting data into the HITRAN spectroscopic database.

HIRDLS: The retrievals will depend on knowledge of absorption cross sections for target species and any interfering species. Absorption cross sections will be derived from spectral line strengths and shapes plus line mixing (line by line cases), or more directly from lab measurements for "heavy" molecules, e.g., CF_2Cl_2, with highly complex spectra. The accuracy objectives for constituent abundance at altitudes below 50 km are 5-10% absolute with a precision of 1-5%. The upper troposphere and lower stratosphere are scientifically important regions where temperatures can be less than 200 K. This is a potential problem since the quality of spectral data is generally worse at low temperatures. Also, the narrow HIRDLS filter widths (15 to 120 cm^{-1}) pose a more stringent spectral requirement than in the case of broader filters. Highest priority spectroscopic improvements are:

$ClONO_2$, N_2O_5, $CFCl_3$, CF_2Cl_2: Cross sections and temperature (and pressure) dependencies to allow low-temperature (< 200 K) calculations.

H_2O: Information on halfwidths and temperature dependencies in all spectral regions.

HNO_3: Information for 11 and 7 μm bands.

H_2O continuum: Improvements for tropospheric measurements.

MLS: The highest priority needs for improved spectroscopic data that could benefit MLS chemistry measurements of the lower stratosphere and upper troposphere are:

(a) laboratory measurements and theoretical expressions for water vapor continuum and dry air continuum between 100 and 2500 GHz (accuracy of 5% or better). Extend work in the 200-300 GHz range to higher frequency, and develop a physically well-founded, unified, and broadly applicable model the water vapor continuum over the full 100-2500 GHz range.

(b) line width parameters, including temperature dependence (accuracy of 3% or better) for

- OH lines at 2.5 THz (2 lines)
- HO_2 lines at 649.7 and 660.5 GHz
- HNO_3 lines at 181, 232 and 234 GHz
- Lines near the 2.5 THz OH lines to aid in interpretation of the MLS OH measurements: O_3 at 2509.6 and 2543.2 GHz, O_2 at 2502.3 GHz, H_2O at 2531.9 GHz

Other line width parameters are also very valuable. Parameters including temperature dependence (accuracy of 3% or better) for the HCN line at 177 GHz for HCN measurements, which is used as a tracer of biomass and other pollution in the upper troposphere, also need improvement.

TES: New measurements that could benefit TES algorithm refinement and validation must correspond to conditions to which TES algorithms will be applied, specifically: pressures between 0.001 and 1 atm (1 to 1000 mb), temperatures between 200 K and 300 K, and spectral wavenumbers from 650 to 3000 cm^{-1} (wavelengths from 3.3 to 15.4 μm).

Highest priority requirements for improved spectroscopic data are:

a) Pressure broadening coefficients - temperature dependence of widths and shifts for H_2O, CO (1-0 and 2-1 bands) and 6.2 μm band of NO_2
b) Aerosol spectral (infrared) properties
c) Cross sections using air-broadened gas samples, with adequate characterization of the temperature-pressure dependencies, for PAN (Peroxyacetyl Nitrate) and PNA (Peroxynitric Acid) between 650 and 2500 cm^{-1}, and Acetone and Acetic acid between 650 and 2000 cm^{-1}

Also valuable are improvements in methanol line parameters at 10 μm and cross sections of CH_3OOH (methyl hydroperoxide).

OMI:

Retrieval algorithms rely on accurate temperature dependent absorption cross sections of the molecules and on refractive indexes of aerosols (especially desert dust aerosol in the UV). Highest priority needs for improved spectroscopic data are:

O_3: 240-1000 nm. Vacuum measurements at 0.001 nm resolution, 0.0001 wavelength

accuracy, over a range of temperatures from 180-400 K, 240-400 nm <1%, 400-1000 nm < 2% accuracy.

O_2-O_2: 300-600 nm. Vacuum measurements at 0.1 nm resolution, 0.01 wavelength accuracy, over a range of temperatures from 250-300 K, and <2% accuracy.

SO_2: 300-330 nm. Vacuum measurements at 0.001 nm resolution, 0.0001 wavelength accuracy, over a range of temperatures from 250-300 K, and <2% accuracy.

Spectroscopy Contact – Dr. Phil DeCola 202-358-0768

APPENDIX B

INSTRUCTIONS FOR RESPONDING TO NASA RESEARCH ANNOUNCEMENTS (1852.235-72, OCTOBER 2002)

(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. The NASA contracting officer will determine the appropriate award 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). All proposals involving NASA employees as either PI or as a CO-I must be shown in full cost in accordance with Agency full cost accounting standards (www.hq.nasa.gov/fullcost).

