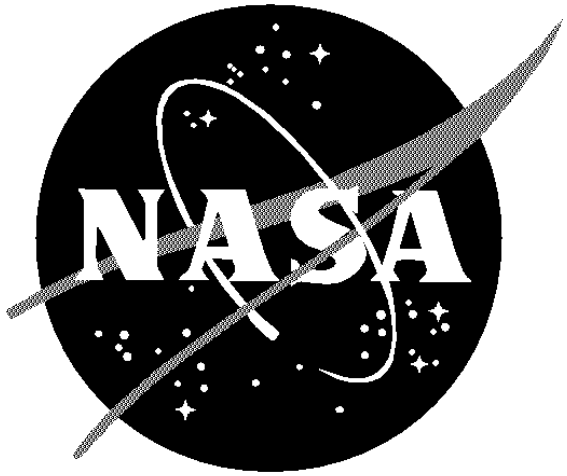

National Aeronautics and Space Administration

April 1, 2004

NN-H-04-Z-YS-003-N

RESEARCH ANNOUNCEMENT

TROPICAL CLOUD SYSTEMS AND PROCESSES (TCSP)

Notice of Intent Due May 1, 2004
Proposals Due July 1, 2004

OMB Approval No. 2700-0087

TROPICAL CLOUD SYSTEMS AND PROCESSES (TCSP)

NASA Research Announcement
Soliciting Research Proposals
for
Period Ending
July 1, 2004

NN-H-04-Z-YS-003-N
Issued April 1, 2004

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

Tropical Cloud Systems and Processes (TCSP)

1. INTRODUCTION

1.1 Purpose of this NASA Research Announcement

This NASA Research Announcement (NRA) solicits investigations of tropical cloud systems and their environmental feedbacks which contribute to a unified approach to study variations in the Earth's climate system. This NRA specifically seeks proposals for scientific investigations and research activities contributing to the continuation and enhancement of NASA's Atmospheric Dynamics and Thermodynamics Program and Radiation Sciences Program. This announcement seeks innovative investigations that utilize NASA's observational 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 dynamic attributes of the upper troposphere/lower stratosphere. It also seeks proposals that utilize this knowledge in facilitating the development and evaluation of models and data assimilation systems that include representations of tropical cloud processes and their impact on the Earth's climate system. The announcement is for the selection of investigations to be carried out for a period of up to three years.

1.2 Programmatic Ties to NASA's Earth Science Enterprise Objectives

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 mission of NASA's Earth Science Enterprise (ESE) is to develop a scientific understanding of the Earth system and its response to natural or human-induced changes and improve prediction capabilities for climate, weather and natural hazards. The ESE research program aims to acquire a deeper understanding of the Earth System by describing how its component parts and their interactions have evolved, how they function, and how they may be expected to continue to evolve on all time scales. The challenge is to develop the capability to predict those changes that will occur in the future, both naturally and in response to human activity. These interactions occur on a continuum of spatial and temporal scales ranging from short-term weather to long-term climate, and from local and regional to global scales. The Enterprise also seeks to provide accurate assessments of changes in the composition of the atmosphere, the extent and

health of the world's forest, grassland, and agricultural resources, and geologic phenomena that can cause natural hazards.

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 roadmaps for the Atmospheric Composition, Climate Variability and Change, Water and Energy Cycle and Weather Focus Areas provide the strategic framework for research under this NRA. 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. While the opportunities for research in this NRA fall within the four aforementioned focus areas, there are strong interrelationships with other focus areas that must not be overlooked in research plans.

The NASA Office of Earth Sciences (OES) has a keen interest in key aspects of the tropical environment and support a program for systematic global atmospheric measurements which specifically include global temperature, water vapor, precipitation and chemical constituents used for understanding both short- and long-term variability of climate and physical processes. Since much of the tropics are covered by ocean and inaccessible densely forested land, there is limited opportunity for surface-based measurements; the remote sensing perspective that NASA provides has the potential to significantly enhance our knowledge of tropical behavior. The satellite measurements, when carefully tied to field campaigns, can be used to advance our understanding of the relationship between climate change and the frequency/intensity of tropical weather disturbances. These disturbances play a disproportionately large role in atmospheric transport and mixing, energy transformation, cloud systems development and precipitation.

1.3 Important Linkages Between This NRA and NASA's Earth-Monitoring Satellite Observations Platforms

Over the past few decades, the ESE and antecedent programs, such as Mission to Planet Earth, have made major investments in space-based and sub-orbital observations, model development, infrastructure and research conducted by the broad scientific community to address these scientific issues. In particular, NASA and partner agencies launched the Tropical Rainfall Measurement Mission (TRMM), Quickscat, Terra (the flagship of the Earth Observing System [EOS] program), Aqua, Jason, ICESat and QuickTOMS

missions. Additional satellites, including CloudSat, Aura, PARASOL, CALIPSO and GPM, are scheduled for launch after 2003 and will provide additional measurements of cloud vertical structure, spatial and temporal variability of ozone, water vapor and cirrus in the upper troposphere and lower stratosphere, as well as detailed measurements of aerosol and cloud distributions. Many of these observables will be obtained at horizontal and vertical resolutions not previously available from satellite observations. Of particular value is the expected "A Train" consisting of Aura, CALIPSO, CloudSat, PARASOL and Aqua. These spacecraft and associated field campaigns are ushering a new era of integrated scientific studies of the Earth system. *Proposals in response to this NRA are encouraged to demonstrate how in situ airborne and ground site observations can be blended with and complement the wealth of information collected by this diverse constellation of remote sensors.* Validation studies of NASA satellite missions relevant to cloud and precipitation properties, aerosols and atmospheric chemistry are also encouraged under the auspices of this NRA, in the context of the scientific objectives of TCSP. In addition, this NRA will offer limited support of uninhabited aerial vehicle (UAV) investigations consistent with the core scientific objectives outlined above, and as detailed in Appendix A.

The strength of NASA's Earth science program is derived from the integration of different classes of observations (ground, in situ and space), basic research, modeling, and data analysis. In particular, NASA's ESE research strategy recognizes the need for close linkage between the observation programs and the data analysis and predictive Earth system modeling programs at all relevant spatial and temporal scales. Developing the means for full utilization of global observational data (e.g. through systematic data assimilation) and for analysis and discrepancies between observed and modeled fields is considered an essential part of the program. The synergy between global Earth observations (satellites), analysis, and modeling is perceived as an essential means to answer these scientific questions and as one of NASA's most important contributions to the U.S. Climate Change Science Program (CCSP).

1.4 Scientific Rationale for This NRA

The overarching objective of this combined NRA is to investigate the Earth's cycling of atmospheric water, aerosols, trace chemicals and radiative energy, and the variability of these cyclings within the context of the total Earth system. On the scale of tropical cloud systems and surrounding undisturbed regions in the deep tropics, this NRA solicits investigations related to several specific, synergistic areas of study. Here, the term "tropical cloud systems" is taken to include both tropical cyclones and mesoscale convective systems of continental and maritime origin. A major thrust of this NRA will be to improve the understanding and prediction of tropical cyclone genesis, intensity, motion, rainfall potential and landfall impacts by remote and *in situ* sensing of the three phases of water from spaceborne and airborne platforms. A second focus 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. Opportunities to

study these processes abound in the arena of developing tropical cyclones, and during inactive periods in the tropical cyclone genesis region.

