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In this issue

EDITOR'S CORNER

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On October 14 and 15, the U.S. House of Representatives and Senate approved the Appropriations Conference Committee bill that provides funding to the Veterans Administration, Department of Housing and Urban Development, and Independent Agencies (including NASA) for FY00. This bill, approved by President Clinton on October 20, provides funding for NASA of $13.653 B, of which the Earth Science Enterprise is $1.455 B. Of this budget, $663.2 M is for the Earth Observing System (EOS), $231.5 M for EOSDIS, and $420.2 M for applied research and data analysis, including the research & analysis program, EOS calibration and validation program, and EOS Interdisciplinary Science (IDS) investigations. The conference report includes $36.3 M of the Earth Science budget for earmarks, including support of research centers at eight universities for natural resource training and remote-sensing applications; support of biodiversity programs at two museums; a space-based research initiative for the study and detection of forest fires; funding for continued development of battery technology; and support for additional uses of the EOSDIS Core System to make data more readily available for potential user communities.

The bill preserves the Triana program, but directs NASA to suspend all work on the development of the satellite until the National Academy of Sciences (NAS) has completed an evaluation of the scientific goals of the Triana mission. In the event of a favorable report from the NAS, Triana may not launch prior to January 1, 2001. The bill also directs NASA to develop a five-year plan detailing a robust program for utilization of unmanned aerial vehicles (UAVs) in the Earth Science Program. The bill also calls for NASA to submit a report by March 15, 2000 articulating the EOS-II strategy for Earth science, through fiscal year 2010.

The launch of Terra is currently scheduled for no earlier than December 16 from Vandenberg Air Force Base in California. The spacecraft has been fully fueled, and several mission readiness reviews are planned for the next few weeks. There is a 2-day launch window of December 16 and 17. No launch attempts will be made in 1999 after December 20 due to safety concerns

associated with the transition to Year 2000. Barring any unforeseen obstacles, Terra should be returning unprecedented science data within the next few months. I'm sure you share my excitement for this milestone event in the EOS program.

The next EOS Investigators Working Group meeting will take place April 13-15 in Tucson, Arizona at the Hilton East Hotel. The main themes of the meeting will be early mission status results from Terra, and topical sessions on ocean, land, and atmospheric science findings from recent missions such as Landsat 7, QuikScat, and ACRIMSAT. EOS validation activities, new IDS team introductions, and European and Japanese Earth observation mission status overviews will also be presented. A draft agenda is being formulated at this time and will be distributed in the next few weeks. Logistics and travel information can be found on the EOS Project Science Office web site at http://eospso.gsfc.nasa.gov/eos_homepage/logreg.html.

NASA selected 'Aqua' as the name for the EOS PM spacecraft after a selection process was undertaken to determine a new, more descriptive name for this flagship Earth Observing System mission. Nominations were solicited from the EOS PM community; and the four science teams on the PM platform, the PM Project Office, and the EOS Project Science Office (including both Goddard and NASA Headquarters) voted on their preferences among 17 nominations. Aqua, Latin for 'water,' was selected as the number one choice both because it signifies the information PM will obtain about the water cycle (on the land, in the atmosphere, and in the ocean), and because it forms a nice complement to the choice of 'Terra' made earlier this year through a contest conducted by the American Geophysical Union for renaming EOS AM (see *The Earth Observer*, vol. 11, no. 1).

Finally, all Algorithm Theoretical Basis Documents (ATBDs) for the EOS Chemistry and SOLSTICE missions have been revised in response to the review panel report following the May ATBD review. This round of ATBD reviews covered HIRDLS, MLS, TES, and SOLSTICE. All instruments received favorable reviews, and the resultant revisions to the algorithms will insure that scientifically valid and high-quality data products are produced from these missions. I'm confident that the next round of ATBD reviews in February of next year will be equally successful. These reviews will include ACRIM III, AIRS/AMSU/HSB, AMSR-E, SAGE III, TIM, and Data Assimilation.

Images from the IKONOS Satellite

These one-meter resolution black-and-white images were collected October 11, 1999. The image on the left is of San Francisco and features Aquatic Park and Fisherman's Wharf. The image on the right is of New York City and features lower Manhattan including the World Trade Center and the Brooklyn Bridge (Images courtesy of Space Imaging).

EOS PM Science Working Group Meeting Minutes

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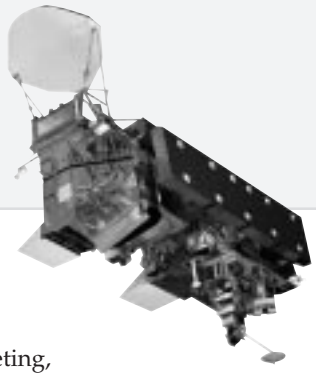

The EOS PM Science Working Group met on October 15, 1999 at Goddard Space Flight Center to discuss a range of topics, with emphasis on validation in the morning and spacecraft maneuvers in the afternoon.

The meeting was chaired by EOS PM Project Scientist Claire Parkinson, who opened with a brief update on the mission, including confirmation that the scheduled launch date is December 21, 2000. She gave short status statements on each of the six EOS PM instruments, with their expected delivery dates to the spacecraft company, TRW. Two of the instruments, the Advanced Microwave Sounding Unit (AMSU) and Clouds and the Earth's Radiant Energy System (CERES), are already delivered, while the other four are scheduled for delivery in the time frame of October-December, 1999.

Parkinson also presented the results of the voting for a new name for EOS PM. Voting was done by e-mail, with a ballot containing 17 candidate names compiled over the previous several months. The voting was done individually within each of the following six groups: the AIRS/AMSU/HSB Science Team, the AMSR-E Science Team, the CERES Science Team, the MODIS Science Team, the PM Project, and the EOS Project Science Office. With equal weight given to the results from each of the six groups, the top vote-getter was "Aqua." Three days after the meeting, NASA Associate Administrator Ghassem Asrar confirmed Aqua as the new name for EOS PM.

The opening remarks from the chairperson were followed by presentations from each of the four science teams, in each case providing a team update and an indication of planned validation activities for EOS PM.

AMSR-E Science Team

The Advanced Microwave Scanning Radiometer-EOS (AMSR-E) Team presentation was made by Elena Lobl, the AMSR-E Team Coordinator. Amongst the improvements mentioned as recently having been made in the AMSR-E algorithms is the addition of convective/stratiform differentiation in the precipitation algorithm, illustrated with results from the Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI). Lobl showed a sample TMI North Atlantic sea surface temperature (SST) anomaly image from the period of the September 1999 passages of hurricanes Floyd and Gert. She pointed out the ability of TMI's through-cloud retrievals to show detailed patterns in storm-induced negative SST anomalies.

Lobl also presented results from the Southern Great Plains (SGP) 1999 field campaign in Oklahoma. The results verify the sensitivity of C-band radiometry to soil moisture in the top 2.5 cm of the ground in areas with low vegetation cover.

The AMSR-E Team proposal to do much of their data processing at Marshall Space Flight Center (MSFC), the home base of the AMSR-E Team Leader, through a Science Investigator-led Processing System (SIPS) has been approved, much to the relief of the AMSR-E Team. The team members feel that having control of the processing at MSFC should greatly simplify the data processing effort. The Beta versions of the AMSR-E algorithms were delivered to the Team Leader Science Computing Facility (TLSCF) last year, and the engineering version 1 (V1) is due to the TLSCF by November 1, 1999. The engineering version of the algorithm software is due to the SIPS by March 1, 2000, and the launch version is due by August 1, 2000.

The Japanese are responsible for AMSR-E instrument calibration, but the calibration team includes members from the U.S. AMSR-E Team. Regarding validation, the Japanese and U.S. teams each have validation plans and are working together to merge these into a coordinated plan. Validation analyses will include satellite intercomparisons with TMI and Defense Meteorological Satellite Program (DMSP) Special Sensor Microwave Imager (SSMI) data as well as field data and aircraft campaigns. Lobl showed a post-launch validation timeline, plus a chart of the AMSR-E standard products. She mentioned the interest within the AMSR-E Team to have joint calibration/validation activities with other PM science teams and suggested an intercomparison workshop six months after launch. When questioned about an aircraft experiment scheduled for

early 2001, Lobl and AMSR-E-colleague Chris Kummerow responded that the experiment will still be valuable even in the event of a launch delay preventing receipt of AMSR-E data during the aircraft campaign.