(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 (also see paragraph l). 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. Of particular interest are proposed use of radioactive or hazardous materials or lasers.

(ii) Identify and discuss risk factors and issues throughout the proposal where they are relevant, and your approach to managing these risks.

(iii) 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 and Page Format.** Unless otherwise specified in the NRA, effort should be made to keep proposals as brief as possible, concentrating on substantive material. **Proposals are not to exceed 20 pages**, including references and figures (cover pages, certifications, budget sheets, and attachments are not included in this page limit). 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. Cost is of substantially less weight than the other factors combined.

(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 Proposals Including Foreign Participation.**

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.** 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.

(o) **Data Policy**

NASA's policy is to work cooperatively with other U.S. government agencies and our international partners in the development of a comprehensive capability to observe and understand the Earth. In addition, both National and NASA policy require NASA to support private-sector investment in commercial space activities by committing the U.S. government to purchase commercially available goods and services. NASA will not develop a mission that in any significant way competes with or duplicates commercially available goods or services from U.S. industry.

APPENDIX C

Required Proposal Cover Page

Two steps are required to submit a cover page. The first step is to complete the proposal cover page (see SAMPLE Appendix D) **electronically** to the SYS-EYFUS Website located at **http://proposals.hq.nasa.gov/**. If the proposer has submitted an electronic Notice of Intent (Appendix F) to SYS-EYFUS, the same user UserID and password can be used to complete the electronic proposal cover page. 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 SYS-EYFUS is not current.

The second step is to print a **hard copy** (see Appendix D) of the electronic cover page that must be signed by the Principal Investigator and an official 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.

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

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

Once you receive your User ID and Password, **login** to the SYS-EYFUS website 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.

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 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 Inv		**Authorized Institutional**	
ga		**Orga**	
Dep		**Dep**	
Ma g			
City, State Zip:		**ity, S**	
Telephone N		**Tel hone N**	
ax N		**Fax N**	
E		**ail**	
Principal Inv Si	_____	**Authorized Inst tional Si**	_____
	_____		_____

Co-Investigator:

Name	Telephone	Email	Institutio	Address

Budget:

Year	Budget
1	
2	
3	
Total	

Check all that apply:

Ground-Based & Sondes ☐

High Altitude Balloons

January	'05	☐
September	'05	☐
January	'06	☐
September	'06	☐
October	'07	☐

AVE

January	'05	☐
September	'06	☐
June	'07	☐
October	'07	☐

UAV

April	'06	☐
June	'07	☐

INTEX-B ☐

TC-4

January	'06	☐
January	'07	☐

Modeling, Analysis and Non-coincident validation ☐

Laboratory Spectroscopy ☐

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 D

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

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

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

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

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

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

Appendix E

Notice of Intent to Propose

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

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

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

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

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

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

At a minimum, the following information will be requested:

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

A separate NOI must be submitted for each intended proposal.

Appendix F

Acronym List

ARM	Atmospheric Radiation Measurments
CALIPSO	
ESSP	The Earth System Science Pathfinder
SAGE	Stratospheric Aerosol and Gas Experiment
POAM	Polar Ozone and Aerosol Measurement
HALOE	Halogen Occultation Experiment
TOMS	Total Ozone Mapping Spectrometer
GOME1&2	Global Ozone Monitoring Experiment
SBUV2	Solar Backscatter Ultraviolet 2
ACE	Atmospheric Chemistry Experiment
NDSC	Network for the Detection of Stratospheric Change
AGAGE	Advanced Global Atmospheric Gases Experiment
MAESTRO	Measurements of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation
TC^4	Tropical Composition, Cloud and Climate Coupling
INTEX	Intercontinental Chemical Experiment – North America
AVE	Aura Validation Experiment
UAV	Uninhabited Aerial Vehicle
SCIAMACHY	
GOMOS	
MIPAS	
MOPITT	Measurements of Pollution in the Troposphere
AIRS	Atmospheric Infrared Sounder
TCSP	Tropical Cloud Systems and Processes

APPENDIX G

Current And Pending Research Support From All Other Sources

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

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

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

Please provide this information in the following format:

I. Principal Investigator

A. Current FY 2000 Support

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

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

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

For both current and pending support provide information on:

II. Co-Investigators

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

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

APPENDIX H

Suggested Contents