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EDITORIAL

Get Involved

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Much of the continuing success of AGU is a result of the volunteer work of members. A major contribution to these efforts is from the over 40 committees that plan, oversee, and have operational roles in our meetings, publications, finances, elections, awards, outreach, and technical activities. The names of committees are provided in the accompanying text box; their current membership and descriptions can be found on the Web. One of the most important but difficult tasks of the incoming AGU President is to re-establish these committees by appointing hundreds of volunteers. Thus, I now urgently need your help in staffing these committees.

I encourage you to volunteer for committees and/or nominate other AGU members to committees. Such suggestions are more helpful, and more likely to be followed, if accompanied by a few lines giving the reasons why you, or whomever else you suggest, would be a good fit to the particular committee's activities.

Service on several of the committees involves one or two committee meetings per year usually at AGU headquarters in Washington. These meetings are approximately 2 days each and, of course, there is some preparation for them. Other committees conduct their activities through e-mail and conference calls, and, as required, meet during the annual AGU meetings. Members are reimbursed for their expenses for attendance at meetings not held at the annual AGU meetings. Service on these committees provides the individual member with an inside look at how the AGU functions and the personal reward for having contributed to the health of the Union in a substantive way.

Please take a moment now to send me your suggestions by using the Web form at http://www.agu.org/inside/nomination.html. You can also send nominations by e-mail to chayes@agu.org or mail to John Orcutt, AGU, 2000 Florida Ave., NW, Washington DC 20009.

Thanks for your help!

—JOHN ORCUTT, President-elect

Committees

The current committee membership and the committee charges for 2002–2004 can be found at http://www.agu.org/inside/union_comm.html.

Administrative

- Budget and Finance
- Nominations
- Statutes and Bylaws
- Tellers

Program

- Development
- Education and Human Resources
- Excellence in Education Award
- History of Geophysics
- Honors and Recognitions
  - Fellows (must be a Fellow to serve)
  - Bowie Medal
  - Bucher Medal
  - Ewing Medal
  - Fleming Medal
  - Hess Medal
  - Horton Medal
  - Lehmann Medal
  - Macelwane Medal
  - Revelle Medal
  - Smith Medal
  - Whitten Medal
  - Falkenberg Award
  - Flinn Award
- Information Technology
- International Participation
- Regional Advisory Committees for
  - Australia/New Zealand
  - Europe
  - Japan
  - North America
- Meetings
- Public Affairs
- Public Information
  - Cowen Award
  - Perlman Award
  - Spilhaus Award
  - Sullivan Award
- Publications

Focus Groups

The descriptions and current officers can be found at http://www.agu.org/inside/focus_group.html. Any AGU member may affiliate with a Focus Group. This call is for individuals who would like to serve as an officer.

- Atmospheric and Space Electricity
- Global Environmental Change
- Mineral and Rock Physics
- Paleoceanography and Paleoclimatology
- Cryosphere Sciences
- Study of the Earth's Deep Interior
- Non-Linear Geophysics

Mission Investigates Tropical Cirrus Clouds

PAGES 45, 50

It has been 18 months since NASA conducted the highly successful Cirrus Regional Study of Tropical Anvils and Cirrus Layers-Florida Area Cirrus Experiment Study (CRYSTAL-FACE). The measurement campaign was designed to investigate the physical properties and formation processes of tropical cirrus clouds. CRYSTAL-FACE was sponsored by NASA's Earth Science Enterprise as an integral component of its Earth observation research strategy, and included substantial collaboration with the National Oceanic and Atmospheric Administration, the National Science Foundation, the Department of Energy, and the Naval Research Laboratory.

During July 2002, the mission's six aircraft (NASA ER-2, NASA WB-57, Scaled Composites Proteus, University of North Dakota Citation, NSF-supported NRL P-3, and NRL Twin Otter) operated from the Key West Naval Air Facility. In addition, ground sites were located at the Tamiami airport on the east coast of Florida and near Everglades City on the west coast of Florida. Aircraft and ground site measurements are listed in Table 1. Data archiving is complete, and the data are now available to the general scientific community. Detailed instrument descriptions as well as the final data can be found on the CRYSTAL-FACE Web site (http://cloud1.arc.nasa.gov/crystalface/).