AIRS/AMSU/HSB Science Team

The Atmospheric Infrared Sounder (AIRS) Team presentation was made by the AIRS Project Scientist George Aumann. Aumann reported that the AMSU-A on NOAA-15 (equivalent to the PM AMSU) is working well and that the Humidity Sounder for Brazil (HSB) is equivalent to the AMSU-B scheduled to fly on NOAA-L. The AIRS instrument itself has completed vibration testing and is currently in thermal vacuum testing.

There was some discussion at the meeting regarding the goal of global 1-K root-mean-square temperature retrieval accuracy from the AIRS/AMSU/HSB system in 1-km layers in the troposphere. No one disagreed with the statement that this is a key goal, but several in the room were not aware that the 1-K/1-km accuracy level is not a Level-1 requirement. The AIRS instrument would require the addition of wedged filters to reach the 1-K/1-km accuracy level.

Aumann then presented a list of the expected AIRS data products and discussed the status of the AIRS Level 1b Algorithm Theoretical Basis Document (ATBD). The Level 1b algorithms are not being revised at this point, but the ATBD is being augmented to include new test results that, among other things, enable a narrowing of the large error bars appearing in the original ATBD. Aumann showed a signal-to-noise scatter plot containing all 2378 AIRS channels. Some channels are markedly better than others regarding signal-to-noise ratio, and AIRS Team member Joel Susskind explained that, because of the large number of channels on AIRS, the final-product AIRS algorithms will be able to avoid the channels exhibiting the greatest noise. With respect to spectral purity, there are no detectable leaks down to the 0.003 μm level. Below that there are some artifacts in the data, but the integrated out-of-band response is significantly less than the noise. Aumann showed calibration plots and explained that a linearity correction will be applied to improve further the instrument calibration. This was followed by a plot of vertical profiles through the atmosphere of simulated retrieval accuracies for the AIRS/AMSU/HSB suite of instruments.

While processed data for assimilation into forecast models should be available within 3 hours after receipt of telemetry data, Aumann indicated that Level 2 products can lag about 24 hours behind the data downlink. Level 2 performance validation for the AIRS will be based on ground truth radiosondes and ocean buoys. The ground-based validation will involve a large-scale international effort including field locations in the U.S., Australia, Brazil, France, Korea, and China. In closing, Aumann encouraged the PM Science Teams to work together to create combined data products, advocating specifically, as an example, the creation of a consensus EOS PM SST product, in addition to the three or four separate SST products that will be obtained based on the individual instruments. Bruce Barkstrom seconded the need to coordinate, specifically in the determination of cloud-free pixels, but mentioned also that the effort required could be considerable.

MODIS Science Team

The Moderate Resolution Imaging Spectroradiometer (MODIS) Team presentation was made by the MODIS Team Leader Vince Salomonson and the MODIS Project Scientist Bob Murphy. Salomonson began with a brief review of the 36-band MODIS instrument and the key geophysical parameters being obtained from each of the band groupings. The PM MODIS instrument has considerable strengths, including the elimination of some of the problems identified in the Terra MODIS. Some problems do currently exist on the PM MODIS, however, including focal plane misregistration and a series of worrisome and unexplained pixel outages in the 1.2- and 1.6-μm bands.

The calibration strategy for MODIS includes a suite of onboard calibrators (a blackbody, a solar diffuser and solar diffuser stability monitor, and a spectroradiometric calibration assembly), spacecraft maneuvers to view the moon and deep space, and co-registration of bands.

Salomonson indicated that all MODIS Level 1 products will be processed by the Goddard Distributed Active Archive Center (DAAC). Level 2-4 data, for both the Terra MODIS and the PM MODIS, will be processed by the MODIS Adaptive Processing System (MODAPS) and then ingested into the Goddard DAAC for data distribution. In operational readiness tests for Terra, the Goddard DAAC has successfully ingested 100% of the Level 0 and ancillary test data. Although the data processing functionality was demonstrated, sustained operations were not. Salomonson is confident that there will be enough data available to validate the instrument and to produce the Terra at-launch data products. Salomonson expects it to take until about a year after launch before the MODIS Team will be able to produce full global products operationally.

The MODIS Team recently conducted its Mission Operations Science System

(MOSS) version 3 dry run. This was a week-long test in which a 48-hour test data set was processed and distributed through the MOSS system. Two major problems were identified, bringing down the system temporarily, but once the problems were solved, the processing continued.

Regarding validation, Murphy explained that the PM validation efforts are an extension of the Terra plans and will include field experiments, coordinated ground-based networks, and cross-comparison with other sensors, such as the AIRS on PM. The MODIS/AIRS comparisons will involve radiances, SSTs, land surface temperatures, and land surface emissivities. MODIS Level 1 products will be validated in two phases: first, through the use of its on-board calibrators and second through feedback from the science data. Extensive vicarious calibration efforts will include surface-based measurements at key test sites at the White Sands Missile Range in New Mexico, the Railroad Valley Playa in Nevada, and a thermal infrared test site yet to be determined (several are being investigated).

The three MODIS discipline groups—Atmosphere, Land, and Oceans—have their own validation strategies, and Murphy elaborated on each. Validation sites are spread throughout the globe, and several field campaigns for the Terra MODIS are well along in the planning stages. Because the current focus is on the upcoming Terra mission, detailed field campaign planning for the PM mission remains in the future. Both Elena Lobl of the AMSR-E Team and George Aumann of the AIRS/AMSU/HSB Team expressed interest in the MODIS suggestion of an initialization cruise at about six months after launch.

CERES Science Team

The CERES Team presentation was made by the CERES Instrument Working Group Leader Bob Lee and the CERES Team Leader Bruce Barkstrom. Lee reported that the CERES instrument calibration is tied directly to the National Institute of Standards and Technology (NIST) radiance standards. He said the CERES Team has done a very good job of calibrating and characterizing their blackbodies. Instrument data-processing parameters are available at http://lposun.larc.nasa.gov/~jack/task37data.html. This site contains details about the CERES sensor gains, spectral responses, zero-radiance offsets, and ground-to-flight sensor gain stabilities.

Lee presented a physical layout of the CERES instrument. He said the plan is to calibrate CERES by looking at deep space (through spacecraft maneuvers) as well as looking at the onboard blackbodies, solar diffuser, and tungsten lamp. The blackbodies are used for calibrating CERES' total and window channels, while the shortwave channel uses the tungsten lamp. Lee explained that for the TRMM CERES, the team noted a 0.1-0.2 % increase in gain on orbit versus what was measured on the ground. He suspects that twelve days of thermal vacuum were insufficient for full vacuum adaptation. The CERES sensors aboard TRMM were stable to within 0.2 % (0.2 Watts per square meter per steradian) over the first 18 months the satellite was in orbit.

Regarding validation, Barkstrom pointed out that his team has 10 months of TRMM CERES data to work with, making the use of simulated data unnecessary. He plans to store and distribute these data through the Langley TRMM Information System (LaTIS), which is accessible through the EOS Data and Information System (EOSDIS) Data Gateway. Barkstrom said radiation budget data involve a multi-dimensional space including wavelength, space (latitude, longitude, and height), angle, and time. Errors in the data are a strong function of the time and space scales of the data products. Thus, each CERES product faces unique validation challenges. From the standpoint of the CERES investigation, validation is used to remove obvious errors and bound the uncertainties of the fields in the data products. The basic focus of CERES validation remains examination of global consistencies and anomaly patterns. However, the CERES Team also plans to use surface-based measurements, aircraft, and balloon *in situ* data to validate CERES data. Most of the *in situ* data the CERES Team will use come from efforts, such as the Atmospheric Radiation Measurement Program (ARM), that produce data for other investigations as well. Barkstrom provided a list of current sites that CERES plans to use for validation. For each site, CERES will produce time series of footprints with broadband radiances and fluxes, as well as cloud properties. He offered to expand the list if other teams are interested.

The CERES validation schedule will focus on Level 1 radiance and calibration/navigation in the first six months after launch (L + 6 months), the Level 2 Earth Radiation Budget Experiment (ERBE)-like product starting at L + 9 months, the Level 2 cloud properties starting at L + 18 months, the Level 2 surface and atmospheric fluxes starting at L + 36 months, and the Level 3 gridded data and time averages starting at L + 42 months. Barkstrom also noted that CERES plans to produce new Angular Distribution Models from the CERES instruments that operate in Rotating Azimuth Plane scan mode (which samples all directions) for the final CERES data products.