One of the major uncertainties that has limited our confidence in General Circulation Models (GCMs) is their inability to accurately represent the formation of clouds and the impact of clouds and upper tropospheric water vapor on the radiation budget of the surface-atmosphere system. The processes leading to formation of tropical cirrus clouds and the dessication/hydration of the tropopause region must be better understood so that that the models can realistically represent their behavior in the current atmosphere and in the potentially changed atmosphere of the future. Many aspects of the chemical, dynamical and physical processes occurring in the tropical upper troposphere/tropical tropopause are not well understood. Elucidating key processes in this region is essential for progress on issues involving global climate change, Earth's radiation balance, stratospheric ozone depletion, and global tropospheric chemistry.

Previous NASA-sponsored campaigns such as the Cirrus Regional Study of Tropical Anvils and Cirrus Layers – Florida Area Cumulus Experiment (CRYSTAL-FACE) were able to sample occurrences of convection quite well in the subtropics, and have lead to an improved understanding how cirrus evolves and impacts the upper atmosphere. However, significant system-to-system variability continues to hamper our understanding of how deep moist convection is linked to presence of cirrus clouds. Hypotheses regarding this linkage require further testing, particularly in the context of understanding the complete lifecycle of convection (particularly the dissipative stage) with the goal of developing promising new parameterization schemes for the GCMs. Strong winds frequently advect evolving cirrus layers far from their generating convection, out of range of the aircraft. The CRYSTAL FACE domain over Florida was unable to adequately sample patently tropical and maritime convective systems, which will be a major thrust of the new campaign in Costa Rica. In addition, since the subtropics were mainly sampled during CRYSTAL FACE, the science team was unable to directly address Tropical Tropopause Layer (TTL) dehydration issues to the extent that this might be accomplished in the deep tropics.

In terms of tropical cyclone investigations, hurricane researchers have made significant strides in better predicting where a hurricane will move and where it will make landfall. Our ability to better forecast changes in hurricane intensity, however, has not kept pace with track forecasts. Previous campaigns such as the NASA Convection and Moisture Experiments (CAMEX) have elucidated many key processes critical to understanding tropical cyclones. Our understanding of the environmental and storm-internal processes which control the often unexpected and dramatic changes in hurricane intensity is far from complete. It is a major challenge to forecasters and a high priority for NASA, NOAA, USWRP and NSF interests. Compounding the challenge of predicting tropical cyclone intensity change is our lack of knowledge about the myriad factors leading to the genesis of these storms. While several synoptic-scale influences such as the role of sea surface temperature, shear and upper tropospheric disturbances have been investigated for decades, there is an emerging view that mesoscale and cloud-scale processes play a critical role in determining why a small fraction of tropical disturbances develop into

hurricanes. In order for the next generation of numerical models to improve forecasts of genesis and intensity change, new strategies must be devised for optimal assimilation of small scale, targeted observations and deficiencies in key parameterizations of atmospheric water must be addressed.

There is a pressing need to better understand the factors leading to tropical cyclone intensity change and genesis. However, previous CAMEX field campaigns have not adequately obtained observations related to genesis, because instances of these types of systems at previous deployment locations were rare. Airborne measurements of cloud and precipitation properties have led to improved microphysical parameterizations, but have also pointed out the need for measurements at a greater variety of atmospheric temperature levels. Numerical modeling efforts have demonstrated a requirement for higher resolution humidity information to drive the model convection, but additional observations in the hurricane core and synoptic environment are needed to initialize and validate these models.

Additionally, much remains unknown about potential linkages between aerosols, cloud processes and rainfall. To what extent do particulates such as dust from deserts and smoke from fires modulate cloud microphysical processes, with corresponding impacts on cloud cover, cloud optical properties, and rainfall intensity? Research is beginning to offer clues about these complex interactions, such as reduction of rainfall in areas of high aerosol concentration and possible inhibition of tropical cyclone intensification in regions where dusts are prevalent. Field campaigns such as TCSP – by providing detailed measurements of cloud microphysical properties – can be combined with NASA's unique capability to remotely detect sources of enhanced aerosol concentration (i.e. MODIS). This synergy offers a unique opportunity to answer some of the outstanding questions related to the aerosol-cloud-rainfall connection in tropical locales.

The research represented in this NRA builds upon past satellite, in situ, surface and numerical modeling datasets in the pursuit of understanding changes in the Earth's atmosphere. Both the CRYSTAL-FACE and CAMEX3/CAMEX4 investigations (http://cloud1.arc.nasa.gov/crystalface/ and http://camex.msfc.nasa.gov) and addressed many of the issues for which TCSP will provide the next significant step in integrating the surface-in situ-satellite system of observations toward the goal of providing new data for testing and improving Earth System models. In that context, proposals are encouraged that utilize CRYSTAL-FACE and CAMEX data from models and observations that have particular relevance to both TCSP and the combined objectives of the CRYSTAL-FACE, CAMEX and TCSP missions. Proposals that integrate multiple datasets from surface, in situ and satellite observations toward model improvements that seek to resolve outstanding cloud system questions in anticipation of TCSP are encouraged. For those proposals that include both CRYSTAL-FACE and/or CAMEX analysis and participation in the TCSP mission, a clear statement of the division of resources is required.

TCSP deployment is planned in Costa Rica during the summer of 2005. This campaign will be conducted to capitalize on a number of ground networks, airborne sciences

platforms (both manned and unmanned) and space-based assets. The field campaign will be executed according to a prioritized set of scientific objectives listed in Appendix A. NASA brings to the table a vast network of satellite remote sensing platforms and the potential to fly one or more airborne platforms. It is anticipated that the NOAA Hurricane Research Division (HRD) will participate and features a deployment pool of two low-altitude P3 turboprops and upper tropospheric Gulfstream IV jet. Basing the campaign in Costa Rica also offers opportunities for NASA ESE partnership with proposed NSF-funded tropical cyclogenesis and hurricane rainband studies, including potential participation of the NRL P-3 aircraft and its ELDORA Doppler radar. Documents describing HRD and NSF proposed research may be found at the CAMEX website http://camex.msfc.nasa.gov. The Costa Rican site is thus ideally suited to maximize the objectives of TCSP. The eastern tropical Pacific Ocean, on average, consistently experiences more tropical cyclones each season than the Atlantic, and the active genesis region of these storms is concentrated in a limited domain well within aircraft range. Storms developing within the Gulf of Mexico and the far western Caribbean may also serve as useful targets. Aircraft will be in an excellent position to sample, on a daily basis, a variety of non-cyclonic convective systems, including maritime convective systems and the cirrus they generate near Costa Rica and the Panama Bight. In addition, there will be opportunities to profile the TTL in clear-sky regions, downwind of convection, and in the presence of detached cirrus layers. A map showing the domain of the proposed field campaign and the useful range of aircraft based in Costa Rica are provided in Appendix A.