BY ERIC JENSEN, DAVID STARR, AND OWEN TOON

The CRYSTAL-FACE mission was motivated by the importance of tropical cirrus clouds in the Earth's climate system. Cumulonimbus clouds and the extensive cirrus shields they generate have large impacts on solar and infrared radiative fluxes, as well as on the upper tropospheric water vapor budget. As greenhouse gases from human activities warm our climate, the tropical cumulonimbus-anvil cloud systems will possibly intensify, resulting in more extensive cirrus. Understanding these feedbacks is crucial for predicting overall climate change, but the feedbacks are neither well understood nor well represented in general circulation models (GCMs) used to predict climate change.

The CRYSTAL-FACE project has five primary goals: to determine the sensitivity of anvil properties to the intensity of convection; to understand the evolution of cirrus anvils over their life cycle; to better understand the factors controlling the distribution of water vapor in the upper troposphere; to better understand the factors that control the concentration of water vapor in the lower stratosphere; and to validate remote sensing of cirrus, particularly NASA's EOS Terra and Aqua satellites.

Measurement Strategy

To meet these goals, several coordinated flights were made in and around cumulonimbus-anvil cloud systems over the southern Florida peninsula. Coordinating six aircraft in rapidly evolving convective cloud systems presented a major challenge. The remote sensing validation objectives required coincident sampling of cloud volumes with both in situ instrumentation and airborne, ground-based, and satellite-borne remote sensing instrumentation. A NASA Polarimetric radar system (N-POL) was installed near the western ground site to provide real-time information about the locations and strengths of convective systems. Special software relying on aircraft tracking information from the Federal Aviation Administration was used for real-time tracking of the CRYSTAL-FACE aircraft locations. Flight plans were frequently adjusted based on the cloud system evolution and the locations of aircraft. For the ER-2, Proteus, WB-57, and Citation, the general strategy was to set up flight lines in and above the cirrus outflow anvils. The P-3 flew lines close to the convection for cloud structure measurements with the Electra Doppler Radar (ELDORA). The Twin Otter sampled aerosols in convective inflow regions and small developing cumulus clouds, and flew along the same lines as the higher aircraft for radiative flux measurements. The real-time coordination of aircraft by the personnel stationed at the N-POL site greatly enhanced the value of the airborne measurements. Figure 1 shows an example of flight tracks used to sample a cumulonimbus-anvil system near Naples, Florida, on 29 July.

The central goals of the mission involved learning more about the physical processes in cirrus anvils and how the anvil properties depend upon convective strength and environ-