Formation of a Validation Working Group

Following the four science team presentations, Parkinson recommended, and the group approved, the formation of an EOS PM Validation Working Group (named later in the day by Mike Gunson). This group will consist of Elena Lobl and Frank Wentz from the AMSR-E Team, George Aumann and Mike Gunson from the AIRS Team, Tom Charlock and Pat Minnis from the CERES Team, and Wayne Esaias, Michael King, Jeff Morisette, and Kurt Thome from the MODIS Team. The group is tasked with increasing communication about validation plans amongst the EOS PM science teams and facilitating the development of joint validation efforts and the exchange of data. The formation of the Validation Working Group concluded the morning session. Subsequent to the October 15 meeting, Peter Hildebrand of Goddard Space Flight Center (GSFC) agreed to chair the group. Hildebrand is the new Branch Head of GSFC's Microwave Sensors Branch and has considerable experience in validation, obtained during many years at the National Center for Atmospheric Research in Boulder, Colorado. He is new to the EOS program and will bring a fresh perspective to the validation efforts.

Statement for ESDIS

The afternoon session began with a brief discussion of a one-paragraph statement drafted by the PM Project Scientist in response to a request from the Earth Science Data and Information System (ESDIS) for an "EOS PM Long-Term Science Plan for Nominal Observational Modes." The core of the statement is that there should be no intentional significant interruptions of the basic observational mode (providing systematic, global coverage) without prior review and approval by the EOS PM Science Working Group. This draft statement was unanimously adopted, prior to the group's moving on to the main topic of the afternoon session, i.e., spacecraft maneuvers.

Spacecraft Maneuvers

All instruments on the PM spacecraft are intended to make observations of the Earth system. However, the spacecraft has the capability of performing various maneuvers to provide non-Earth views that could be of value in the calibration of the instruments and the analysis of the data. The issue of which maneuvers to have the PM spacecraft perform has been contentious for some time, as the four science teams have conflicting needs, preferences, and concerns, but it was important at this meeting to formulate a maneuver timeline for the first 90 days after launch. Briefly, the basic positions of the four teams are:

(a) The AIRS Team would prefer no maneuvers, because maneuvers are not needed for AIRS, they ensure the absence of Earth-system data during and surrounding the period of the maneuver, and they add a risk factor. The AIRS Team Leader, Mous Chahine, and Project Scientist, George Aumann, confirmed that they do not want the AIRS instrument turned on until after completion of the initial maneuvers. Hence, if maneuvers have to be done, they should be done at the earliest possible date, so as not to delay the opening of the AIRS instrument any longer than necessary.

(b) The CERES Team requires a maneuver to obtain an essential view of deep space for their calibration efforts. Bruce Barkstrom and Bob Lee explained that the CERES Team needs either three constant-pitch-rate maneuvers or two inertial-hold maneuvers, preferably soon after day 30 of the mission. The constant pitch-rate and inertial-hold maneuvers are both classified as pitch maneuvers and involve a flipping over of the spacecraft. The CERES Team would also like a yaw maneuver, which involves a lesser turning of the spacecraft, of no more than 11 degrees and lasting no more than 15 minutes. Lee explained that the team only needs a single yaw maneuver and that it should be done early in the mission.

(c) The MODIS Team also requires a deep-space maneuver, although it cannot take advantage of it until somewhat later in the mission than the CERES Team would prefer. Bob Murphy explained that scheduling the maneuver at day 65 (or as soon thereafter as the moon would be out of the way) would be the appropriate timing for MODIS at this point, based on their current scheduling of MODIS events early in the PM mission. He indicated, however, that it might be possible to accelerate this schedule, and that the MODIS Team members will have a much better handle on this after they obtain MODIS data from the Terra mission. Murphy and Gerry Godden also explained the desire for a series of yaw maneuvers over the course of four days early in the mission, and for small roll maneuvers to view the moon on the order of five times per year throughout the mission. The yaw maneuvers appropriate for MODIS involve 13 orbits on each of two days with the MODIS doors closed and the same sequence on two days with the MODIS doors opened. The desired yaw maneuvers last approximately 5

minutes during each orbit, with incremental turn changes of 2 degrees from orbit to orbit. Each small roll maneuver will last no more than 10 minutes and will roll the spacecraft no more than 20 degrees.

(d) The AMSR-E Team does not require maneuvers, but feels that the team could benefit from a view of deep space. Hence the AMSR-E Team is in favor of a deep-space maneuver, but would prefer to minimize the number and extent of additional maneuvers. Elena Lobl and Chris Kummerow presented the AMSR-E Team position, which is driven in part by the scientific value obtained by the spacecraft maneuvers performed during the TRMM mission, which also contains a microwave radiometer (the TRMM Microwave Imager [TMI]). It is important that both the large reflector and the cold-sky mirror on AMSR-E obtain a view of cold sky during the desired deep-space maneuver.

As the discussion proceeded, George Morrow and Pete Pecori, the PM Project Manager and Deputy Project Manager, respectively, explained several constraining factors. The first and most important regarded the deep-space maneuver and the fact that TRW has only analyzed and agreed to the constant-pitch-rate maneuver, not the inertial-hold maneuver. This quickly ended the discussion of the inertial-hold possibility. Second, Morrow and Pecori explained the importance of having all essential initial testing of the spacecraft and instruments completed by day 90 because of the contractual agreement with TRW. This necessitates both having the AIRS instrument turned on preferably at least 30-40 days prior to day 90 and doing, at least once prior to day 90, each type of maneuver likely to be done at any time during the duration of the mission.

The discussion was aggressive, but there was a shared recognition of the need for a reasonable compromise, and the result was a consensus agreement to the following:

(1) The deep-space maneuver will be a constant-pitch-rate maneuver done on three consecutive orbits, preferably on day 55 or as soon thereafter as the moon is out of the way. It is possible that the day-55 timing might have to be shifted toward, or to, day 65, if the MODIS Team finds that it cannot make use of a pitch maneuver done as early as day 55. If, on the other hand, the MODIS Team determines that it can accelerate the MODIS schedule to allow the maneuver even earlier than day 55, this would have advantages for the other teams. Bob Murphy has an action item to report back on further MODIS Team analyses of this issue.

(2) A series of yaw maneuvers with the MODIS doors closed will be done on days 26-27, and a second series of yaw maneuvers with the MODIS doors open will be done on days 30-31. Bob Lee of the CERES Team and Gerry Godden of the MODIS Team were given the action item to determine the specifics of the second series of yaw maneuvers, to accommodate both the CERES and MODIS needs. Subsequent to the meeting, Lee and Godden determined that the CERES needs can be met through the MODIS yaw maneuvers.

(3) A small roll maneuver, to enable a view of the moon from the MODIS Space View Port, will be done on day 40, or as soon thereafter as the moon is appropriately positioned.

All maneuvers should be done during the primary shift of the mission operations team.

Closing and Sub-Groups

Following the agreement on spacecraft maneuvers to be executed during the first 90 days of the mission, marking a major accomplishment for this Science Working Group, Parkinson adjourned the general meeting and had two smaller groups remain an additional 50 minutes. Specifically, Bob Lee and Gerry Godden met with each other and with the mission operations team regarding the yaw maneuvers; and Elena Lobl, Mike Gunson, Bob Murphy, Claire Parkinson, and George Aumann met in the initial meeting of the newly formed EOS PM Validation Working Group. In the latter meeting there was an enthusiastic exchange of ideas on how this group can best encourage and support joint validation and data-exchange efforts amongst the EOS PM Science Teams.

May 1999 User Working Group Meeting—ORNL DAAC for Biogeochemical Dynamics

— *Robert Cook and Larry Voorhees (Oak Ridge National Laboratory) and Curtis Woodcock (Boston University)*

The User Working Group (UWG) of the Oak Ridge National Laboratory (ORNL) DAAC met on May 10-11, 1999 in Herndon, Virginia. This meeting was devoted primarily to a review of the mission and objectives of the ORNL DAAC (see text box) and the role of the UWG. The need for such an overview meeting was primarily prompted by the timing of the release of the National Research Council's review of the DAACs, which raised fundamental questions about the mission and future activities of NASA's ESDIS (Earth Sciences Data and Information System), and the ORNL DAAC. The NRC review prompted considerable discussion within the UWG, which helped clarify the ORNL DAAC's role. The discussions were lively, wide ranging, and productive.

