A.13 ATMOSPHERIC COMPOSITION: SOUTHEAST ASIA COMPOSITION, CLOUD, CLIMATE COUPLING REGIONAL STUDY

Amendment 21 on November 1, 2010. This version of the text replaces the prior draft version in its entirety, including the name.

1. Scope of Program

Atmospheric composition changes affect air quality, weather, climate, and critical constituents such as ozone. Atmospheric exchange links terrestrial and oceanic pools within the carbon cycle and other biogeochemical cycles. Solar radiation affects atmospheric chemistry and is, thus, a critical factor in atmospheric composition. Atmospheric composition is central to Earth system dynamics, since the atmosphere integrates surface emissions globally on time scales from weeks to years and couples several environmental issues. NASA's research for furthering our understanding of atmospheric composition is geared to providing an improved prognostic capability for such issues (e.g., the recovery of stratospheric ozone and its impacts on surface ultraviolet radiation, the evolution of greenhouse gases and their impacts on climate, and the evolution of tropospheric ozone and aerosols and their impacts on climate and air quality). Toward this end, research within the Atmospheric Composition Focus Area addresses the following science questions:

- How is atmospheric composition changing?
- What trends in atmospheric composition and solar radiation are driving global climate?
- How does atmospheric composition respond to and affect global environmental change?
- What are the effects of global atmospheric composition and climate changes on regional air quality?
- How will future changes in atmospheric composition affect ozone, climate, and global air quality?

NASA expects to provide the necessary monitoring and evaluation tools to assess the effects of climate change on ozone recovery and future atmospheric composition, improved climate forecasts based on our understanding of the forcings of global environmental change, and air quality forecasts that take into account the feedbacks between regional air quality and global climate change. Achievements in these areas via advances in observations, data assimilation, and modeling enable improved predictive capabilities for describing how future changes in atmospheric composition affect ozone, climate, and air quality. Drawing on global observations from space, augmented by suborbital and ground-based measurements, NASA is uniquely poised to address these issues. This integrated observational strategy is furthered via studies of atmospheric processes using unique suborbital platform-sensor combinations to investigate, for example: (1) the processes responsible for the emission, uptake, transport, and chemical transformation of ozone and precursor molecules associated with its production in the troposphere and its destruction in the stratosphere and (2) the formation, properties, and transport of aerosols in the Earth's troposphere and stratosphere, as well as aerosol interaction with clouds. NASA's research strategy for atmospheric composition encompasses an end-to-end approach for instrument design, data collection, analysis, interpretation, and prognostic studies.

2. Description of Solicited Research

The Atmospheric Composition research programs are soliciting proposals for participation in two airborne campaigns to be conducted in 2012 to investigate atmospheric processes related to deep convection, chemistry/photochemistry, aerosols and clouds in mid-latitude and tropical environments. Multiple comprehensively instrumented aircraft are required to accomplish this research. NASA and the National Science Foundation plan to collaborate to conduct two synergistic campaigns designed to sample the atmosphere in two very different convective environments: summer mid-latitude continental North America and fall tropical Southeast Asia. Through this call, the Upper Atmosphere Research Program, the Radiation Sciences Program, the Tropospheric Chemistry Program, and the Atmospheric Composition Modeling and Analysis Program seek instrumentation teams and data analysis teams for participation in these studies.

Understanding and predicting the composition of the boundary layer and free troposphere are important to climate studies, air quality and biogeochemistry. Natural and anthropogenic sources emit aerosols and gases primarily into the boundary layer. Numerous processes, including photochemistry, convection, and cloud processing, transform, transport, and in some cases remove these chemical and aerosol species from the atmosphere. Material not removed from the atmosphere can be transported very long distances, especially in the free troposphere, with the result that emissions from one region may have impact not only in that region but also on broader continental and global scales.

The upper troposphere and lower stratosphere (UT/LS) is an important region for Earth's climate because water vapor, ozone, cirrus clouds and aerosols in this region strongly contribute to radiative forcing of the climate system. The UT and LS have very different chemical compositions resulting in strong gradients across the tropopause. Convective transport is a major pathway for rapidly moving chemical constituents and water from the boundary layer to the upper troposphere and in some cases to the lower stratosphere. These transport processes control the abundances of compounds that regulate stratospheric ozone quantities. Globally, the Asian monsoon anticyclone is believed to be a dominant pathway for transport from the troposphere into the stratosphere. Yet the impact of convective transport on the UT/LS composition and chemistry has not been fully characterized on either the continental or global scale.

