National Aeronautics and Space Administration
Earth Observer : January - February 2005 : Vol. 17 : No. 1

The Earth Observer

. . . advancing knowledge of Earth through exploration

In This Issue

Editor's Corner

Michael King
EOS Senior Project Scientist

I'm pleased to report that NASA Earth Science information—including data from a number of EOS missions—has made significant contributions in the aftermath of the recent tsunami disaster. The Moderate Resolution Imaging Spectroradiometer (MODIS) on Terra has provided numerous images of various parts of the impacted region that have been helpful in assessing how the coastline has been altered by the disaster. Though MODIS was not specifically designed to make the very detailed observations that are usually necessary for mapping coastline changes, the changes in this case are so substantial that MODIS can observe them.

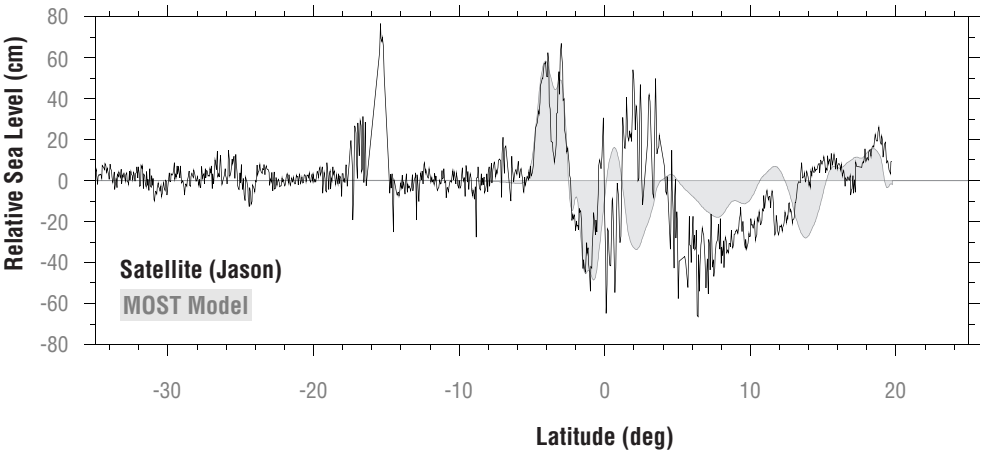
The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), also on Terra, captures higher resolution images than MODIS and has also been useful for assessing changes in the landscape caused by the tsunamis. Likewise, the Enhanced Thematic Mapper Plus (ETM+) on Landsat 7 acquired some excellent regional imagery of the tsunami damage on December 29, 2004, three days after the event that highlighted the variable extent of the damage. The results were forwarded to the Indonesian government, who found the information helpful as they planned their response to the disaster.

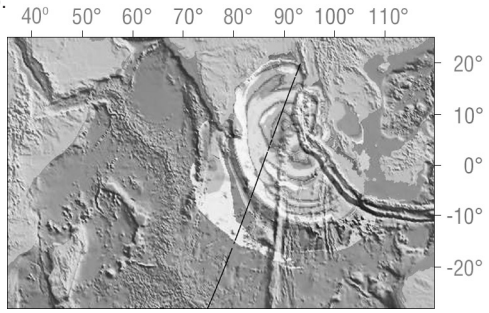
Meanwhile, the Multi-angle Imaging Spectroradiometer (MISR) on Terra was able to capture unique time-lapse imagery of the breaking waves on December 26, 2004, off the coast of Sri Lanka. The MISR imagery provides measurements of the location and timing of the breaking waves, their angle relative to the shoreline, and their speed of propagation. In conjunction with bathymetric measurements of ocean depth, this information can be used to refine and calibrate tsunami propagation models. Improving these models has two primary benefits for society. First, a detailed understanding of wave interactions with coastal areas is necessary for developing damage mitigation approaches. Second, a better predictive capability of the models will make possible more accurate near-real-time forecasts of tsunami arrival times and effects.