Revised Mission Statement

The UWG agreed to the following revised Mission Statement for the ORNL DAAC:

> *To meet the needs of NASA's Earth Science Enterprise (ESE) and Earth Observing System (EOS), the mission of the ORNL DAAC is to assemble, distribute, and archive data for research, education, and policy formulation in terrestrial biogeochemistry and the ecosystem dynamics of global environmental change. The anticipated kinds of data include both ground-based and remote-sensing measurements related to biogeochemical and ecosystem processes. Sources of data include NASA-funded field campaigns, (such as FIFE, OTTER, BOREAS, EOS Land Validation, LBA), selected relevant measurements from EOS satellites, as well as other biogeochemical dynamics data useful to the global-change research community.*

This revised mission incorporates the UWG recommendation that the mission of the ORNL DAAC reflect the Earth Science Enterprise's mission. The ESE mission is broader than that of EOS and includes, for example, the missions of the Terrestrial Ecology, Land Cover/Land Use Change, and Land Hydrology Programs. ESDIS will work with the ORNL DAAC's Program Scientist and User Working Group to prioritize the DAAC activities to ensure that EOS and ESE are supported.

ORNL DAAC for Biogeochemical Dynamics: An Overview (http://www-eosdis. ornl.gov/)

The Oak Ridge National Laboratory (ORNL) DAAC has the responsibility for archiving and distributing biogeochemical dynamics data from NASA's field campaigns as well as global-scale data sets for global-change research. ORNL is a Department of Energy facility in eastern Tennessee, with a history of managing environmental data. Ground-based measurements are needed to calibrate and verify remote-sensing data and to parameterize and validate models of local-, regional-, and global-scale processes for projecting changes in the Earth's ecosystems. NASA field campaigns provide point and imagery data to develop the extrapolation process. The field campaigns supported by the ORNL DAAC include: FIFE (First ISLSCP [International Satellite Land Surface Climatology project] Field Experiment), BOREAS (Boreal Ecosystem-Atmosphere Study), LBA (Large-scale Biosphere Atmosphere Experiment in Amazonia), Earth Observing System (EOS) Land Validation, and SAFARI 2000 (Southern African Regional Science Initiative).

Regional- and global-scale data sets of vegetation, soils, hydrology, and climate supplement data from these intensive site-specific investigations are crucial for validating remote-sensing products and for driving and validating models at continental or global scales.

As a data center that supports field investigations, the ORNL DAAC provides a link between the data provider and the end user after completion of a field project. This task involves developing an understanding of the objectives of the field experiments, how the data sets are interrelated within the field project, and how the project relates to other field investigations. We prepare ourselves for archiving and distributing such data by being involved in the field investigation as early as possible. For example, we are currently participating in the planning, scoping, and background-data-gathering activities for the LBA field campaign. Data from the ecology and hydrology components of this multidisciplinary international investigation will be archived at the ORNL DAAC. By participating in these early stages of a project, we not only develop a solid understanding of the purpose of the investigation, but we also form a close working relationship with the project management, principal investigators, and project data-management staff.

NRC Review of the DAACs

In 1997-1998, EOSDIS, including the ORNL DAAC, was reviewed by the National Research Council's Committee on Geophysical and Environmental Data. NASA requested the EOSDIS review, based on the outcome of the 1995 review of the U.S. Global Change Research Program and the role of NASA's Office of Earth Science activities in this program. The complete text of the NRC Review of the DAACs, which was released in early 1999, may be found at http://books.nap.edu/catalog/6396.html.

The UWG discussed the six recommendations from the NRC for the ORNL DAAC and the general recommendations for all DAACs. A brief summary of the NRC recommendations and UWG discussions is presented here.

The NRC committee encouraged the ORNL DAAC to develop a mission and strategic plan that guides every decision the DAAC makes, from participation in the relevant EOS flight missions, to priorities for data acquisition, ingest, and preparation. The UWG and the ORNL DAAC revised and clarified the mission statement (discussed above) and discussed a draft strategic plan written by the DAAC staff. The DAAC is in the process of preparing a strategic plan for all aspects of DAAC operations and has worked first on the science elements. In addition, the ORNL DAAC is participating in the development of an ESDIS Project Strategic Plan, which is based on the EOS Science Plan and the ESE Earth Science Implementation Plan.

Several of the NRC recommendations in the ORNL chapter were targeted at ESDIS and the EOS and ESE Programs. The NRC recommended that ESDIS incorporate metadata for ground-based measurements into the ECS Metadata Model, and that NASA investigate establishing a Memorandum of Understanding with DOE, which is the parent agency of ORNL, for long-term archival of biogeochemical dynamics data at ORNL. The ORNL DAAC will continue to work with ESDIS to develop a more-detailed understanding of users and to serve as the basis for enhancing the performance of EOSDIS and individual DAACs. The NRC thought that ESDIS should devote greater attention to the role of the ORNL DAAC in the success of the EOS Program—in particular the importance of its role in validation of land data products. This attention will support the ORNL DAAC's activities as a full player in EOSDIS and thereby help it become better integrated within the DAAC system.

The NRC emphasized the need for ground-based measurements to properly interpret remotely-sensed data. Integration of *in situ* and remote sensing data is a fundamental question of scales: how does one relate field measurements made at a point (e.g., gas transport measurements from flux towers, net primary productivity, river discharge, leaf area index) with remote-sensing measurements made with 250-m or 100-km resolution? The UWG agreed that there was fundamental research that needed to be addressed through targeted funding, not from routine DAAC activities.

UWG Charter and Operations

The UWG agreed that the charter should be revised, although the basic responsibility and authority of the UWG will remain essentially unchanged from the March 1994 version of the Charter. The UWG was established to provide guidance and give recommendations to the DAAC on data archival activities. The UWG does not provide a formal review of the DAAC; however, the UWG could recommend to ESDIS that the ORNL DAAC be peer reviewed by a separate process.

A significant change is the implementation of a committee structure to augment the UWG's efforts to provide guidance to the DAAC. Four new UWG committees were established: ecosystem modeling, field campaigns, land validation, and technology innovations. These committees will meet once a year, usually in conjunction with other meetings. The full UWG will meet once a year, and an executive committee, made up of the UWG chair and the chairs of the four committees, will meet once a year.

The UWG agreed to revise the make-up of the group. *Ex officio* members now will include the ORNL DAAC Manager, the ORNL DAAC Scientist, the ORNL DAAC Program Scientist, and the ESDIS Project Representative. The UWG recommends that senior ESDIS management be invited to attend at least one of the full UWG meetings every other year.

Voting members will include scientists representing past and current NASA field projects in biogeochemical dynamics, NASA interdisciplinary studies projects, and biogeochemical dynamics projects sponsored by other agencies or institutions. The UWG membership should include someone from the Environmental Sciences Division, ORNL, as is stated in the current charter. The *ex officio* Members will be non-voting members.

Mercury

The development and use of the Mercury system at the ORNL DAAC drew strong praise and support from the UWG. Mercury is a distributed, Web-based system for metadata search and data retrieval (for a description of Mercury, see

text box). It works with data and metadata residing on investigators' web servers. Mercury makes the metadata searchable by copying it to a central site and organizing it with Internet search engine software. Users search the index at ORNL and can be connected to the data by a hypertext link.

This new approach for coordination of distributed data will significantly expand the ability of the DAAC to provide access to a wider range of data. The UWG suggested that the Mercury system be used to support the ecosystem-modeling community by making important data sets available, which may not be ready for archive. Furthermore, the UWG recommended that the climate, soil, vegetation, land use, and hydrology data sets identified by Jon Foley be included in Mercury.

The UWG encouraged the DAAC to be more proactive in identifying, acquiring, and ingesting data sets that are within the general UWG guidance. In the past, the DAAC sought UWG concurrence on each data set prior to acquiring. To implement this suggestion, the DAAC should compile and maintain a list of potential new data sets; from this list the UWG and DAAC will prioritize data sets for ingest into the archive.

End Note

The expectation following this meeting, which was devoted to concerns of a more-fundamental nature, is that future meetings can return to more-direct discussion of data set priorities and to a review of, and recommendations for, DAAC actions.