The spaceborne, suborbital and airborne observational capabilities of NASA put it in a unique position to assist the hurricane research community in addressing shortcomings in the current state of the science. The anticipated launch of several new satellites over the next one to three years, and the prospect of using UAVs for hurricane and climate systems monitoring during the next decade, offer new research tools that need to be explored and validated. Of great importance is the way in which observations of detailed cloud microphysical processes coupled with remote sensing instruments will lead to improvements of the remote sensing retrievals.

1.5 Related Opportunities

The ESE plans to release an NRA for global Water and Energy Cycle research (part of the NASA Energy and Water Cycle Study [NEWS] implementation) in the near future. This NRA will provide opportunities for complementary investigations that utilize remote sensing data and models to understand key processes governing the global cycling of water and energy. In addition, the ESE will also likely solicit an NRA which will provide comprehensive validation of AURA. The AURA validation will involve both short-term field campaigns (using aircraft, high altitude balloons and ground-based components) and long-term observations (utilizing ground-based networks, radiosondes, ozonesondes, water vapor sondes, and comparison with other satellite measurements). TCSP contains specific scientific measurements that may benefit AURA, and there may be occasions where TCSP can leverage from the AURA mission; however, proposers to TCSP should

bear in mind the scientific focus of this NRA. Those proposing more comprehensive validation efforts should respond to the AURA NRA.

1.6 Information on Awards

Awards will be made for a period of three (3) years for approved projects. Funding at a level of approximately $7 million per year is expected to be available for this solicitation. It is anticipated that the average NASA award will be funded in the range of $150,000 per year.

Funds are not currently available for awards under this solicitation. The U.S. 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.

Participation in the program is open to all categories of domestic and foreign organizations, including educational institutions, industry, non-profit institutions, NASA centers, and other U.S. 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 the United States cannot be funded by NASA.

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

1.7 Proposal Submission Requirements

Proposals may be submitted at any time during the period ending **July 1, 2004**, 4:30 pm EST. NASA reserves the right to consider proposals received after that date in accordance with Appendix B, paragraph 11, i.e. "the selecting official deems the late proposal to offer significant technical advantage or cost reduction." All proposals submitted to NASA will be evaluated using scientific peer review. Proposals selected for funding will be announced during the Fall of 2004.

Any grant or cooperative agreement resulting from this NRA is subject to the provisions of the NASA Grant and Cooperative Agreement Handbook, which can be found on-line at http://ec.msfc.nasa.gov/hq/grcover.htm.

All prospective proposers are *strongly* encouraged to submit a Notice of Intent in response to this NRA. This will facilitate planning of the peer review process. The notice of intent should be submitted by **May 1, 2004** via electronic means using the SYS-EFUS Web site as described in Appendix E. The Notice of Intent should specify

information on the NRA number, PI and Co-I names and addresses, title of proposal, telephone and fax numbers of PI, email address and brief summary of the proposed work (not to exceed 300 words).

1.8 Appendices

Technical information contained in Appendix A describes in more details the specific scientific objectives of the TCSP NRA, a listing of desired measurements, and information on the logistics of the field campaign. Appendices B and C present important guidelines and information required for preparation of proposals solicited by this NRA. Appendix D contains required certifications, disclosures, and assurances. Appendix E includes the budget summary with instructions, and Appendix F contains specific instructions on transmittal of the Notice of Intent.

Identifier:	NN-H-04-Z-YS-003-N
Submit Notice of Intent To:	**Conventional Mail:** NASA Peer Review Services, Code Y Tropical Cloud Systems and Processes Proposals 500 E Street, SW, Suite 200 Washington, D.C. 20024-2760 Fax: 202-479-0511 **Electronically:** Enter the requested information through SYS-EFUS Web site located at http://proposals.hq.nasa.gov/ (see Appendix E).
Submit Proposals To:	NASA Peer Review Services, Code Y Tropical Cloud Systems and Processes Proposals 500 E Street, SW, Suite 200 Washington, D.C., 20024-2760 (For overnight delivery purposes only, the recipient telephone number is 202-479-9030).
Number of Copies Requested:	20
Selecting Official:	Dr. Jack Kaye, Director Research Division Office of Earth Sciences NASA Headquarters
Obtain Additional Information:	Dr. Jeffrey Halverson Deputy Program Scientist Code YS NASA Headquarters 300 E Street, SW Washington, D.C. 20546 TEL: (202) 358 1199 FAX: (202) 358 2770 EMAIL: jhalvers@hq.nasa.gov

Please use identifier number NN-H-04-Z-YS-003-N when making an inquiry regarding this Announcement. Your interest and cooperation in participating in this effort are appreciated.

ORIGINAL SIGNED BY

_____ Date: _____

Dr. Ghassem Asrar, Associate Administrator for Earth Science

Appendix A: Technical Description

TCSP (Tropical Cloud Systems and Processes) is an integrated program of observations, modeling studies and analyses designed to investigate a broad range of inter-related and stand-alone scientific topics pertaining to the deep tropical atmosphere. Satellite remote sensing is a central theme of TCSP. Satellite observations will be utilized in mission planning, to provide coincident data sets for integrated analyses, and will be the target of specific validation efforts.

A1. Research Topics

The key research topics studied by NASA's Earth Science Enterprise fall largely into five categories: Variability, Forcing, Response, Consequences and Prediction. Each of these categories addresses challenging, scientifically important and cross-disciplinary problems:

1. *How is the global Earth system changing (Variability)?*
2. *What are the primary causes of change in the Earth system (Forcing)?*
3. *How does the Earth system respond to natural and human-induced changes (Response?)*
4. *What are the consequences of change in the Earth system for human civilization (Consequences)?*
5. *How will the Earth system change in the future (Prediction)?*

Research supported by this NRA is expected to be responsive to eight specific questions related to cloud systems, precipitation and atmospheric predictability, as addressed within NASA ESE's broad scientific strategy. This strategy has been articulated in ESE (2003) [see document Earth Science Enterprise Research Strategy, available from National Aeronautics and Space Administration (NASA), Washington, D.C., found at web site http://www.earth.nasa.gov/visions/ESE_Strategy2003.pdf and detailed in the article by Asrar et al. (2001) [see Asrar, G., J.A. Kaye and P. Morel, 2001: NASA research strategy for Earth system science: Climate component. *Bull. Amer. Meteorol. Soc*., 82, 1309-1329]. These scientific questions are as follows:

a) (Variability) How are global precipitation, evaporation and cycling of water changing?
b) (Forcing) What trends in atmospheric constituents and solar radiation are driving global climate change?
c) (Response) What are the effects of clouds and surface hydrologic processes on Earth's climate?
d) (Response) How do atmospheric trace constituents respond to and affect global environmental change?
e) (Consequences) How are variations in local weather, precipitation and water resources related to global climate variation?
f) (Prediction) How can weather forecast duration and reliability be improved?

g) *(Prediction) How will future changes in atmospheric composition affect ozone, climate and global air quality?*
h) *(Prediction) How will water cycle dynamics change in the future?*