Data from Jason and TOPEX/Poseidon (as well as data from the European Space Agency's Envisat and the U.S. Navy's Geosat Follow-On) was useful in tracking the tsunami waves as they propagated across the open ocean. These instruments wouldn't normally be able to detect such an occurrence and won't be useful as a detection system; yet it appears that in this specific case, the two satellites were in the right position at the right time to detect the changes in sea surface height caused by the waves. Researchers from the NOAA Laboratory for Satellite Altimetry in Silver Spring, MD, were able to detect the tsunami in profiles of sea level along the satellites' flight paths by comparing the sea level seen on December 26, 2004, with the sea level measurements the satellites picked up a few days, or weeks, earlier.

U.S. and French teams, working in parallel with data from the joint NASA/French Space Agency's Jason and TOPEX/Poseidon, independently confirmed the satellites' measurements of the height of the tsunami waves. "These observations are unique and of tremendous value for testing and improving tsunami computer models and developing future tsunami early warning systems," said Lee-Lueng Fu of NASA's Jet Propulsion Laboratory in Pasadena, CA.

Jason data used to track the tsunami waves as they propagated through the Indian ocean (left & right images).





HIRDLS still is providing new science results. The first temperature retrieval has been obtained and the results compare favorably with analysis.

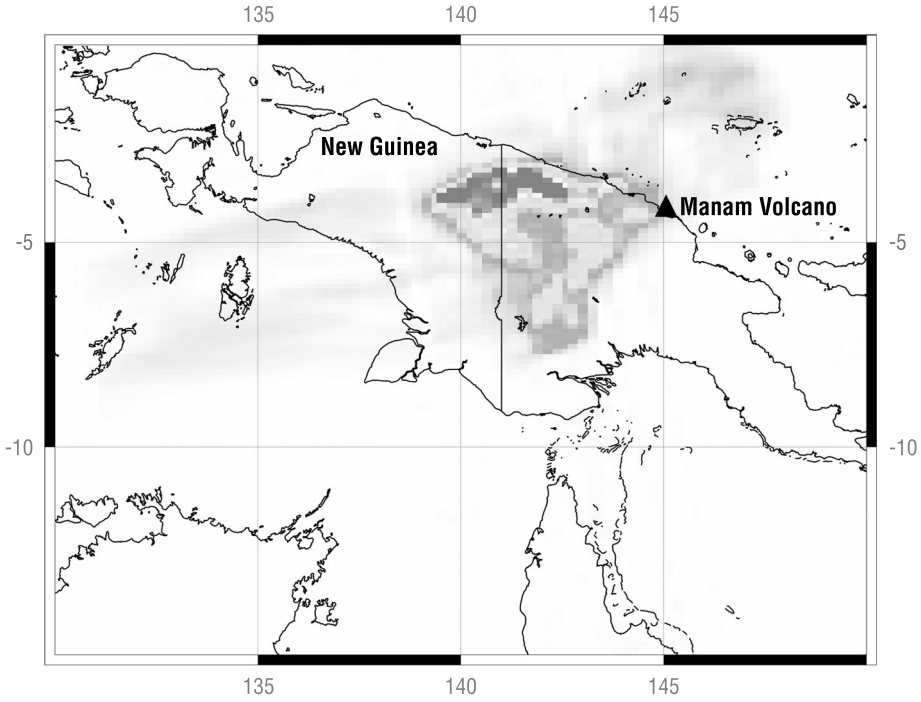
I'm also pleased to report that the Aura spacecraft is doing well and beginning to provide valuable new science information.

- MLS got timely coverage of the Antarctic ozone (O_3) hole in October. New discoveries related to Hydrochloric Acid (HCl) chemistry have also been made.
- TES has viewed curtains of tropospheric O_3 in the South Atlantic (Ascension Island) associated with biomass burning in West Africa.
- OMI has acquired preliminary tropospheric column maps. Tropospheric O_3 over the South Atlantic correlates nicely with TES tropospheric profile data. OMI is also producing maps of Nitrogen Dioxide (NO_2) and recently obtained some Sulfur Dioxide (SO_2) profiles over the erupting Manam Volcano on New Guinea.
- HIRDLS has a kapton blocking part of the scan mirror, which prevents it from being able to make horizontal scans and reduces some of its planned capabilities. However,