This meeting also marked the end of Bill Emanuel's (University of Virginia) tenure as Chair of the UWG. The ORNL DAAC and the UWG have benefitted greatly from the outstanding efforts of Bill Emanuel, whose service to the UWG has shown his great devotion. His help and tireless attention to the issues confronting the ORNL DAAC and its UWG are greatly appreciated. Curtis Woodcock (Boston University) now serves as Chair.

Mercury: A distributed web-based search and retrieval system http://mercury.ornl. gov/

Mercury is a web-based system that allows the searching of distributed metadata files to identify data sets of interest and the delivery of those data sets directly to the user. The researcher providing the data set maintains full control of both metadata and data files.

To submit a data set to Mercury, researchers prepare associated metadata with Mercury's Metadata Editor (see below). Next, they make the metadata, documentation, and data (optionally) accessible to Mercury by simply placing them on a web server. Researchers need not run any database software on their machines, and their data can reside in any convenient format (ASCII, netCDF, spreadsheets, HDF-EOS, etc.). Periodically, Mercury retrieves the metadata files via the Internet and automatically builds a metadata index (used to provide the search capabilities) at the central ORNL data facility.

Mercury is designed to support the data and information needs of field projects (like the EOS Land Validation Program and LBA-Ecology[a]) where the critical aspects of a desirable system are: 1) early exchange of data between researchers, 2) complete control of data visibility in the system maintained by researchers, 3) rapid and economic deployment, and 4) high automation and easy scalability. In addition, Mercury is being used by the DAAC to provide early access to data sets generated for regional and global ecosystem modeling activities (climate, vegetation, soils, hydrology, and land-cover/land-use change). The development of Mercury has been funded by the LBA-Ecology project, ESDIS, NASA's Prototype Office, and ORNL.

The Metadata Editor, developed by ORNL staff, provides the capability to insert metadata into existing web pages. This metadata, although not necessarily visible when viewing the web page over the Internet with a browser, is accessible to Mercury. The Metadata Editor is easily adapted for different projects by providing a new configuration file that identifies metadata elements, their structure, and their allowable values. These configuration files are eXtensible Markup Language (XML) Data Type Definition (DTD) files. LBA-Ecology is developing a software tool to allow creation of EOSDIS Guide Documents that will work with the Metadata Editor.

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[a] *The Large-scale Biosphere Atmosphere (LBA) Experiment in Amazonia Ecology component selected the name Beija-flor (which means "flower kisser" in Portuguese) for its implementation of Mercury. Beija-flor is represented by a hummingbird (Brazil's national bird) traveling from flower to flower, gathering nectar.*

Requirements For Landslide Signature Observation By Satellite

— *Luis G. Hidalgo (lhidalgo@reacciun.ve), University of Central Venezuela Engineering Faculty, School of Civil Engineering, Department of Hydrometeorology, Caracas, Venezuela*

Abstract

A list of requirements for satellite observation of landslide signatures is presented for northern South America. Images with a frequency of 15 days with a spatial resolution better than 1170 m^2 (at the sub-satellite point) inside the time interval 9:45-13:00 LST are required. Panchromatic, yellow, red, and infrared radiometric bands are necessary to delimit slides. The joint use of satellite images and color photographs is recommended whenever possible. Satellites such as *Landsat-7* and *Terra* meet these requirements.

Introduction

A landslide is a slipping down of soil, rocks, and debris on a mountain side. After the landslide, a signature constituted by a bright spot of bare soil or rock generally remains in the mountain. The signature presents a sharp contrast with the darkness of the background forest. Landslides are no rare phenomena in the scarped mountains of northern South America, but there is not a well established procedure to observe and follow up the signatures.

One kind of landslide develops rapidly in a period from minutes to hours, such as that on September 6, 1986 in the *Henry Pittier Forest Park* near *Maracay* (Venezuela, 10°20´N, 67°40´W) where a large slide associated with an intense rainfall ran down the corrose of the Limon River reach. Lives and civil structures were damaged irrecoverably. The slipping down produced a characteristic grave sound that was audible far away, but that was not interpreted as a landslide by the people crossing or camping in the park. The corresponding signature of the slide is exhibited in Figure 1. A second kind of slide does not develop so fast, but in terms of days to weeks. A slide of this last kind occurred in the period May 15-18, 1999 in the Andes near *Tabay* (Venezuela, 8°38´N; 71°05´W). The landslide sound was audible in *Tabay* during hours of calm wind and light motor traffic. Figure 2 presents the signature of this slide taken near noon, May 18, 1999. A photo dated August 27, 1999 (Figure 3) indicates few changes in the slide signature, as can be deduced by a comparison with Figure 2. The photographs of the signature near *Tabay* are useful for diagnosis, and they were taken from the same place during the moments in which the signature presented maximum brightness under similar zoom settings. Figure 4 shows the signature of Figure 3, but at a time in which the area was illuminated laterally and clouds were present. Color photography permits an evaluation of the signature alteration. More explanations on the principles of the use of photography for satellite applications that will not be summarized here were given by Hidalgo (1998).

The observation of a landslide is very difficult because of its sudden nature, but the signature persists and can be followed up. The growth of a landslide signature is an indication of new landslides. New landslides are indications of geological instability in an area that represents new contingency problems. These problems need permanent observation and follow up for periods of years to decades.

The necessity of satellite imagery

Two main facts point to the use of the large geographical capability of satellite imagery. First, photographs of the signatures can be taken on the ground from routes and small towns, but it is possible that other cases are occurring in uninhabited areas, and that no information is thereafter gathered. Second, a single signature can be studied by ground photography but the presence of additional hidden signatures outside the photograph is possible. These two facts confirm the need for satellite-imagery. However, the use of photography is maintained whenever possible because of its superior resolution, color discrimination, and precise registration capability. The requirements for the satellite-imagery part of the observational needs for an area such as that in Figure 2 are listed below.

- Spatial resolution in the order of R_S=1170 m^2 or better (sub-satellite pixel of 34 m x 34 m). This value was obtained by dividing the area (A_S=140000 m^2) of the spot of Figure 3 by a minimum number of pixels (N=120) suitable for statistical analysis. The signature of Figure 3 is accepted as the minimum slide area for satellite monitoring. The value of A_S was determined using the photograph-camera geometry and single calculations. The data for calculations embraced a distance of 2

km from camera to signature, zoom of 80 mm, film frames of 36 mm x 24 mm, paper print size of 150 mm x 100 mm, mean land slope of 45° and a signature area of 1.6% of the whole print. Figures 2-3 present sectors of the whole photographs only. Some features of the calculations were presented by Hidalgo (1993).

- Repeat time of about N_R=15 days or less with passes in the interval 9:45-13:00 LST during more than 10 years are the time requirements. That number of days will permit the evaluation of a determined slide signature after its formation, and the interval will permit maximum illumination and minimum interference of tropical cumulus convection. There are no time references in the main local journals, but the signature of Figure 1 extends over a period of about 13 years. The observation of landslide signature must be a never-ending activity for the safety of the citizens but the present analysis recommends a 10-year monitoring span with the same family of satellites.

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- Some radiometric bands: The panchromatic band in the range 0.4-0.7 μm will be necessary to calculate the approximate area of the signature. Some single-color bands, such as the yellow and the red, could be used successfully to trace the boundary between soil and forest. The thermal-infrared band helps to delimit the signature by thermal differences in case of lateral illumination and shadows.

- Image format: Images constituted by 640 pixels/line in the West-East direction (left-right of screen) with 250 lines in the North-South position (top-down of screen) that could be fitted to single computer screens are very useful for analysis without problems related to image fitting. That format represents an area of about 22 km x 9 km if the pixel is 34-m wide by 34-m high. An approximate search radius of 8 km centered on the geographical co-ordinates of the slide is recommended. A binary grey-scaled pixel of 8 bits taken from the source image is necessary for the use

Figure 1. Signature of a landslide in the *Henry Pittier Forest Park* (Venezuela) that occurred on September 6, 1986. Date of picture is May 1, 1989.

Figure 2. Signature of a landslide developed during the period May 15-18, 1999 in the Andes near *Tabay* (Venezuela). Time and date of picture are 11:45 LST, May 18, 1999. This Figure is a sector of the corresponding whole color print.