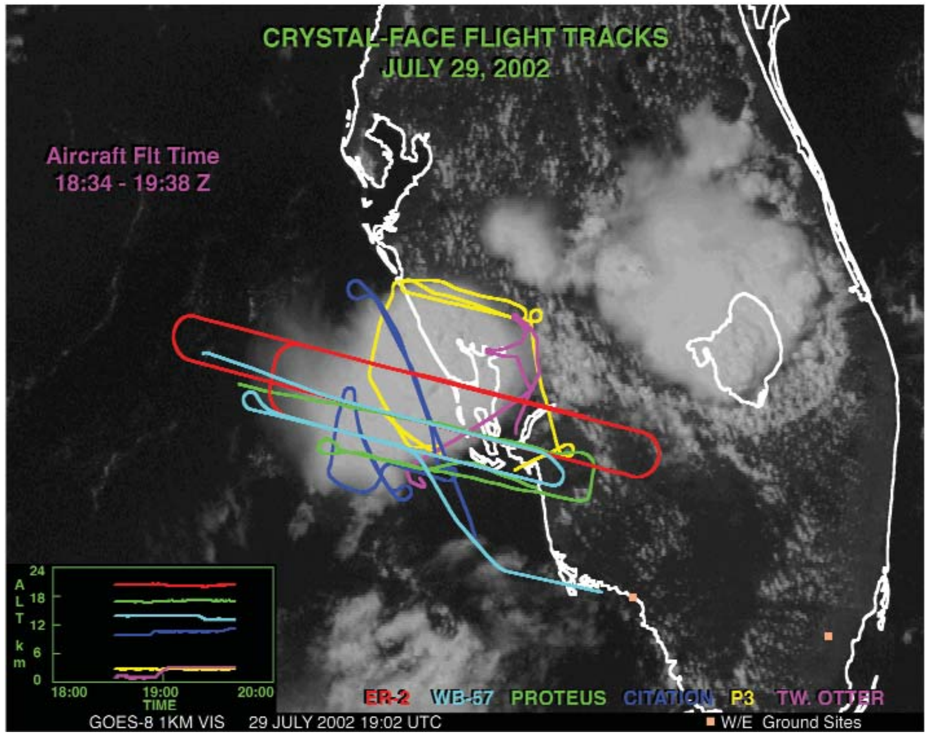

Fig. 1. Flight tracks from about an hour of the 29 July cumulonimbus-anvil sampling mission are overlaid on the corresponding GOES visible image. The aircraft were flown below, within, and above the anvil to make remote sensing and in situ measurements. The P-3 was flown alongside the convection for radar measurements. (Courtesy of Louis Nguyen, NASA Langley Research Center).

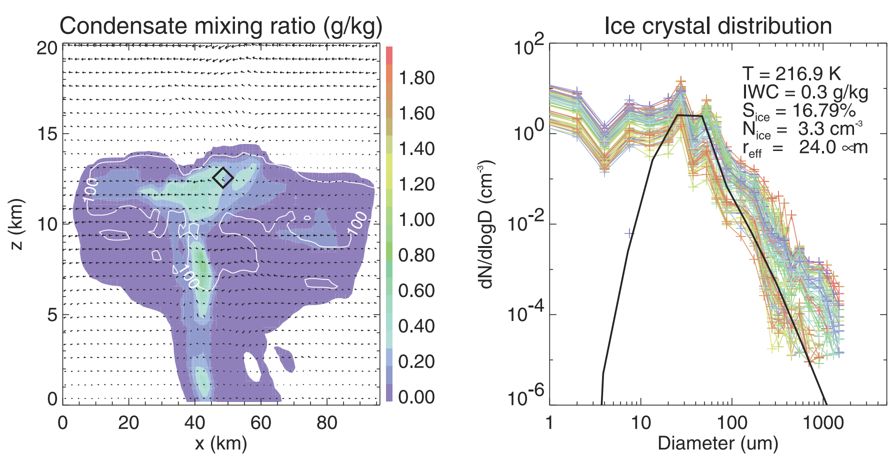

Fig. 2. Model results are shown from a three-dimensional cloud model simulation of the cumulonimbus cloud sampled on 29 July 2002. The simulation was initialized with aerosol measurements from the aircraft and with meso-scale model fields provided by Donghai Wang at NASA Langley Research Center. The left panel shows a cross-section of condensate mixing ratio (ice + water, color shading) and 100% relative humidity with respect to ice (white contours) in a mature anvil. The right panel shows the ice crystal size distributions measured (colored lines) by a combination of instruments on the WB-57 (unpublished data courtesy Darrel Baumgardner, 2003) and simulated (black line) at the location indicated by the black diamond in the left panel. The size distribution data points were within a 1-km altitude range centered on the height of the size distribution extracted from the simulation and at times when the number concentrations were comparable. (Unpublished model results courtesy of Ann Fridlind and Andy Ackerman, NASA Ames Research Center.) The discrepancy in the 1 to 10 microns region is unresolved at this time. Problems with the particle size distribution retrieval and possible model shortcomings are being explored.

mental conditions. The case study approach was used: for each of several cumulonimbus-anvil cloud systems and isolated cirrus systems, an attempt was made to characterize the environmental conditions (thermodynamics, wind speeds, aerosol composition), deep convection properties (structure, updraft speeds, droplets, and ice crystal size distributions), and the resulting cirrus (structure, ice crystal size distributions, dynamics, and radiative properties) through as much of the anvil lifecycle as possible. Small, developing cumulus clouds were investigated with the Twin Otter, which sampled aerosols, cloud condensation nuclei, and droplets.