Aircraft measurements of atmospheric composition provide a comprehensive suite of observations to understand these processes during focused experiment periods. They are also useful for calibration and validation of the longer-term observations of earth observing satellite sensors and the retrieved data products generated from those observations. In particular, these measurements will be useful in the calibration and validation of the more mature A-Train and Terra satellites and the new Glory and NPP observatories. The measurements made on these campaigns will also be useful in the planning of future satellite missions, especially the Aerosol, Cloud, and Ecosystems (ACE), as well as Geostationary Coastal Air Pollution Events (GeoCAPE) Decadal Survey Missions.

In both of these airborne campaigns, the NASA DC-8 will provide observations from near surface to 12 km and the NSF/NCAR Gulfstream-V (GV) aircraft will sample convective outflow and slow ascent of air from 12-14 km. Because of the higher altitude of the tropopause in the tropics, a third aircraft is required for the Southeast Asia phase. During this phase the NASA ER-2 will provide high altitude observations reaching into the lower stratosphere, as well as important remote sensing observations connecting satellites with observations from lower flying aircraft and surface sites. Observations in these two diverse environments will enable fundamental improvements in understanding the role of deep convection in UT/LS composition and ability to predict how it will influence and be influenced by climate change.

2.1 Southeast Asia Composition, Cloud, Climate Coupling Regional Study

The Southeast Asia Composition, Cloud, Climate Coupling Regional Study ($SEAC^4RS$) (http://www.espo.nasa.gov/pub/SEAC4RS-overview-21OCT2010.pdf) will address key questions regarding the influence of Asian emissions on atmospheric chemistry, clouds, climate, and air quality. Observations will focus specifically on the role of the Asian monsoon circulation and convective redistribution in governing atmospheric composition and chemistry. Southeast Asia stands out globally in satellite observations. The region includes a number of important surface sources for natural and anthropogenic gases and aerosols. Both low and high clouds are prevalent and deep convection is common. During the Asian summer monsoon season (July-September), MLS CO observations are consistently enhanced in the UT/LS over southern Asia each year, a feature unique to this region. Such observations point to the region's unique meteorology and sensitivity to rapidly changing emissions of gas phase and aerosol pollutants in Asia. Understanding the sensitivity of this region to changes in climate and air quality requires an understanding of how dynamical, physical, chemical, and radiative processes are influenced by these emissions. $SEAC^4RS$ will take place in August and September 2012. The primary goals of $SEAC^4RS$ are to provide key validation data for satellite observations in regions of convective cloud and outflow and to address the following specific questions.

1) How are pollutant emissions in the tropics redistributed via deep convection throughout the troposphere?

2) What is the evolution of gases and aerosols in deep convective outflow and what are the implications for the UT/LS chemistry?

3) What influences and feedbacks do aerosol particles from anthropogenic pollution and biomass burning exert on local meteorology through changes in the

atmospheric heat budget (i.e., semidirect effect) or though microphysical changes in clouds (i.e., indirect effects)?

2.2 Deep Convective Clouds and Chemistry Study

The Deep Convective Clouds and Chemistry (DC3) field experiment (http://utls.tiimes.ucar.edu/science/dc3.html) will study the impact of continental, midlatitude deep convection on the UT/LS composition and chemistry above the continental U.S. during the lifetime of individual storms and during the period 12-48 hours after active convection. The primary goals of DC3 are to:

1) Quantify and characterize the convective transport of fresh emissions and water to the upper troposphere within the first few hours of active convection, investigating storm dynamics and physics, lightning and its production of nitrogen oxides, cloud hydrometeors effects on scavenging of species, surface emission variability, and chemistry in the anvil.

2) Quantify the changes in chemistry and composition in the upper troposphere after active convection, focusing on 12-48 hours after convection and the seasonal transition of the chemical composition of the UT.

These goals will be addressed by sampling convection during May and June 2012 over U.S. locations, including northeast Colorado, central Oklahoma, and northern Alabama. These locations give the opportunity to contrast the effects, and the storm processes influencing those effects, on UT composition for regions of remote continental air versus those with air masses more influenced by anthropogenic emissions and for the much different storm kinematics and microphysics of regions with abundant boundary layer moisture versus those with drier environments.