Figure 3. As in Figure 2 but for 12:10 LST, August 27, 1999

Figure 4. As in Figure 2 but for 9:45 LST, August 29, 1999. The landslide signature area is illuminated laterally and clouds are present.

of software produced with single compilers and inexpensive file managers. The calibration curve for counts is also needed.

- Affordable cost and prompt availability of sector imagery on the Internet.

- The preferable satellites are those of the latest technology, such as Landsat 7 and Terra, which provide data with such high accuracy and spatial resolution as to permit practical use in landslide-signature applications.

The analysis of the capabilities of those satellites and the comparison with the present requirements are outside the range of the present work. Details of satellite *Terra* are given by King (1999)

Conclusion.

It was possible to establish a list of the main requirements for observation and follow up of single landslide signatures by imagery from satellites such as *Landsat-7* and *Terra*.

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USRA/GSFC Graduate Student Summer 2000 Program In Earth System Science

— GSSP Program Coordinator (GSSP@gvsp.usra.edu), Universities Space Research Association, Seabrook, MD

The Universities Space Research Association, in collaboration with the Goddard Space Flight Center's Earth Sciences Directorate, is offering a limited number of graduate-student research opportunities for the Summer of 2000. The Program is scheduled for June 5 to August 11, 2000.

The aim of this program is to attract and introduce promising students to Earth system science career options through hands-on educational research experiences in the Earth sciences at NASA. Each student will be teamed with a NASA scientist mentor with parallel scientific interests to jointly develop and carry out an intensive research project at GSFC over the ten-week period. NASA mentors will be drawn from within the three participating Earth Science laboratories at Goddard: The Laboratory for Atmospheres, The Laboratory for Hydrospheric Processes, and The Laboratory for Terrestrial Physics.

Students will also participate in an introductory lecture series and informal weekly lunch discussions with GSFC researchers, and have the opportunity to tour key NASA facilities and meet with NASA and industry scientific leaders.

The program is open to students enrolled in, or accepted to, accredited U.S. graduate programs in the Earth, physical or biological sciences, mathematics, or engineering disciplines. Students will be selected on the basis of academic record, demonstrated motivation and qualification to pursue multidisciplinary research in the Earth sciences, clarity and relevance of stated research interests to NASA programs, and letters of recommendation. Preference will be given to students who have completed at least one year of graduate study. Minorities and women are encouraged to apply.

Students must commit for the full ten-week period (June 5 - August 11, 2000). Because of NASA/GSFC security regulations, citizens of certain proscribed nations *may* be ineligible. Prospective applicants who are non-U.S. citizens should contact the Program Coordinator to confirm eligibility.

Details and a formal application may be obtained by contacting the GSSP Program Coordinator at the mail address or e-mail address below, or downloaded from ***http://www.gvsp.usra.edu/gssp***. The deadline for applications is February 11, 2000.

GSSP Program Coordinator
Universities Space Research Association
7501 Forbes Boulevard, Suite 206
Seabrook, MD 20706
e-mail: *GSSP@gvsp.usra.edu*

Annual Depletion Of Antarctic Ozone Results Are In: 'Ozone Hole' Smaller Than Last Year

— David E. Steitz, Headquarters, Washington, DC
— Cynthia O'Carroll (cocarrol@pop100.gsfc.nasa.gov), Goddard Space Flight Center, Greenbelt, MD

A NASA satellite has shown that the area of ozone depletion over the Antarctic — the well-known ozone "hole" — is a bit less in 1999 than it was last year.

"This Antarctic year's ozone depletion area, or ozone 'hole,' is very large, but slightly smaller than that of 1998," said Dr. Richard McPeters, principal investigator for the instrument that made the measurements.

This year's study found that an ozone "low" had formed between New Zealand and Antarctica on Sept. 17. This sort of ozone low, commonly referred to as a "mini-hole," is a result of the redistribution of ozone by a large weather system. The "mini-hole" moved eastward along the rim of the Antarctic "ozone hole" for a number of days after Sept. 17.

Preliminary data from the satellite show that this year's Antarctic ozone depletion covered 9.8 million square miles on Sept. 15. The record area of Antarctic ozone depletion of 10.5 million square miles was set on Sept. 19, 1998.

The ozone levels are expected to decrease over the next two weeks. The lowest amount of total-column ozone recorded to date this year was 92 Dobson Units on Oct. 1. In contrast, ozone levels of 90 Dobson Units were observed at one point last year. Dobson units measure how thick the ozone layer would be if all the overhead ozone molecules in a column of atmosphere could be brought down to the Earth's surface.

Globally, the ozone layer averages approximately 300 Dobson Units, which would correspond to a layer about 1/8th of an inch (3 millimeters) thick at the Earth's surface, about the thickness of two stacked pennies. In contrast, during the annual Antarctic ozone "hole," the amount of ozone in the ozone "hole" is about 100 Dobson Units, about 1/25th of an inch, or approximately the thickness of a single dime.

The slightly decreased size of the ozone "hole" from last year is not an indication of the recovery of Antarctic ozone levels. The current year-to-year variations of size and depth of the ozone "hole" depend primarily on the variations in meteorological conditions.

The Antarctic ozone losses are caused by chlorine and bromine compounds released by chlorofluorocarbons (CFCs) and halons. Due to international treaties regulating the production of these gases, the amount of chlorine in the stratosphere is close to maximum value and, in some regions, is beginning to decline. In the next century, chlorine-induced ozone losses will be reduced as chlorine amounts throughout the stratosphere decline, and ozone levels will begin to recover. The actual rate of recovery will likely be affected by the increasing abundance of greenhouse gases in the atmosphere. Detecting the recovery of the ozone hole will require a number of years of measurements.

Ozone molecules, made up of three atoms of oxygen, comprise a thin layer of the atmosphere that absorbs harmful ultraviolet radiation from the Sun. Most atmospheric ozone is found between 6 and 18 miles above the Earth's surface.

Ozone shields life on Earth from the harmful effects of the Sun's ultraviolet radiation. Scientists and others have a keen interest in ozone depletion. Increased amounts of ultraviolet radiation that reach the Earth's surface due to ozone loss might increase the incidence of skin cancer and cataracts in humans, depress the human immune system, harm some crops, and interfere with marine life.

These measurements were obtained between mid-August and early October using the Total Ozone Mapping Spectrometer (TOMS) instrument aboard NASA's Earth Probe (TOMS-EP) satellite. NASA instruments have been measuring Antarctic ozone levels since the early 1970s. Since the discovery of the ozone "hole" in 1985, TOMS has been a key instrument for monitoring ozone levels over the Earth.

TOMS ozone data and pictures are available on the Internet: http://toms.gsfc.nasa.gov or http://pao.gsfc.nasa.gov/

NASA Unveils New, Most Accurate Map Of Antarctic Continent

— David E. Steitz, NASA Headquarters, Washington, DC.
— Allen Kenitzer (alemotze@pop100.gsfc.nasa.gov), Goddard Space Flight Center, Greenbelt, MD.

For 18 days during the Southern Hemisphere spring of 1997, a NASA-launched Canadian satellite called RADARSAT-1 collected pieces of a puzzle that will help scientists study the most remote and inaccessible part of the Earth — Antarctica. Scientists now have put the puzzle pieces together, forming the first high-resolution radar map of the mysterious frozen continent.

With fine detail to the point of picking out a research bungalow on an iceberg, the new map has both answered scientists' questions about the icy continent, and left them scratching their heads about what to make of strange and fascinating features never seen before.

"This map is truly a new window on the Antarctic continent, providing new beginnings in our Earth science studies there," said Dr. Ghassem Asrar, Associate Administrator for Earth Science, NASA Headquarters, Washington, DC. The new map was produced as part of NASA's Antarctic Mapping Project.

The most amazing features scientists now see are twisted patterns of ice draining from the ice sheet into the ocean. "We were surprised to see a complex network of ice streams reaching deep into the heart of East Antarctica," said Kenneth Jezek, a glaciologist from the Byrd Polar Research Center at Ohio State University. Ice streams are vast rivers of ice that flow up to 100 times faster than the ice they channel through, with speeds up to 3000 feet per year. "There are some extraordinary ice streams in East Antarctica that extend almost 500 miles — nearly the distance along the Mississippi River from New Orleans to Cairo, Illinois," Jezek said.