In addition to the many coordinated flights over the southern Florida peninsula, the long-range aircraft (ER-2, WB-57, and Proteus) made two coordinated sorties south to about 12°S to sample the upper troposphere and lower stratosphere in the deep tropics. For these flights, way points were defined in advance to maximize sampling in the deep tropics, and the aircraft were flown in a stacked formation as often as possible.

A core objective of the mission was to provide measurements useful for development and improvement of algorithms used for retrieval of cirrus properties from remote sensing instruments. For this purpose, in situ measurements in tropical cirrus were made coincident with ground-based, airborne, and satellite-borne remote sensing measurements. Most flights included segments coordinated with the Aqua, Terra, or TRMM satellites, and cirrus were often sampled over the ground sites. In addition, the ER-2 and Proteus instrumentation included several instruments that served as prototypes of current or planned satellite instruments [e.g., cloud radars, lidar, and the Moderate Resolution Imaging Spectroradiometer (MODIS) Airborne Simulator (MAS) on the ER-2; National Polar-orbiting Environmental Satellite System (NPOESS) Aircraft Sounder Testbed, Research Scanning Polarimeter, and an airborne version of the Polarization and Directionality of the Earth's Reflectances (POLDER) on the Proteus].

Examples of satellite validation efforts include evaluation of cloud and aerosol retrievals from MAS and MODIS on Terra and Aqua as well as thin cirrus retrievals by MISR on Terra using in situ measurements. In addition, these measurements are being used to support algorithm development for future satellite missions. For instance, the in situ measurements in cirrus over the ground sites are being used to improve retrieval of ice water content from radar measurements.

Table 1. Aircraft and Ground Site Measurements

Measurement	*ER-2*	*Proteus*	*WB-57*	*Citation*	*Twin Otter*	*P-3*	*Ground sites*
T, p, humidity profiles	X	X					X
Solar, IR radiative fluxes	X		X		X		X
Cloud structure	X	X				X	X
Cloud dynamics	X		X			X	X
Cloud optical depth	X				X		X
Particle phase	X	X					X
Ice water path	X	X				X	X
In situ T, p, humidity	X		X	X	X		
Crystal size		X	X	X			
Crystal habit		X	X	X			
Condensed water and ice	X		X	X		X	X
Cloud extinction			X	X	X		
Cloud particle number density			X	X			
Ice nuclei			X	X			
Cloud condensation nuclei					X		
Aerosol size distribution			X		X		
Aerosol composition			X		X		
Tracers (e.g., CO CH_4, CO_2, O_3)			X		X		
NO_x, HNO_3			X				
Water isotopes			X				

Data Analysis and Modeling Studies

Most of the CRYSTAL-FACE analysis and modeling studies are at an intermediate stage at this time, and numerous publications are expected over the next several months. The following provides a small sampling of some of the science issues emerging from the mission.

The CRYSTAL-FACE aircraft payloads included an unprecedented set of instruments for measuring cirrus microphysical properties. The WB-57 and Citation flew multiple instruments for measuring aerosol and ice crystal size distributions, ice surface area, and total condensed mass using a variety of techniques (see Web site for details). Analysis of various measures of ice crystal size in anvils suggests that the crystals are much smaller and more reflective than is generally assumed in GCMs. The anvil optical properties appear to be dominated by crystals with effective radii of 5 to 20 microns [*Garrett et al.*, 2003].

Several groups are modeling the cloud systems observed in the case studies (see example in Figure 2). The observations are being used to constrain model simulations of deep convection and anvils, and the models are being used to understand physical processes and sensitivities in the cloud systems.