In other news, in the last issue, I acknowledged the successful launch of Polarization and Anisotropy of Reflectances for Atmospheric Science coupled with observations from a Lidar (PARASOL) by the French Centre Nationale d'Etudes Spatiale (CNES). I can now report that PARASOL is positioned in its control box in the A-Train constellation, 131 seconds behind Aqua. PARASOL reached the constellation orbit at 705 km on February 3, 2005. When CloudSat and Cloud-Aerosol Lidar Infrared Pathfinder Satellite Observations (CALIPSO) launch later this year, they will be placed between Aqua and PARASOL in the formation.

Also, February 25, 2005, marked the fifth anniversary of the Terra first-light. The Terra Science Team plans a meeting on February 24, and then on February 25, team leaders and Principal Investigators will give presentations highlighting the accomplishments of the past five years in the morning, followed by a party in the afternoon in honor of the fifth anniversary.

Lastly, I would like to acknowledge two EOS missions on the second anniversary of their launch, the Ice Clouds and Land Elevation (ICESat) mission (January 13) and the Solar Radiation and Climate Experiment (SORCE) mission (January 25). Both of these missions continue to provide new scientific knowledge about the Earth's environment. I would like to commend all who have participated in these highly successful missions.



OMI-captured SO_2 profiles over the Manam Volcano on New Guinea

AIRS Science Team Meeting Summary

— Hartmut "George" Aumann, aumann@jpl.nasa.gov, Jet Propulsion Laboratory

The Atmospheric Infrared Sounder (AIRS) Science Team Meeting was held November 30 through December 2, 2004, at the Greenbelt Marriott in Greenbelt, MD. The meeting was divided into three major sessions: 1) Status of the AIRS Project, Instrument and Software; 2) AIRS Data Assimilation; and 3) Development of Advanced Product Generation Algorithms and Research Products.

Session 1: Status of the AIRS Project, Instrument and Software

Moustafa Chahine (JPL—AIRS Science Team Leader) gave the introductory remarks. More than two years of AIRS data are now available, and the quality of the AIRS data has exceeded his highest expectations. A paper has been submitted to the *Bulletin of the American Meteorological Society* (BAMS) which summarizes the many AIRS accomplishments.

Tom Pagano (JPL—AIRS Project Manager) summarized the AIRS Project Status: The AIRS and Advanced Microwave Sounding Unit (AMSU) instruments are in excellent health.

George Aumann (JPL—AIRS Project Scientist) provided the AIRS Calibration and Science Status Overview. With the absolute radiometric calibration stability established at the better than 10 mK/year level, AIRS data are making their entry into climate applications. The numerical weather forecasting centers have made great progress and now show positive impact in both the northern and southern hemispheres, as will be discussed in the Data Assimilation session.

Eric Fetzer (JPL) discussed the methodology of validation, i.e., accuracy assessment of the Version 4.0 (V4.0) Level 2 products and results using the European Centre for Medium-range Weather Forecasts (ECMWF), Rawindsonde Observations (RAOBs) and Advanced Microwave Scanning Radiometer for EOS (AMSR-E). The retrievals meet the 1K/1km accuracy requirement over non-polar oceans with up to 80% cloud cover. Validation over land and under polar conditions is in progress. Details of the results will be compiled in the AIRS Level 2 (L2) Product Validation Report, which is part of the Version 4.0 delivery to the Distributed Active Archive Center (DAAC). The results of the validation effort also form the basis for 40 papers for the special AIRS validation issue in the *Journal of Geophysical Research* (Journal of Geophysical Research). Deadline for the Journal of Geophysical Research paper submission is February 14, 2005. Level 3 products (developed by Stephanie Granger at JPL), which map AIRS L2 retrievals onto global maps, are becoming a very useful tool for the evaluation of the data for real and software-related trends.