Ice streams form the most energetic parts of the Antarctic ice sheet, and scientists believe that they are quite susceptible to environmental change. Ice streams also transport most of the snow that falls on the continent's interior and dump it into the ocean.

"We've recently used RADARSAT and other satellite data to estimate that one ice-stream system sends over 19 cubic miles of ice to the sea every year — an amount equivalent to burying Washington, DC, in 1700 feet of ice every 12 months," said Jezek.

Antarctica looks pure, white, and mostly featureless to the low-resolution satellites that previously mapped the frozen landscape. With the new RADARSAT map, however, the continent comes alive. Blocks of broken sea ice line the coast and sedimentary rock protrudes from the rocky walls of Antarctica's Dry Valleys. The vast, perplexing Antarctic Ice Sheet flows and twists into the sea, volcanoes poke through the ice sheet, and ice streams flow like rivers into the Southern Ocean. Even the tracks of wayward snow tractors on their way to inland stations are visible. "We have a new view of the entire southern continent. It shows us something about an extraordinary part of our world and how humans may be changing it — on both local and global scales," said Jezek.

Jezek and his colleagues have been working to complete the enormous map since the Canadian Space Agency began the mission with a complex in-orbit rotation of the satellite. Researchers chose RADARSAT because its radar collects data day and night, through cloudy weather or clear. Such capability enabled the mapping to be completed in just 18 days, compared to the last satellite map of Antarctica, which required images from five different satellites spanning a 13-year period from 1980 to 1994. Even at that time, parts of the continent remained obscured by cloud cover.

The map also depends on accurate ground measurements by scientists from many of the nations that study Antarctica. "The entire mission was conducted in a true spirit of international cooperation, and that is why it succeeded," said Verne Kaupp, NASA's Alaska SAR Facility Director and Chief Scientist.

RADARSAT-1 is owned and operated by the Canadian Space Agency (CSA). Its data is distributed and marketed by RADARSAT International, a Canadian company licensed by the CSA. "We at the Canadian Space Agency are very pleased to make this significant contribution to the international science community," said Dr. Rolf Mamem, Director General, CSA Space Operations Branch. "We are looking forward to the exploitation of these data for the benefit of all."

(Continued on page 18)

Earth Science Education Update

Opportunity To Participate In Digital Library For Earth Science Education

— *Nahid Khazenie (nkhazeni@pop100.gsfc.nasa.gov), Education Program Manager, Office of Earth Science, NASA Headquarters*
— *Steve Graham (steve.m.graham.2@gsfc.nasa.gov), EOS Project Science Office, Raytheon ITSS*

Earth science educators at all levels are invited to participate in a new initiative.

The National Science Foundation (NSF) and NASA have joined together to sponsor development of a Digital Library for Earth System Education (DLESE). The library is envisioned as providing: 1) easy, organized access to high-quality, peer-reviewed educational materials about all of the Earth system at all educational levels, and 2) student friendly access to data about the Earth system. The goal is to build a community library that meets the needs of educators in all parts of the Earth sciences.

The first steps are already taking place. NSF and NASA sponsored a community workshop to develop an initial library vision and plan last summer. Preliminary reports from that workshop are posted on the web (http://geo_digital_library.ou.edu) and will be overviewed in a special session at the San Francisco American Geophysical Union (AGU) meeting (EP03, Wednesday afternoon). The preliminary reports are intended as a starting point for community discussion.

You can also become involved in discussion of the preliminary reports using list-servers established at the DLESE web site (http://geo_digital_library.ou.edu). The library effort is moving forward beyond planning. With NSF funding, a prototype library system is under construction by a consortium that includes the University Corporation for Atmospheric Research, Incorporated Research Institutions for Seismology, the Universities Space Research Association, the Keck Geology Consortium, the University of Colorado, and the University of California-Santa Barbara. This effort will be guided by a steering committee that will be looking for your input both electronically and through a set of committees. If you are interested in helping on a committee, please contact one of the following people: Donald Johnson, University of Wisconsin, donj@ssec.wisc.edu; Cathryn A. Manduca, Keck Geology Consortium Coordinator, cmanduca@carleton.edu; or John T. Snow, University of Oklahoma, jsnow@ou.edu

NASA Quest Learning Technologies Channel

Located at NASA's Ames Research Center, the QUEST Learning Technologies Channel (LTC) produces live streaming video programs with open Chat Rooms for live interaction with NASA Scientists and experts participating in the programs.

A recently archived program, "As the Sun Burns," discussed the affects of the invisible ultraviolet (UV) rays emitted by the sun. These are the rays that cause our skin to burn and affect global warming. Guest experts included a solar scientist and an opthamologist who explained the effects of these rays and how we can best protect ourselves. This was the first in a year-long Webcast Series on Solar Science, which includes on-line curricula for grades 2-12. For more information, see <http://quest.arc.nasa.gov/ltc/>.

ESE Interactive Educational CD-ROM

An overview of the latest research related to our global environment is now available on CD-ROM from NASA's Earth Observing System (EOS) Science Project Office. The Earth Science Enterprise Educational CD-ROM contains a myriad of images, animations, and narrations on the four major topics emphasized by the program including the Earth's atmosphere, land, ice, and oceans. The presentation of these topics ranges from general to a more-detailed and scientific approach suitable for high school and undergraduate university curriculums.

Both natural and human-induced changes to our global environment are illustrated, and narrated. The Earth Science Enterprise CD-ROM travels the globe — from deforestation and habitat loss on land, to the vital production of phytoplankton in the ocean, to the instability of Arctic glaciers, to the Earth's interaction with the sun's energy.

Also included are overviews of the many components of the Earth Observing System as well as data and information, and educational resources. Complement-

ing the CD-ROM is an Activity Supplement that contains activities for students on the topics displayed in the CD-ROM.

For more information or copies of the CD-ROM, please contact:

Lee McGrier
Phone: (301) 441-4259
e-mail: lmcgrier@pop900.gsfc.nasa.gov
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TOPEX/Poseidon Resources

An image gallery has been added to the TOPEX web site at http://topex-www.jpl.nasa.gov/discover/image-gallery.html. It is designed to serve the TOPEX/POSEIDON/JASON-1 Science Working Team, NASA, educators, and the general public by providing images readily available for import into presentations, posters, and brochures.

El Niño/La Niña mouse pads have been produced and are available from the JPL Employees Recreation Club. They can be ordered through http://www.jplerc.org/store.htm.

EOS Scientists in the News

— Emilie Lorditch (elorditc@pop900.gsfc.nasa.gov), Raytheon ITSS EOS Science & Information Team

"NASA Images Show Shrinking Ozone Hole," *CNN Interactive* (Oct. 1) by Ann Kellan. Paul Newman (NASA GSFC) says that the hole in the ozone layer over the South Pole is slightly smaller than last year. Scientists predict that the ozone hole will disappear completely by 2060.

"Fire's Role in Global Warming Studied," *Environmental News Network* (Sept. 27). Dean Graetz (CSIRO) reports that fires make a significant contribution to the greenhouse effect and possibly account for 40 percent of annual global greenhouse gas emissions. Graetz says that little is known about where fires occur and how much carbon they release.

"Maryland Laser Tests May Help in Global Warming Battle," *Balitmore Sun* (Sept. 25) by Frank Roylance. Ralph Dubayah (Univ. of Md.) explains how the Vegetation Canopy Lidar (VCL) will reveal the height and age, and the amount of carbon in the trees. By applying this information, Dubayah hopes to measure the effects of deforestation on the global carbon budget.

"Floyd: Offspring of La Niña," *Washington Post* (Sept. 16) by Guy Gugliotta. Kevin Trenberth (NCAR) says that the strength of Hurricane Floyd is not unexpected because La Niña shifts the winds north that ordinarily would tear a hurricane apart before it could form. This leads to more frequent and stronger storms during La Niña events.

"Hurricane Floyd," *NBC Nightly News* (Sept. 16). Roger Pielke, Sr., (Colo. State Univ.) and Roger Pielke, Jr. (Colo. State Univ.) discuss hurricane Floyd and why it is such a powerful storm.

"La Niña Intensifies Threat of Hurricane Season," *CNN Interactive* (Sept. 10) by Ann Kellan. Tony Busalacchi (NASA GSFC) explains that during El Niño events the sub-tropical jet stream shifts south, which blocks and weakens hurricanes, but La Niña shifts the jet stream north leaving an "open door" for hurricanes to form.