These general science questions are used to frame more specific TCSP science objectives related to 1) the dynamics and thermodynamics of deep moist convection (DMC) – in the context of both tropical cyclones and tropical maritime cloud systems generating cirrostratus anvils; 2) radiative processes associated with anvil-upper atmospheric interactions; 3) upper atmospheric composition and structure related to convective-scale feedbacks, water vapor, ozone, aerosols and other trace constituents; and 4) assimilation and validation of observations from existing and anticipated NASA satellite remote sensors (including but not limited to TRMM, Terra, Aqua, Aura, CALIPSO and CloudSat). These investigations encompass *in situ* and remotely sensed quantities which can be measured using a combination of aircraft, UAVs, ground-based assets such as radars and soundings, and also numerical modeling studies. A number of key topics have been suggested below to help investigators develop their proposed research:

1. Tropical Cyclones – Structure, Genesis, Intensity Change and Rainfall

Important Topics: (1) What are the roles of environmental vertical wind shear in tropical cyclone genesis, intensification, track and rainfall? (2) How does the amount and distribution of environmental moisture contribute to tropical cyclone genesis, intensification, track, and rainfall? (3) How do large-scale effects, such as interactions between easterly waves, terrain, upper-level troughs, atmospheric dust layers, and the ITCZ, contribute to cyclogenesis and intensity change? (4) How does the surface vortex develop? (5) What factors controls the timing, location and intensity of convection and precipitation (i.e. thermodynamics, kinematics, microphysics, aerosols, cloud-radiation feedbacks), and how these processes feed back to the vortex? (6) How are developing and mature storms impacted at landfall? (7) How does the release of latent heat from microphysical processes feedback upon the updraft and downdraft characteristics of hurricanes and their evolution?

2. Upper Troposphere, Tropopause Layer and Stratosphere

Important Topics: (1) What are the physical mechanisms that control (and cause) long-term changes in the humidity of the upper troposphere in the tropics and subtropics? (2) 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)? (3) What are the mechanisms that control ozone within and below the Tropical Tropopause Layer (TTL)? (4) What mechanisms maintain the humidity of the stratosphere? What are the relative roles large-scale transport and convective transport and how are these processes coupled?

3. Cirrus Anvils – Radiative and Moisture Impacts

Important Topics: (1) Do radiative processes and cloud-radiation interactions contribute to tropical cyclone development and intensification? (2) How do convective intensity and aerosol properties affect cirrus anvil properties? (3) How do cirrus anvils, and tropical cirrus in general, evolve over their life cycle? How do they impact the radiation budget and ultimately the circulation? (4) What controls the formation and distribution of thin cirrus in the TTL, and what is the influence of thin cirrus on radiative heating and cooling rates, and on vertical transport?

4. Satellite Data Assimilation and Validation Studies

Important Topics: (1) What are the capabilities and limitations of using spaceborne and airborne information to improve forecasts of tropical cyclone track, intensity, and rainfall? (2) How can space-based measurements of geophysical parameters, particularly those known to possess strong variations on small spatial scales, be validated in a meaningful fashion? Examples of such quantities include ozone, temperature, pressure, methane, carbon monoxide, nitric acid, and water isotopes, as are currently measured or as part of anticipated missions such as AURA; (3) In the likely event that one or more instruments are selected to measure vertical moisture profiles, how can these profiles be used to validate moisture retrievals from platforms such as AIRS? As stated in Section 1.5, however, proposers should be aware that NASA anticipates soliciting a general AURA validation NRA separate from this announcement. Only those proposers offering specific synergy between the TCSP airborne mission and AURA, and preferably addressing both research and calibration/validation needs, should submit to this NRA.

5. Numerical Modeling Investigations/Improvements in Operational Forecasts

Important Topics: (1) How can parameterizations of hurricane microphysics be improved through the use of *in situ* and remotely sensed microphysical quantities? (2) How can quantitative precipitation forecasts be improved through application or assimilation of remotely sensed microphysical quantities as well as better representations of microphysical, boundary layer, thermodynamic and other processes? (3) How can cloud-resolving and mesoscale models be used to better understand the sensitivity of convectively-generated cirrus to upper tropospheric moisture, aerosols and shear? (4) How can regional and global scale models be used to understand those factors that control the distribution of upper tropospheric water vapor (i.e. the relative roles of local deep convection and large-scale vertical motions) and how can GCM parameterizations of tropical cirrus be improved? (5) How can our understanding of critical processes governing the TTL (i.e. chemistry, cloud microphysics, isotopes, transport processes) be enhanced through numerical modeling investigations?

A2. Education Component

A core mission of NASA is "to inspire the next generation of explorers…as only NASA can." In support of this mission, the Office of Earth Science, in collaboration with the

Office of Education, is committed to fostering the broad involvement of the Earth science community in education with the goals of enhancing the Nation's formal and informal education systems and contributing to the broad public understanding of science, technology, engineering and mathematics (STEM). In particular, the Office of Earth Science supports the development of innovative methods for using Enterprise resources to enhance STEM education through both formal and informal venues and to deepen student understanding of Earth system science and related careers.

One of the Agencies' strategies to accomplish its educational mission is to embed educational components into all new flight missions and research programs. The ESE Education Program facilitates such activities in coordination with the ESE Research Program. Proposals to develop education projects incorporating the unique science relevant to this NRA will be solicited after the selection of research awards are announced. Approximately $300-400K per year will be reserved for 2-4 educational projects. Education proposals are to support the goals and objectives for Earth science education as described in *Inspire the Next Generation of Earth Explorers: NASA's Plan for Earth Science Education 2004-2008* (available online at: http://earth.nasa.gov/education). This plan emphasizes the use of digital information infrastructures to maximize resource delivery and the formation of partnerships to facilitate widespread dissemination and effective of use of ESE educational resources. Projects that build upon ESE accomplishments in education to increase impact and broaden reach are particularly important to this announcement.

The ESE Education Program works to improve STEM education at a national level. Important topics for education proposals include: (1) use of field campaign, satellite and modeling data as a learning resource for K-16+ Earth system science and STEM education; (2) increased awareness of careers relevant to Earth system science; (3) development of educational projects using TCSP datasets to increase public scientific literacy about: why hurricanes form; hurricane prediction; hurricanes as natural hazards including human impacts and coastal/ecosystem impacts; and the role of clouds in climate; and (4) timely development and delivery of integrated datasets suitable for applications by public and private enterprises sensitive to weather and climate (e.g. agricultural efficiency, global energy, aviation, public health, water management, coastal management, disaster management, etc.).

Abstracts for research awards funded under this NRA will be made broadly available. PIs selected for awards are expected to engage in open dialogue and collaborate with individuals submitting education proposals to ensure educational activities support TCSP research priorities.

A3. Experiment Location and Timeframe

It is anticipated that the TCSP campaign will be undertaken during a comprehensive six week field observations period in the June-August timeframe of 2005. It is anticipated that NASA and other agency aircraft will be based out of San Jose, Costa Rica (10° N, 84° W) and Acapulco, Mexico (17° N, 100° W). Figures 1, 2 and 3 show varying ranges

of aircraft deployed from San Jose and Acapulco in relation to the initial location of tropical cyclones (depressions, storms, hurricanes) in June, July and August (based on 1970-2002 climatology). Much of the tropical cyclone genesis region is accessible to aircraft based in both locations. A census of mesoscale convective systems (MCSs) for July, 2003 across the broader region over and surrounding Costa Rica (E. Zipser and colleagues, personal communication) reveals that the Costa Rica region experiences an identical number of oceanic MCSs as other global locations (i.e. Guam, Darwin, Florida waters), when normalized for ocean area, and taken on an annual basis. The spatial distribution of these MCSs is shown in Figure 4. There does not appear to be any geographical concentration or preferred location for these systems. It is thus expected that many suitable targets for anvil and tropopause-region interaction studies will be found within typical sampling range of the TCSP aircraft.