3. Programmatic Information

3.1 Programmatic Priorities

Proposals requesting support for *in situ* and remote-sensing measurements to be deployed on the NASA DC-8 and ER-2 will be considered under this solicitation. Support for measurements to be deployed on the NSF/NCAR GV aircraft is not solicited. Highest priority will be given to instruments consistent with mission objectives (as described in the mission white papers) and with a proven performance heritage. It is not appropriate to propose for significant new instrument development under this call; however, consideration will be given for minor modifications and improvements to existing instruments as may be required to address mission goals. In addition, proposals for relevant surface-based remote and *in situ* observations will be considered for SEAC4RS only.

Satellite teams are solicited to participate in both campaigns (i.e., $SEAC^4RS$ and DC3) by providing near real-time observations and interpretation to guide flight planning and by establishing specific calibration/validation needs for incorporation into aircraft flight plans.

For proposed data analysis/modeling investigations, participation in the SEAC^{4}RS field deployment to facilitate flight planning and implementation of the science plan is essential. Investigators on accepted proposals will be members of the SEAC4RS theory team. Only proposals critical to mission implementation will be considered. NASA is not soliciting data analysis/modeling investigations for the DC3 theory team other than the satellite based activities described in the previous paragraph.

The SEAC^{4}RS campaign will be led by four subject area experts. These areas are:

- Aerosols, clouds, and radiation
- Tropospheric composition
- Upper atmospheric (UT/LS) chemistry and physics
- Meteorology

Proposals for campaign leadership in these subject areas must be submitted separately from proposals for other activities. These proposals need not be as extensive as measurement and analysis/modeling proposals; these proposals should not exceed 5 pages.

Campaign leadership, analysis/modeling, and satellite team proposals will be evaluated separately from measurement proposals.

A solicitation for postcampaign data analysis and modeling proposals using SEAC^{4}RS and DC3 observations will be published at a later time.

3.2 Funding Guidelines

Proposals may request up to three years of funding to cover the costs of preparation, integration (in the case of measurement teams), field deployment, data processing, analysis, and interpretive modeling. Personnel support at an appropriate and justifiable level related to these activities will be considered. Because it is not possible to accurately budget travel costs until deployment sites are finalized, proposers should submit a workforce plan for the deployment that includes the total number of personnel and their respective schedules for participation in the aircraft integration and one or both field intensives as consistent with the Programmatic Priorities. Proposal budgets should not include travel costs. Measurement teams proposing to instrument the DC-8 should provide separate budgets for the integration phase, DC3 experiments science flights, and SEAC^{4}RS science flights. Measurement teams proposing to instrument the ER-2 may provide a single budget, including the integration phase and SEAC^{4}RS science flights.

4. Summary of Key Information

Expected annual program budget for new awards.	~ $9 M
Number of new awards pending adequate proposals of merit	~ 45
Maximum duration of awards	3 years
Due date for Notice of Intent to propose (NOI)	Not requested.
Due date for proposals	February 1, 2011.
Planning date for start of investigation	6 months after proposal due date
Page limit for the central Science-Technical-Management section of proposal	15 pp for all proposals except 5 pp for campaign leadership; see also Chapter 2 of the *NASA Guidebook for Proposers*
Relevance to NASA	This program is relevant to the Earth science strategic goals and subgoals in NASA's Strategic Plan; see Table 1 and the references therein. Proposals that are relevant to this program are, by definition, relevant to NASA.
General information and overview of this solicitation	See the *ROSES Summary of Solicitation*.
Detailed instructions for the preparation and submission of proposals	See the *NASA Guidebook for Proposers* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Submission medium	Electronic proposal submission is required; no hard copy is required or permitted. See also Section IV of the *ROSES Summary of Solicitation* and Chapter 3 of the *NASA Guidebook for Proposers*.
Web site for submission of proposal via NSPIRES	http://nspires.nasaprs.com/ (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Web site for submission of proposal via Grants.gov	http://grants.gov (help desk available at support@grants.gov or (800) 518-4726)
Funding opportunity number for downloading an application package from Grants.gov	NNH10ZDA001N-SEAC4RS

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