EOS researchers please send notices of recent media coverage in which you have been involved to: Emilie Lorditch, EOS Project Science Office, Code 900, Goddard Space Flight Center, Greenbelt, MD 20771, Tel. (301) 441-4031; fax: (301) 441-2432; e-mail: elorditc@pop900.gsfc.nasa.gov

Student, School Receive Award for Naming EOS Satellite

— David D. Herring (dherring@climate.gsfc.nasa.gov), Science Systems and Applications, Inc.

Meet Sasha Jones (left) and Kelly Harfst, Sasha's favorite science teacher. Thanks to Sasha, Ms. Harfst's class now has access to EOS information and data products via a brand new Macintosh G4 computer (far left).

David Herring and Sasha Jones were interviewed by local television media.

Representatives from NASA Goddard, AGU, and the University of Montana presented part of the grand-prize award of a computer and software to Sasha Jones, contest winner. Pictured from left are Heather Milton, ESRI, David Herring, NASA GSFC (SSAI), Sasha Jones, and Frank Ireton, AGU.

Representatives from the EOS Project Science Office, the American Geophysical Union, and the University of Montana converged recently on Brentwood High School in St. Louis, Missouri, to present a computer and special software that enables faculty and students to obtain data from the soon-to-be-launched Terra satellite. Local media were invited to cover the event.

Brentwood High School is receiving this computer and software suite thanks to one of its 1999 graduates, Sasha Jones, who won a joint NASA-AGU essay contest to rename the EOS AM-1 satellite. She chose the name "Terra," the Latin name for Earth, in honor of our planet's mythical Mother Earth. Sasha's entry was selected as the winner by Dr. Ghassem Asrar, NASA's Associate Administrator for the Earth Science Enterprise, after a series of judging rounds distilled the 1,100 entries down to 10 finalists.

Dr. Frank Ireton, AGU's Manager of Education Programs, presented the award to Ms. Kelly Harfst, Sasha's favorite science teacher at Brentwood. Representing the EOS Project Science Office, David Herring presented an overview of Terra's science objectives. Herring also took the Brentwood science faculty on a virtual tour of NASA's Earth Observatory web site. Dr. John Kuglin, who heads the EOS Education Project at the University of Montana, concluded the ceremony with a tutorial on software tools and education support services that his team provides high school educators, enabling them to introduce EOS remote-sensing data into the classroom.

Sasha is now in her freshman year at the University of Missouri-St. Louis, where she is majoring in English Literature. She aspires to becoming a high school or middle school English teacher.

In addition to winning the computer and software for her school, Sasha won a trip for her and her family to watch Terra's launch at Vandenberg Air Force Base, California.

(Continued from page 15)

NASA Unveils New, Most Accurate Map Of Antarctic Continent

RADARSAT images of Antarctica are available on the Internet at: http://svs.gsfc.nasa.gov/imagewall/antarctica.html

Science Calendar

• 2000 •

Feburary 23-25
AVIRIS Earth Science and Applications Workshop, Jet Propulsion Laboratory. Contact Robert Green, e-mail: rog@gomez.jpl.nasa.gov, URL: http://makalu.jpl.nasa.gov.

April 11-13
EOS Investigators Working Group Meeting (IWG), Tucson, AZ. Contact Mary Floyd, e-mail: Mfloyd@westover-gb.COM.

Global Change Calendar

December 13-17
The 1999 American Geophysical Union (AGU) Fall Meeting, Moscone Center, San Francisco, CA. Contact: AGU, 2000 Florida Avenue, N.W. Washington, D.C. 20009. Tel. (202) 462-6910; Fax: (202) 939-3229.

• 2000 •

January 9-14
American Meteorological Society 2000, Long Beach Convention Center, Long Beach, CA. Call (202) 682-9006; Fax: (202) 682-9298; e-mail: ams@ametsoc.org.

February 8-9
"Oceanography: The Making of a Science: People, Institutions, and Discovery," Scripps Institution of Oceanography, LaJolla, CA. Contact Ida Herfurth, tel. (858) 534-2826; e-mail: iherfurth@ucsd.edu.

February 16-17
Earth Watch/Intermap STAR-3i IFSAR Data Workshop, Stennis Space Center, MS. Contact Brett Thomassie, e-mail: rbirk@intermaptechnologies.com, URL at http://www.crsp.ssc.nasa.gov/databuy.

February 17-22
American Association for Advancement of Science (AAAS), Washington, DC. Call (202) 326-6736, URL at http://www.aaas.org.

March 7-10
Oceanology International 2000. Call for Papers. Contact Christine Rose, Conference Executive, Oceanology International 2000, Spearhead Exhibitions Ltd, Ocean House, 50 Kingston Road, New Malden, Surrey KT3 3LZ, UK. Tel. +44 (0) 20 8949 9222; Fax: +44 (0) 20 8949 8186/8193; e-mail: christine.rose@spearhead.co.uk; URL at http://www.spearhead.co.uk.

March 14-15
Adaptive Sensor Array Processing Workshop, MIT Lincoln Laboratory. Call for Papers. Contact Edward J. Baranoski, e-mail: kballos@ll.mit.edu, URL at http://sam2000.uconn.edu.

March 27-31
28th International Symposium on Remote Sensing of Environment, Cape Town, South Africa. Call for Papers. For abstracts submission: abstracts@mikom.csir.co.za, or URL at http://www.isrse.co.za, Fax: +27 21 883 8177; tel. +27 21 886 4496 (ask for Deidré Cloete); postal: The 28th ISRSE technical committee, P.O. Box 452, Stellenbosch, 7599, South Africa.

April 4-8
The Association of American Geographers (AAG), Pittsburgh, PA. Contact: (202) 234-1450, e-mail: gaia@aag.org, URL: http://www.aag.org.

May 22-26
ASPRS: The Imaging and Geospatial Information Society, 2000 Annual Conference, May 22-26, 2000. Washington, DC. Call for Papers. For abstracts submission see URL at http://www.asprs.org/dc2000; tel. (410) 208-2855; Fax: (410) 641-8341; e-mail: wboge@aol.com.

May 30-June 3
The 2000 American Geophysical Union Spring Meeting, Washington, DC. Contact AGU, tel. (800) 966-2481 or (202) 462-6900; fax: (202) 328-0566; e-mail: meetinginfo@agu.org; URL at http://www.agu.org

June 12-14
Sixth Circumpolar Symposium on Remote Sensing of Polar Environments, Yellowknife, Northwest Territories, Canada. E-mail: circumpolar2000@gov.nt.ca, tel. (867) 920-3329, URL at http://www.gov.nt.ca/RWED/rs/circumpolar2000.

July 16-23
International Society for Photogrammetry & Remote Sensing (ISPRS) 2000, Amsterdam. Call for Abstracts. Contact organizing secretariat, tel. +31 20 50 40 203; Fax: +31 20 50 40 225; e-mail: isprs@congrex.nl.

July 24-28
IEEE 2000 International Geoscience and Remote Sensing Symposium, 20th Anniversary, Hilton Hawaiian Village, Honolulu, Hawaii. Call for Papers. For up-to-date data regarding submissions, access the conference website at http://www.igarss.org.

July 24-29
International Radiation Symposium (IRS-2000), Saint Petersburg State University, St. Petersburg, Russia. Contact conference coordinator, Evgenia M. Shulgina, St. Petersburg State University, Research Institute of Physics, 1 Ulyanovskaya, 198904, St. Petersburg, Russia; Fax: +7 (812) 428-72-40; e-mail: Evgenia.Shulgina@pobox. spbu.ru; or shulg@troll.phys.spbu.ru.

August 6-17
31st International Geological Congress & Scientific Exhibits, Rio de Janeiro. Contact Tania Franken, tel. 55 21 537-4338; Fax: 55 21 537-7991, e-mail: geoexpo@fagga.com.br, website at http://www.31igc.org.

August 21-25
10th Australasian Remote Sensing and Photogrammetry Conference, Adelaide, Australia. Tel. 026257 3299; e-mail: 10arspc@ausconvservices.com.au

October 16-20
ERS-ENVISA Symposium "Looking at our Earth in the New Millennium," Gothenburg, Sweden. Call for Papers. Contact Prof. J. Askne, e-mail: askne@rss.chalmers.se; website at http://www.esa.int/sympo2000/.

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