Steve Friedman (JPL—Deputy AIRS Project Manager) presented the schedule for the delivery of the V4.0 to the DAAC. V4.0 processing is expected to start at the DAAC in February 2005 going forward in time, and going back to September 2002 at x5 speed. At this rate a consistent three-year V4.0 data set will be available in October 2005. The planned release of the revised Level 2 Algorithm Theoretical Basis Document (ATBD) will be the first post-launch release and will describe the basis of the V4.0 algorithm. Friedman also discussed milestones for Version 5.0 (V5.0) upgrades. The highest priorities for V5.0 are improved surface emissivity retrievals, and improved cloud-clearing with, and independent of, AMSU.

Joel Susskind (GSFC) discussed the performance of the Level 2 V4.0 retrievals. Comparison with the ECMWF Global Circulation Model (GCM) shows that the requirement to generate radiosonde like 1K/1km accuracy has been met. The data record contains the results of all retrievals, even if quality indicators (QA) indicate that the retrieval is good only under a limited set of conditions, e.g., over the ocean and/or above 200 mbar. The new multilayer quality indicators are based on empirical thresholds derived from the September 6, 2002 focus day. **SY Lee** gave a tutorial on how the Level 2 QA is mapped into a number of 16-bit flags. There was consensus that the values of the parameters used for the QA threshold should be copied into the standard products to allow data users to experiment with their own thresholds.

Larrabee Strow (University of Maryland, Baltimore County [UMBC]) discussed the status of the Rapid Radiative Transfer Algorithm (RTA) and the absolute frequency calibration. The frequencies have been stable at the 1 ppm level since September 2002, but the channel spectra shifted on November 8, 2003, when the AIRS instrument was turned back on after the protective shut down during the big solar flare. The RTA delivery in January 2003 is valid from September 1, 2002, through October 31, 2003. The January 2004 RTA delivery, with the new channel spectra locations, is valid from November 15, 2003 until further notice. There are indications of a 0.5-ppm day/night and seasonal variability of the frequencies, which is irrelevant for the 10 ppm frequency accuracy required for retrievals, but needs to be taken into account for critical analysis of the data for climate signals. An algorithmic correction is proposed for V5.0.

Steve Gaiser (JPL) discussed upgrades to the Level 1b calibration in V4.0. Smoothing of the space views for some channels has not changed the mean radiances, but noise has been improved slightly. The way the once-per-month intrusion of the moon into the space view is handled has also been improved. The Level 1b radiances are validated for ocean. Validation for land and the polar regions under very low temperature conditions is in progress. The CalFlag in the Level 1b record is the primary indicator of the quality of the radiances.

Bjorn Lambrigtsen (JPL) gave the presentation on the microwave Level 1b calibration which is still *provisional* since it refers to antenna temperatures only. These temperatures have to be adjusted by scan angle and latitude-dependent corrections of as much as several K to convert to scene brightness temperatures. A correction using empirically derived scan-angle dependence only is implemented in the Level 2 software using ECMWF data from Setpember 6, 2002 as a 30 x 15 matrix. These corrections agree with Phil Rosenkranz's (MIT) evaluation over the ocean—obs-buoy.calc. **Larry McMillin's** (NOAA NESDIS) derived latitude/longitude, land/ocean and brightness temperature dependent microwave tuning coefficients (30 x 15 x 17 matrix) agree with the above over ocean, but show significant difference at high latitudes and over land. Implementation of the improved tuning coefficients and the upgrade of the Level 1b from provisional to beta validated is planned for V5.0.