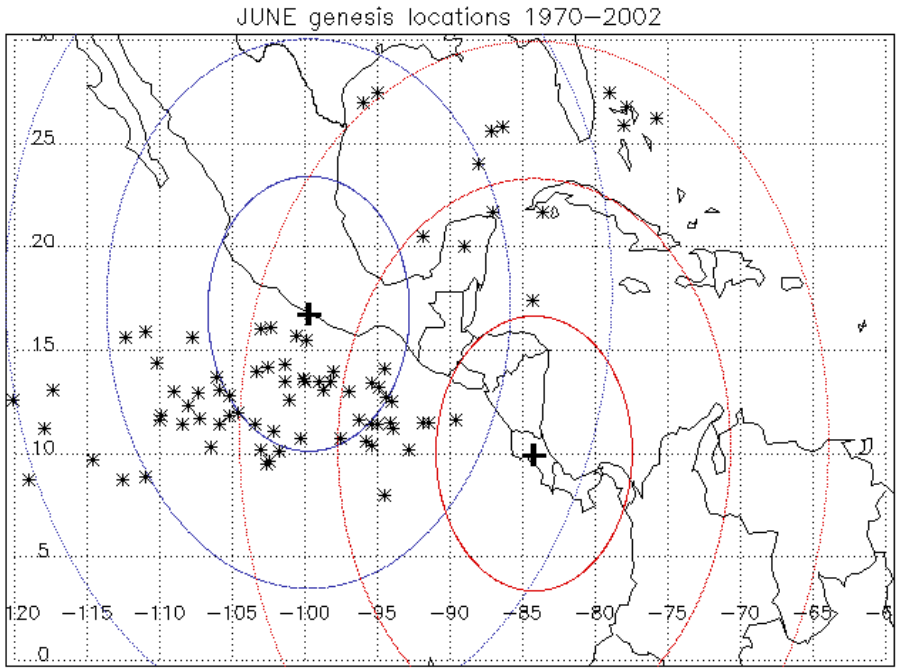

Fig. 1. Initial locations of tropical cyclones (depressions, storms, and hurricanes) for June during the years 1970-2002, according to the National Hurricane Center's best track files. These locations correspond to the completion of the genesis process. The range rings are plotted at 400 n mi (740 km) intervals from San Jose, Costa Rica in red and from Acapulco, Mexico in blue.

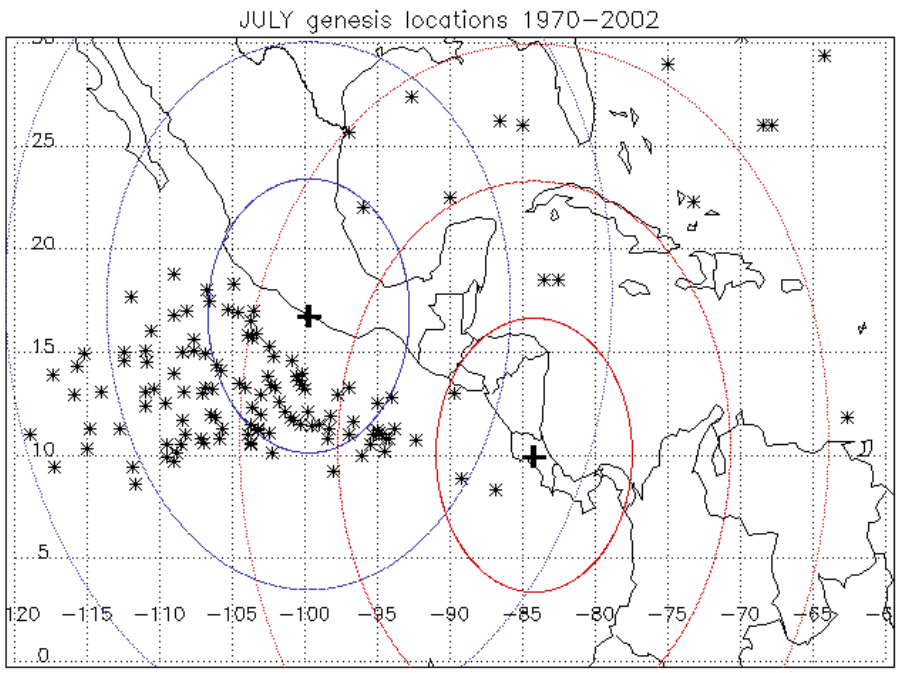

Fig. 2. Same as Fig. 1 except for July.

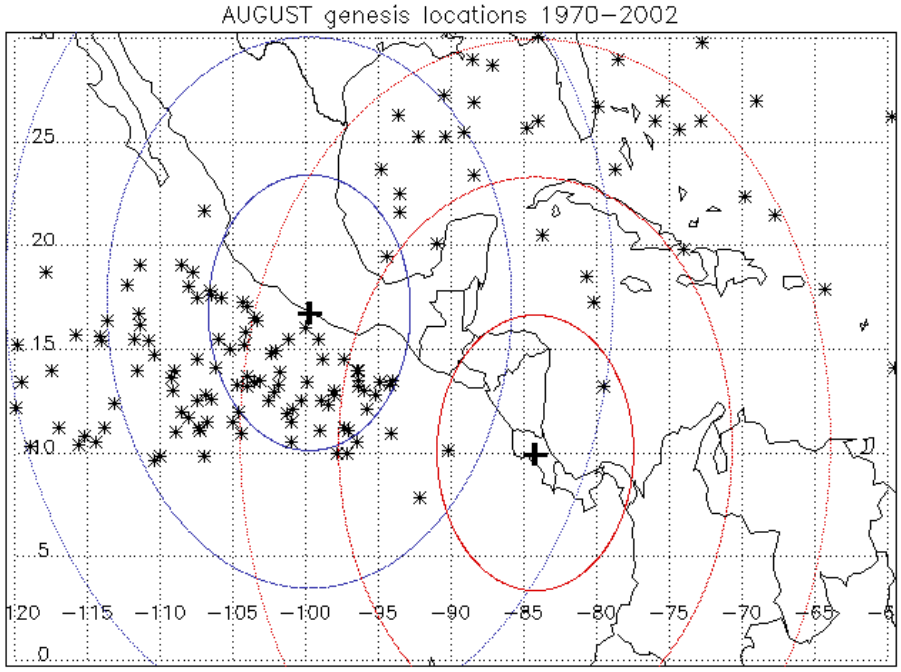

Fig. 3. Same as Fig. 1 except for August.