An interesting issue emerging from these modeling studies is how the large numbers of ice crystals observed in the anvils are generated. It appears that homogeneous freezing of large numbers of liquid drops must be a dominant process, but it is not clear what role heterogeneous ice nuclei play. This issue is particularly intriguing since on the last 2 days of the mission (including the examples shown in the figures), the region was affected by heavy loading of Saharan dust particles. Modeling and data analysis studies are being used to investigate how these dust particles affected the cloud systems observed. *Demott et al.* [2003] measured extremely high numbers of ice nuclei during the Saharan dust events, and *Sassen et al.* [2003] showed that these dust particles can effectively glaciate supercooled liquid clouds at relatively warm temperatures. The relative importance of boundary layer versus free tropospheric aerosols for production of droplets and ice crystals in deep convective updrafts is also being investigated.

In addition, the Twin Otter measurements show that cloud condensation nuclei (CCN) concentrations can be accurately predicted from other aerosol properties even without detailed chemical compositional data, indicating that the atmospheric CCN may be less sensitive to compositional variations than has been previously surmised [*VanReken et al.*, 2003]. Since a key reason for interest in tropical cirrus is their impact on radiation budgets, CRYSTAL-FACE included radiation measurements at the ground sites and on multiple aircraft. The combination of radiative flux measurements above and below cirrus anvils and measurements of cloud microphysical properties are being used to evaluate radiative transfer calculations.

During the CRYSTAL-FACE mission, the WB-57 spent much of its flight time sampling the subtropical uppermost troposphere and lower stratosphere. These flights—with the extensive payload for measuring aerosols, ice crystals, water vapor, tracers (e.g., O_3, CO, CO_2, and aerosols), and water vapor isotopes—provide an unprecedented data set for studying composition and transport in the tropopause region. Nearly all of the WB-57 flights included segments near or above the tropopause, and on eight of the flights the aircraft ascended to its maximum altitude of about 18.5 km. During the first half of July, the lower stratospheric tracer measurements generally indicated transport of mid-high latitude air into the subtropical lower stratosphere [*Richard et al.*, 2003]. Plumes with indicators of biomass burning—high CO_2, high aerosol concentration, and particle composition—were occasionally observed well above the tropopause over the Florida region by the WB-57 instrumentation. With trajectory and aerosol composition analyses, these plumes have been attributed to mid-latitude forest fires.

On several flights, thin cirrus clouds were sampled near the tropopause. In particular, an extensive tropopause cloud layer over southern Florida was sampled for several hours on 13 July. On this day, the ER-2 and WB-57 flew in a stacked formation such that the ER-2 downlooking lidar provided information about the structure of the cloud layer sampled by the WB-57. This tropopause cirrus case study provides an opportunity to investigate the properties and physical processes in these clouds. Trajectory analysis and modeling show that this cloud layer formed in situ near the tropopause as air moved south into the Florida region and cooled considerably. The WB-57 also sampled its own persistent contrail extensively on this flight. The contrail measurements are proving to be very useful for evaluating the water measurements and investigating uptake of HNO_3 on ice crystals.

The CRYSTAL-FACE WB-57 flights also provided an unprecedented set of in situ water isotope measurements in the tropical upper troposphere in and around convectively generated and in situ-formed cirrus clouds. Unlike past satellite remote sensing H_2O isotope measurements, the in situ measurements indicate a great deal of variability in the upper tropospheric water vapor isotope enrichment [*Webster and Heymsfield*, 2003]. The isotope measurements are being used to distinguish ice crystals lofted by deep convection from those grown in situ near the tropopause.