Session 2: AIRS Data Assimilation

AIRS Level 1b data have been distributed in Binary Universal Format Representation (BUFR) format by the National Oceanic and Atmospheric Administration (NOAA)/National Environmental Satellite Data and Information Service (NESDIS) since May 2003. This distribution is a thinned data set of 324 of the 2378 AIRS spectral channels. Thinning by an additional factor of 18 is accomplished by using only the AIRS footprint at the center of every second AMSU footprint. **James Cameron** (UK Met Office) showed small positive impact from assimilating raw 324 AIRS radiances down to the cloud tops. The 4.3-µm CO_2 R-branch channels are assimilated at night only**. Tony McNally** (ECMWF), reported getting positive impact over ocean using radiance assimilation to the cloud tops and *gamma correction* of the radiances for systematic effects, rather than bias tuning relative to the forecast. **John LeMarshall** (Joint Assimilation Office [JAO]) showed positive impact in the northern and southern hemisphere oceans. The results are being written up for a publication. A super-fast RTA, a factor of 30 faster than the current one, is under development, which will allow the ingest of more data. This is expected to further enhance forecast impact. **Bob Atlas** (Data Assimilation Office [DAO]/GSFC), is assimilating Level 2 retrievals. The analysis of January 2003 temperature retrievals shows a positive impact. Most of the impact is achieved through the elimination of spurious cyclones created by the forecast without AIRS data. The attempt to assimilate moisture profiles resulted in a negative impact. **Joanna Joiner** (GSFC) showed that AIRS radiances have positive impact on forecasts in the fvSSI system for January 2003 in both hemispheres. She stated that the expected forecast impact improvements in going from cloud-screening to cloud-clearing have not materialized, but the set-up may not be optimized. **Elena Klein** (graduate student of Eugenia Kalnay at the University of Maryland College Park [UMCP]) reported on progress using the Local Ensemble Kalman Filter(LEKF)/fvGCM with AIRS data. The LEKF may be a breakthrough in data assimilation: It knows about the *errors of the day*, it provides perfect initial perturbations for ensemble forecasting. Matrix computations are done in a very low-dimensional space, which is both accurate and efficient, and it does not require the adjoint of the Numerical Weather Prediction (NWP) model (or the observation operator).

The assimilation of cloud-filtered or above-the-cloud-tops radiances limits the potential for forecast impact, since only 1% of the data is used. The use of cloud-cleared radiances may allow an order of magnitude more data to be used, if they can be quality screened to eliminate outliers**. Larrabee Strow** evaluated the cloud-cleared data as function of the latitude and total-water dependence of (obs-calc.ECMWF) in comparison to the (obs-calc.ECMWF) for strictly cloud filtered radiances. The results look very similar for less than 30-mm total precipitable water. **Evan Fishbein** (JPL) found that the spectral clear tests developed by Aumann for identifying cloud-free data have little useful skill for quality screening cloud-cleared data over ocean. **Mitch Goldberg** (NOAA/NESDIS) found that MODIS data can be used effectively to quality control the cloud cleared AIRS data. About 30% of the cloud-cleared radiances pass his tests and are statistically indistinguishable from clear data. The 324 cloud-cleared channels are now distributed to the NWC in BUFR format.

Session 3: Development of Advanced Product Generation Algorithms and Research Products.

Bob Knuteson (University of Washington [UW]) evaluated the IR surface emissivity returned by the V4.0 PGE over land using very clear data over Egypt. He found that the silicate feature emissivity signal, which is clearly visible in the raw Level 1b radiances, is no longer present in the cloud-cleared radiances. He is working on an alternate emissivity retrieval algorithm with Chris Barnet, NOAA/NESDIS, which may minimize the perturbation of the boundary layer temperature and water due to emissivity error. **Xavier Calbet** (EUMETSAT) showed results with an operational algorithm for AIRS data, and ultimately Infrared Atmospheric Sounding Interferometer (IASI) data, which simultaneously retrieves from a single AIRS field-of-view (FOV) T(p), q(p) and cloud amount without a formal cloud-clearing