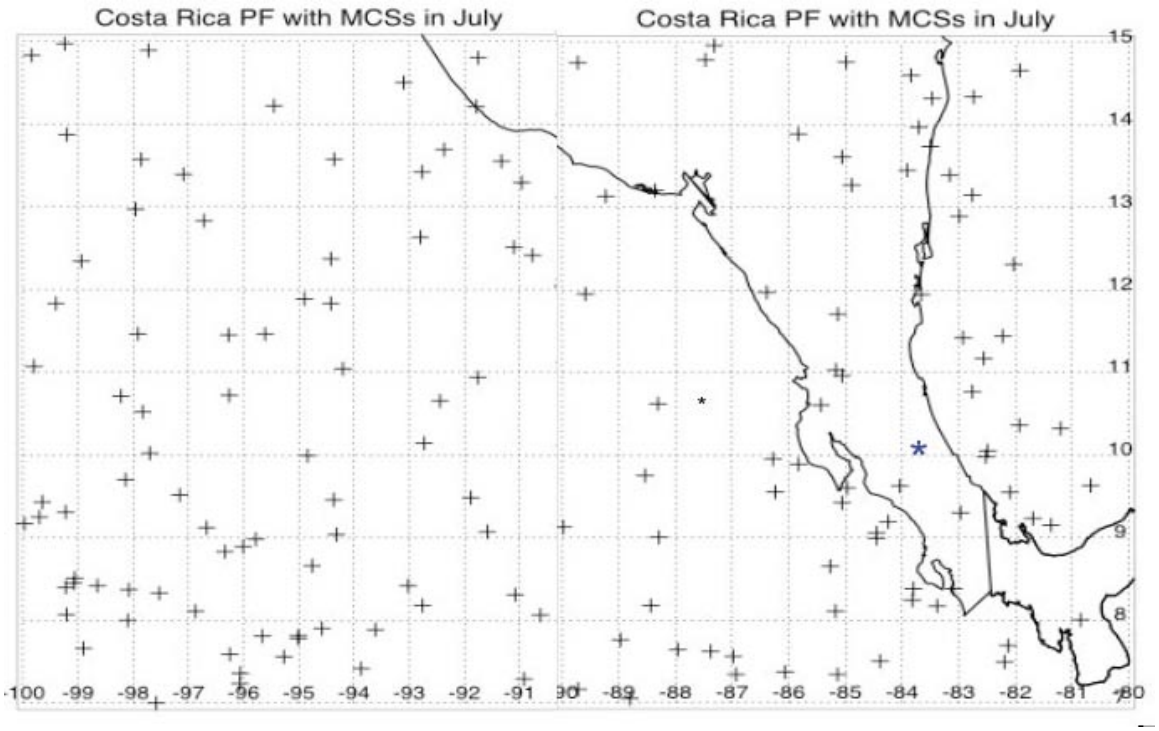

Fig. 4. Distribution of MCSs in July, 2003 based on a census of TRMM precipitation features.

A4. Typical Mission Profiles

It is anticipated that 150 total flight hours (including hours used for integration and ferry) will be provided for participating NASA aircraft, to be divided among 15-20 missions. Examples of hurricane sampling missions from previous CAMEX campaigns can be found at http://camex.msfc.nasa.gov, and typical CRYSTAL FACE cirrus-sampling missions can be found at http://cloud1.arc.nasa.gov/crystal_face/. During TCSP, the challenge is to design missions that will efficiently combine the numerous science objectives outlined in Section A1 above. While the planning and execution of TCSP investigative flights will be developed by the Mission Science Team prior to and during deployment in Costa Rica, following is an example of the broad categories of flights which will be undertaken:

1. Flights sampling the synoptic- and mesoscale environmental conditions in the vicinity of waves, disturbances and incipient tropical cyclones in the eastern Pacific cyclogenesis region;
2. Flights studying the cloud-internal microphysics, dynamics and evolution of tropical cyclones;
3. Flights investigating smaller maritime convective systems and the cirrus they generate closer to Costa Rica and in the Panama Bight;
4. Flights profiling the TTL in clear-sky regions, downwind of convection, and in the presence of detached cirrus layers; and

5. Flights specifically targeting the overflight swaths of one or more NASA satellites i.e. Aura, CALIPSO, CloudSat, Aqua, Terra

It is likely that efficient flights will be designed which will combine elements of these different categories, i.e. a mission targeting a specific developing tropical cyclone in the eastern Pacific will sample convectively generated cirrus during the outbound ferry, and then sample the TTL in a clear air region during the return ferry.

Prospective proposers are advised that safety is a top priority for all of NASA's programs. 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 work force (including employees working under NASA award instruments); and (4) high-value equipment and property.

A5. Ground-Based Networks and Facility Instrumentation

As in past NASA OES-sponsored field campaigns such as CAMEX and CRYSTAL-FACE, it will again be desirable to supplement the airborne and satellite-derived measurements with ground-based systems such as weather radar and upper atmospheric observations. This NRA will support the installation and operation of both the NASA polarimetric radar (NPOL) and 5-cm Doppler radar (TOGA) in Costa Rica (REFS NEEDED). These radars can provide critical information on the structure and evolution of convective systems, which will be beneficial for understanding processes such as the evolution of anvil clouds, detrainment of water substance into the tropopause region, and the behavior of convective systems embedded in easterly waves. NASA will also furnish a dedicated scientist responsible for daily technical and scientific oversight of both radars. However, in the event that meteorological targets of opportunity become available, other scientists in the field may wish to suggest alternate radar measurement strategies, as long as they are consistent with the scientific objectives outlined in Appendix A above .

In addition, this NRA will also consider proposals to establish one or more fixed radiosonde sites for the purpose of providing high quality, vertical profiles of the *in situ* state variables (T, P, RH, winds) and ozone. The purpose of these measurements is to supplement and help validate tropospheric and stratospheric profiles obtained through satellite and aircraft remote sensing means (i.e. structure and properties of easterly waves, convective system environments, anvil properties, column ozone).

A6. Aircraft Instrumentation: Desired Measurements

Table 1 lists the various types of observable parameters solicited by this NRA. Many, if not most, of these quantities have been measured with airborne sensors in the past CAMEX and CRYSTAL campaigns. The references to specific aircraft platforms and instruments in this table are not meant to be either inclusive or exclusive; they are intended only to represent general classes or categories of desired observational

capabilities. The measurements have been stratified according to altitude regions and examples of aircraft (many of which have historically provided the listed measurements) are shown for each layer.

Particular emphasis in TCSP is placed on obtaining *in situ* and remotely sensed (i.e. passive microwave radiometer) microphysical observations within anvils and developing tropical cyclones. These measurements should include, but are not limited to, ice crystal and rimed ice species size distribution, ice crystal shape (habit) and aerosol size distribution. Accurate water vapor measurements are particularly important, throughout the depth of the atmospheric column, since many of the issues concerning anvil cloud growth and persistence, the moisture source of tropical cyclones and moisture changes in the tropopause region hinge on accurate relative humidity determination. The basic radiative measurements are the upwelling and downwelling solar and infrared irradiance both above and below cirrus cloud decks.

Critical to the success of efforts to quantitatively understand the linkage of deep convection to anvil production and the behavior of deep convection in tropical cyclone rainbands and eyewalls are measurements of the magnitude and vertical structure of convective systems. Such measurements will be made by airborne and surface-based Doppler radar. Downward-looking Doppler precipitation measurements in both the cm and mm wavelengths are highly desirable, for characterizing the relationship of the core convective region to the developing cyclone eye, warm anomaly and surrounding cirrus outflow properties. Finally, measurements of the various chemical trace gas and tracer constituents listed in Table 1 are crucial from the standpoint of relating water vapor concentrations to convective source regions, the regulation of water vapor near tropopause and origin of various aerosols.