Several recent studies have documented the occurrence of super-saturation with respect to ice (up to 40–50%) in the mid-latitude upper troposphere [e.g., *Jensen et al*., 2001]. The CRYSTAL-FACE mission provided a unique data set with many hours of in situ water vapor and temperature measurements in the subtropical upper troposphere. Water vapor concentration was measured with two instruments using different techniques. The CRYSTAL measurements indicate even higher ice super-saturations in the cold, subtropical upper troposphere than was observed at mid-latitudes. Possible physical explanations for these high super-saturations are being explored. In addition, substantial ice super-saturations were observed within cold, subtropical cirrus clouds and the WB-57 aged contrail [*Gao et al.,* 2004]. The persistence of substantial super-saturations within anvils, contrails, and thin cirrus was unexpected. Explanations for this intriguing result are being investigated. *Gao et al*. [2004] suggested a mechanism involving inhibition of ice crystal growth by nitric acid uptake on the crystal surfaces.

The CRYSTAL-FACE mission has provided a unique data set for studying tropical cirrus and the upper troposphere/lower stratosphere environment. Many interesting results are emerging from the analysis to date, but the studies so far have only scratched the surface of this substantial data set. We encourage use of the data by investigators beyond the original CRYSTAL-FACE science team.

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New Exploration Focus Will Not Diminish Earth Science Agenda, NASA Says

PAGE 46

A dramatic re-orientation of NASA to focus on space exploration and manned missions to the Moon and Mars will not diminish the agency's Earth science agenda, according to top NASA officials.

The re-orientation, which U.S. President George W. Bush and NASA announced on 14 January, calls for a return to the Moon with robotic missions no later than 2008. A manned mission to the lunar surface would follow between 2015 and 2020, "as the launching point for missions beyond," Bush said.

NASA Administrator Sean O'Keefe said the announcement amounts to "a mandate" for the agency and "support for a set of specific objectives that very clearly identifies exploration and discovery as the central objective of what this agency is all about.

"Our principal destination is Mars, to be sure, and that's why we are there right now," he said, in reference to the Mars exploration rover Spirit that is currently lumbering across that planet's surface. However, O'Keefe and other NASA officials said the agency's new focus and budget priorities would not diminish its Earth science programs.

O'Keefe said the Earth science community "should not be concerned" that the agency's new orientation toward exploration may diminish the Earth science enterprise.

"The priorities that are very clearly emphasized [within the Earth science endeavor]—looking at the climate change research initiative and all the assets that we have developed in Earth science in order to support that over time, our cooperative arrangements with other federal agencies in order to improve forecasting, and a range of other capabilities—those are to be continued. So, in terms of prioritization of the Earth science agenda, there is clearly no diminution of that importance and significance of what we are engaged in there at all."

Ghassem Asrar, NASA associate administrator for the Earth science enterprise, said the Earth science community should look at the agency's re-orientation "as an opportunity for all of us to take the knowledge we have gained about our home planet—which is not complete, there is more to be done, there is no question about it—but apply it very strongly and very pro-actively toward the cause of exploration."

He said, "All the knowledge that we are gaining, for example about modeling the Earth as a system, in understanding its different components—its atmosphere, the oceans, and the land, and life—are going to be needed for exploration of the rest of the solar system and the rest of the galaxy that we are a part of."

Asrar said the new direction would mean some shift in priorities, and some re-allocation of resources, as the agency has been doing for the past several years to meet its mission statement to "improve life here; extend life to there; find life beyond."

However, he emphasized that the Earth science enterprise has much to offer scientifically and technologically, in support of exploration. In addition, he said NASA believes that it makes unique contributions to the national agenda in other activities beyond exploration, including in the area of climate change.

Asrar also noted that Earth science projects that are already funded and in development will be completed, including the first phase of the Earth Observing System. The agency anticipates launching the program's AURA satellite this year and two additional satellites in 2005, bringing the total EOS constellation to 22.

Money to be Shifted

The Bush administration said the funding for NASA's new focus on exploration would total \$12 billion over the next 5 years. This includes a re-allocation of \$11 billion from NASA's current 5-year budget estimate of \$86 billion. The president also is calling for an additional \$1 billion over 5 years. Following fiscal year 2009, the program budget would increase by no more than the rate of inflation, according to the administration.

A significant portion of the \$11-billion re-allocation is expected to be shifted from