step. The current algorithm is stabilized on the forecast surface temperature, forbids super-adiabatic and super-saturated retrievals and works only with known emissivity over ocean. It uses 1900 of the 2378 AIRS channels. **David Staelin** (MIT) showed encouraging results using a neural-net trained cloud-clearing algorithm developed by his graduate student, Cho Chen. The test was limited to granule 208 of July 1, 2002. **Hank Revercomb** (UW) showed results from the SHIS underflights of the EOS Aqua and EOS Aura on October 29, 2004, including preliminary results of comparisons with the Tropospheric Emission Spectrometer (TES). SHIS on the WB57 aircraft now has uplooking and downlooking capability. **Mike Iacono** (AER) discussed algorithms which speed up the radiative-transfer algorithm (RTA) by two orders of magnitude and applied them to the analysis of climate trends in High-resolution Infrared Radiation Sounder (HIRS) data. There is a tradeoff between accuracy and speed. There is general appreciation that one bottleneck to the assimilation of AIRS radiances is the time required to run the RTA. This is true also for the V4.0 Level 2 software, which spends 40% of the execution time evaluating the RTA. **Jon Wright,** (Georgia Tech), discussed the vertical structure of deep convection and upper tropospheric water (UTW) using AIRS retrievals. UTW (water column from 100-500 mb) provides 35% of the water vapor feedback in climate models. He noted that the AIRS UTW is slightly less than UTW in the ECMWF GCM. Measurements of UTW from balloons using frost-point hygrometers by **Larry Miloshevich** (LaRC), represent the continuing effort to verify the accuracy of the AIRS water vapor profiles above 400 mbar, where the accuracy of conventional RAOBs start to degrade rapidly.

Wallace McMillan (UMBC) summarized global results in carbon monoxide (CO) retrievals from AIRS. A write-up has been accepted for publication in *Geophysical Research Letters*. CO from AIRS is generally 10% higher than that from the Measurements of Pollution in the Troposphere (MOPITT) satellite instrument, which in turn is 10% higher than models expected. Striking flow patterns can be seen from forest fires in Brazil and Alaska. (**Figure 1** shows CO retrievals from September 29, 2002. The dark areas are very high concentrations of CO, the light gray slivers along the equator are single day-coverage gaps). **Phil Rosenkranz** (MIT) discussed the validation of the microwave radiative transfer algorithm, which is being written up for the AIRS validation special *Journal of Geophysical Research* issue. **Larrabee Strow** summarized results of day and night aerosol optical depth retrievals over *cloud-free* ocean, which has been submitted to *Geophysical Research Letters*. MODIS retrievals of aerosol optical depth (day time only) are in good agreement. **Joel Susskind** (GSFC) showed his work on precipitation estimates and the generation of Spencer and Christy-like Microwave Sounder Unit (MSU) coarse layer temperature trends for long-term climate records using TIROS Operational Vertical Sounder (TOVS) data. He plans to extend the data record using AIRS and AMSU data. **Eric Fetzer** showed that many low-level temperature inversions which are detected in the AIRS Level 2 algorithm are independently verifiable. The results have been accepted for publication in Geophysical Research Letters. **George Aumann** summarized results of two-year AIRS and AMSU trends over clear tropical ocean. The sea surface temperature retrieved from AIRS tracks the global floating buoys with less than 10 mK/year trend. The observed apparent cooling trend of 80mK/year in the CO_2 sensitive mid-tropospheric channels is explained by the global increase in the CO_2 at the rate of 2.2 ppmv per year. The results have been accepted for publication in *Geophysical Research Letters*.

The next AIRS Science Team Meeting is planned for early May 2005, in celebration of the third year of AIRS data. The meeting will be in Pasadena, CA. Please check the AIRS web site for more information, *airs.jpl.nasa.gov*. The presentations of the speakers shown in boldface in the text can also be found on the AIRS web site.

Notice:

The Earth Observer will no longer be printed after the May-June 2005 issue. We will continue to produce new issues bi-monthly, but they will only be available on-line in PDF format at *eospso.gsfc.nasa.gov/earth_observer.php*.