It is anticipated that this campaign will again be done in cooperation with NOAA/HRD. If this occurs, it may be possible to add some instruments of interest to TCSP on the NOAA P-3 aircraft. Therefore, proposals for this possibility will be considered provided the potential proposers have obtained formal approval from NOAA to the effect that their instruments will be allowed onboard the NOAA aircraft.

Proposers are urged to consult a listing of past airborne instrument deployments. This information can be found at http://camex.msfc.nasa.gov and http://cloud1.arc.nasa.gov/crystal_face/. A subset of these parameters that may be suitably obtained through use of uninhabited aerial vehicles (UAVs) will be evaluated as part of this announcement. Because of the timeframe involved in preparing for the experiment, this NRA does not solicit the development of new instrumentation; only proven instruments will be considered for critical measurements. Proposals for experimental investigations that clearly lack the required measurement sensitivity or are otherwise unsuitable for operation onboard aircraft also will be non-responsive.

Table 1. Observations for Instrumented Aircraft : TCSP

Satellite Remote Sensor

Measurement

Sea surface temperature
Sea surface winds
Cloud cover and height
Cloud optical properties
Aerosols
Temperature soundings
Humidity soundings
Rainfall intensity, structure
Ice scatter
E fields/lightning
Ozone
Chemistry

Upper Atmospheric Aircraft In Situ (e.g. WB-57, Global Hawk)

Measurement

T, p, RH, winds (*in situ*)
H_20 total (CVI+alternate)
Ice size distribution
Ice crystal habit
Cloud extinction
HNO_3
HOx
HCl
H_20 isotopes
N_20, CFCs, CH_4, CH_3BR
CH_3I
BrO
ClO
H_20 vapor
O_3
E fields/lightning
NO_2 column, Br0, HCHO (DOAS)

Upper Atmospheric Remote Sensing (e.g. ER-2, Proteus, Global Hawk)

Measurement

T profiler
Cloud/aerosol lidar
94 GHz radar
Precip Doppler radar
MODIS simulator
Sub-mm radiometer (~600 GHz)
Microwave radiometers
(~10-350 GHz)
Dropsonde
Solar spectral flux
Broadband IR, solar flux

Middle Atmospheric Observations (i.e. DC-8, Altair, Predator B, Cessna Citation)

Measurement

T, p, RH, winds (*in situ*)
Turbulence
T profiler
H_20 vapor
O_3
Ozone lidar (nadir)
Ozone lidar (zenith)
H_20 lidar (nadir)
H_20 lidar (zenith)
Cloud extinction
H_20 total
Ice size distribution
Ice crystal habit
Ice water content
Ice nuclei
Aerosol size distribution
Precipitation Doppler radar
Microwave radiometer
E fields/lightning
Dropsonde
NOx
HNO_3
Acetone and PAN
HOx
N_2O, CFCs, CH_4, CH_3Br
CH_3I-etc.

HCHO, HOOH, CH_3OOH

Lower Atmospheric Aircraft (P3, Aerosonde, Twin Otter)

Measurement

T, p, RH, winds (*in situ*)
Turbulence
H_2O vapor
CO
O_3
NOx
Aerosol column
(sunphotometer)
HCHO, HOOH, CH_3OOH
Aerosol size distrib
Aerosol composition
CCN
Solar spectral flux
Broadband IR, solar flux
N_2O, CFCs
94 GHz radar
Wave height/sea state
Dropsonde
Precipitation Doppler radar

Surface-Based

Doppler radar
Sounding(s)
Surface observations (land, buoy)
O3 soundings
Disdrometers
Rain guages
E fields, lightning
Profiler

All suborbital platforms used in this investigation must comply with NASA aviation safety policies. The platforms referenced in the above table are provided as examples of platforms that can safely meet the flight performance requirements needed to obtain the targeted observables. All proposals should include a recommended platform, and all platforms will be considered. Information about NASA aviation policies and potential platforms is available from the NASA/ESE Suborbital Science Program website http://www.earth.nasa.gov/science/suborbital.

A7. Aircraft Instrumentation: Logistics

When planning experiments, potential investigators must first recommend a specific platform and provide a rationale for that platform, and then address the logistics associated with the platform in a detailed appendix. When recommending large, multi-sensor platforms, investigators must include the integration logistics. For example, the NASA DC-8 and ER-2 platforms will require airborne experimental investigators to be at the Dryden Flight Research Facility for about four (4) weeks prior to the field experiment. Likewise, the NASA WB-57, P-3B and S-3 each require substantial integration time at their home bases of Johnson Space Center, Wallops Flight Facility, and Glenn Research Center, respectively.

At a minimum, this appendix should provide information relative to the selected platform, airborne instrumentation, field personnel required, and shipping. The minimum requirements should be defined in each of the following areas:

1. Airborne Instrumentation

a) recommended suborbital platform and instrument;
b) the amount of rack space that will be required;
c) power requirements;
d) description of inlets/exhausts and/or optical window(s) required;
e) size and number of compressed gas bottles, coolers, pumps, etc. that will be required to mount externally to the rack space;
f) cooling flow rate and temperature required to sustain continuous operations under all flight regimes;
g) total volume and weight of all equipment and supplies

2. Personnel/Travel

The number of individuals required to operate the proposed instrumentation during flight operations, and the number, if any, of additional non-flight personnel required during the field deployment of TCSP, should be defined along with their proposed schedule for integration and deployment. Travel costs for each participant should be included as a separate line item in the proposed budget. The mission Project Manager will be responsible for allocation of investigator seats aboard the DC-8.

3. Shipping

An estimate of the volume and weight of the equipment that will be required to be shipped to each respective integration site should be provided. In addition, an estimate of the volume and weight of additional equipment or special items, such as compressed gases, that will be required to be shipped to each intensive deployment site should be identified.

4. Special requirements, such as, the need for liquid nitrogen, dry ice, helium, etc., at the integration sites and/or during the TCSP deployment should be defined. Other non-standard operating procedures and requirements should also be discussed.

5. Supply similar logistical information, as applicable, for surface-based investigations.

A8. Program Management

Close interagency cooperation in the past has made possible advancements in our understanding of tropical cyclones, convective systems and climatically important cirrus. It is intended that this spirit of interagency cooperation will be maintained.

While NASA will provide overall management of the mission, other federal agencies including National Science Foundation (NSF), Office of Naval Research (ONR), Department of Energy (DOE), Department of Defense (DOD), and National Atmospheric and Oceanic Administration (NOAA) are encouraged to be strong participants.

A9. Science Team

The TCSP Science Team will be composed of: (1) the selected Principal Investigators of experimental proposals for each experiment aircraft and surface-based observation systems; (2) Principal Investigators selected for theoretical/modeling studies. The Science Team will be chaired by the one or more Mission Scientists or Deputy Mission Scientists. *Individuals proposing an experimental or theoretical investigation may also propose to serve as Mission Scientist or Deputy Mission Scientist.*

The Science Team will: 1) determine its own structure and method for interactions among Team Members and the various aircraft Mission Managers to achieve the mission objectives and the goals of the TCSP missions; (2) develop detailed plans to conduct the TCSP mission to meet the objectives, which may include allocation of flight hours toward realization of the various science goals; and (3) be responsible for establishing a data management, archiving and data protocol plan that will promote the timely publication and dissemination of scientific results in accordance with the data handling policies of the OES. The data policy for OES projects requires that data be made available to the public after a brief period of exclusive use by science teams for validation of the data, which for the TCSP mission shall be no more than 6 months after return from the field deployment.

A10. Previous NASA Campaigns to Investigate Tropical Clouds: A Heritage

The Convection and Moisture Experiment (CAMEX) campaigns included investigations of hurricane processes in the Atlantic during the fall of 1998 (CAMEX-3) and 2001 (CAMEX-4), in collaboration with NOAA's Hurricane Research Division (HRD) and Aircraft Operations Center (AOC). The CAMEX field missions have provided a major scientific component of a multi-agency effort to observe tropical cyclone formation,

motion and intensification, and improve the prediction of hurricane behavior near landfall. The practical aspects are obvious: NOAA flies low, NASA flies high; NOAA and NASA aircraft have different but complementary remote sensing capabilities. NOAA and NASA aircraft have proven their ability to sample an entire storm. Altogether, a total of eight tropical storms and hurricanes were investigated during the CAMEX field campaigns, in addition to supporting validation for the TRMM satellite. Most notable of the storms investigated was Hurricane Humberto, which was sampled on three consecutive days during a cycle of both increasing and decreasing intensity. Analyses of CAMEX data is leading to fruitful publication on such varied topics as eyewall convective structure, the impacts of orography on landfalling hurricanes, hydrometeor particle size distributions using passive microwave algorithms, how the structure of the upper level warm core is impacted by wind shear, detailed mesoscale model simulations of processes controlling rainfall distribution and storm evolution, and how high resolution water vapor observations contribute to improved hurricane intensity and track forecasts. The CAMEX program, as a participant in the multi-agency US Weather Research Program (USWRP), will focus heavily on improving understanding of tropical cyclone intensity change - an issue at the top of the USWRP initiative, and also consistent with long-term interests of NOAA HRD scientists.

The CRYSTAL FACE mission was motivated by the importance of tropical cirrus clouds in the Earth's climate system. A core objective of the mission was to provide measurements useful for the development and improvement of algorithms used for retrieval of cirrus properties from remote-sensing instruments. *In situ* measurements in tropical cirrus were made coincident with ground-based, airborne, and satellite platforms – including careful mission coordination with Aqua, Terra and TRMM satellites. Real-time coordinated flights were performed in CRYSTAL-FACE utilizing six aircraft at a time with great success. During CRYSTAL FACE, DOE/ARM instrumented a ground site consisting of a lidar, radar, radiometers and soundings. NSF and NRL provided a P3 aircraft flying the ELDORA and the Twin Otter aircraft, NPOESS funded the Proteus high altitude aircraft, and NOAA supported instrument and theory teams. The University of North Dakota Citation provided critical data *in situ* data in the middle and upper troposphere.

As a result of CRYSTAL-FACE, new findings are emerging on the role of tropopause cirrus, in which mesoscale model simulations show *in situ* cloud formation with no direct association with deep convection, and which also irreversibly dry the tropopause layer. Some of the emerging findings include an unexpected persistence of supersaturation within tropical clouds, unprecedented *in-situ* water isotope measurements in and around upper tropospheric clouds (which indicate large variability in the upper level water vapor isotope enrichment), and new insights on how dust and smoke particles (originating from African deserts and midlatitude forest fires, respectively) impact cloud microphysical processes and the composition of lower stratospheric air.

A11. Specific Guidelines in Preparing Responses to This NRA

Fifteen (15) copies of the proposal should be submitted. One copy must bear original signatures. Original signatures are to be placed on an official cover page, which is generated electronically and printed through SYS-EFUS; an example of the required cover page is located in Appendix C. Notice of Intent is requested within two (2) weeks after release of this Research Announcement. Proposals should not exceed 15 pages of single-spaced standard font of size 12, exclusive of title, abstract, references, vitae, budget information and certificates. Vitae should not exceed 3 pages per investigator, including publications. A work plan, which describes the specific tasks for each year of the proposal, should be included as part of the text. Proposals should be self-contained and should not refer to other material, such as websites on the internet. If color figures are included, they should be included in all copies provided. Attached preprints and reprints of publications and reports will be ignored in the review process. To facilitate recycling, proposals should be prepared without binders or plastic covers. Appendices C and D contain a cover sheet, required certifications and budget summary form which must be submitted with the original signature version of all proposals.

Note that proposers should prepare their budgets to include full cost accounting. The reference for the NASA Full Cost Initiative can be found at http://www.hq.nasa.gov/fullcost.

Proposals will be subjected to both mail and panel reviews. Approved proposals will be funded in installments (typically annually) for a period of up to three (3) years, subject to demonstrated satisfactory performance and the availability of funds.

Further details to assist proposers in preparing their submissions can be found in the Guidebook for Proposers Responding to a NASA Research Announcement, which includes NASA Headquarters policy on submitting a Notice of Intent (NOI) and accessing SYS-EFUS. The website may be found at: http://www.hq.nasa.gov/office/procurement/nraguidebook.

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 **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** 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:

i) Click the hyperlink for **new user** that will take you to the Personal Information Search Page.
j) Enter your first and last name. SYS-EYFUS will **search** for your record information in the SYS-EYFUS database.
k) Confirm your personal information by **choosing** the record displayed.
l) 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 on this proposal shall also be strictly complied with. Disclosure of this proposal for any reason outside the Government evaluation purposes shall be made only to the extent authorized by the Government.

Principal Investigator Na		**Authorized Institutional Official Name:**	
Organiz on:		**Organization:**	
Depar ent:		**Department:**	
Mailing Ad ss:		**ling A d**	
City, State Zip:		**y, S Zip:**	
Telephone N ber:		**Tele ne N mber:**	
Fax Nu er:		**ax N mber:**	
Email Ad s:		**ail A ress:**	
Principal Investigator Signature:	_____	**Authorized Inst tional Official Si ature:**	_____
Date:	_____	**Date:**	_____

Co-Investigator:

Name	Telephone	Email	Institution	Address

Budget:

Year	Budget
1	
2	
3	
Total	

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

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

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

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

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

1. LOBBYING

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

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

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

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

2. GOVERNMENTWIDE DEBARMENT AND SUSPENSION

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

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

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

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

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

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

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

Appendix E

BUDGET SUMMARY

For period from _____ to _____

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

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

***Facilities and Administrative Costs.**

INSTRUCTIONS FOR BUDGET SUMMARY

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

* Facilities and Administrative (F&A) Costs

Appendix F

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:

m) Click the hyperlink for **new user** which will take you to the Personal Information Search Page.

n) Enter your first and last name. SYS-EYFUS will **search** for your record information in the SYS-EYFUS database.

o) Confirm your personal information by **choosing** the record displayed.

p) 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.