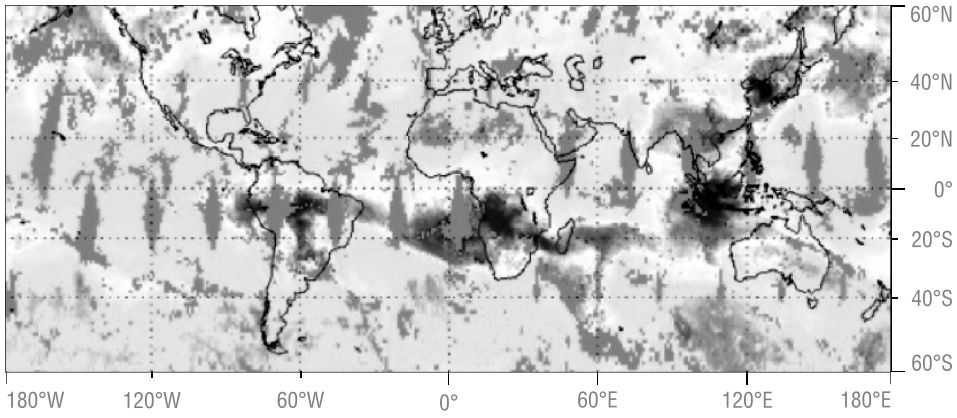


Figure 1: Large columns of CO rising from forest fires in Brazil and South East Asia are carried around the world (AIRS CO retrievals for September 29, 2002, from Wallace McMillan's GRL paper presented at the meeting).

Second CERES-II Science Team Meeting

— Gary G. Gibson, Gary.G. Gibson@nasa.gov, NASA Langley Research Center (LaRC)
— Shashi K. Gupta, s.k.gupta@larc.nasa.gov, LaRC

The second meeting of the new Clouds and the Earth's Radiant Energy System (CERES-II) Science Team was held November 2-4, 2004 in Williamsburg, VA. The meeting was held jointly with the Atmospheric Radiation Measurement (ARM) and the Global Energy and Water-cycle Experiment (GEWEX) Cloud System Study (GCSS) cloud-modeling working groups.

The meeting objectives included a review of the status of CERES data products; an examination of 4 years of Terra data to assess variability and potential trends in calibration, radiation, and clouds; a discussion of a new GEWEX radiative-flux assessment activity; and an overview of CERES flux and cloud-property capabilities relevant to ARM and GCSS cloud modeling. The next CERES-II Science Team meeting will be hosted at the Geophysical Fluid Dynamics Laboratory (GFDL) in Princeton, NJ by Leo Donner and Brian Soden on May 3-5, 2005.

Climate Program Overview

Bruce Wielicki (LaRC) reported on the state of the U.S. Climate Change Science Program (CCSP), NASA Earth Science, CERES, Intergovernmental Panel on Climate Change (IPCC), National Polar-orbiting Operational Environmental Satellite System (NPOESS), and NPOESS Preparatory Project (NPP). CCSP has formed an Observations Working Group with a Data Management sub-working group. The next step is to examine observation requirements. The multi-agency report of a workshop on satellite calibration requirements for climate data records has been published. The IPCC meeting on climate sensitivity was held in April. The working group report outlines a new way to use perturbed physics ensembles to attempt to infer more rigorous uncertainty in climate predictions. Wielicki is a contributing author on a chapter for changes in top-of-atmosphere (TOA) fluxes. This marks the first inclusion of radiation-budget data in observations of climate change.

At NASA, Space Science and Earth Science are now merged as they were in the 1980s. The implications for future funding in the Earth Sciences segment are not clear. NASA is currently planning the next Earth System Science Pathfinder (ESSP) competition for FY05. Water/energy cycle and modeling research announcements are now underway, and the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) lidar and CloudSat radar are expected to launch in 2005. In the CERES program, 20% budget cuts were taken in FY04 which resulted in significant staff reductions. The FY05 and FY06 plan calls for further reductions of 5% per year. Dealing with the implementation of NASA's full-cost accounting system continues to be a challenge.

For the second time, the CERES Flight Model (FM)-5 instrument has been knocked off of the NPP gap-filling mission due to budget problems. CERES has been working with NPOESS to estimate costs of transitioning CERES data product codes to the NPOESS system. NPOESS has formally requested NASA to provide the stored CERES FM-5 instrument for use on the first NPOESS to be launched in 2011. CERES has requested that the required processing for climate data products be done at LaRC. CERES has re-examined the radiation-budget data-gap risk and found that the risk moderately exceeds climate goals. CERES has submitted the gap analysis and suggested minimum improvements to the FM-5 mirror attenuated mosaic (MAM), calibration, and characterization if used on NPOESS.

Wielicki briefed the team on the status of the GEWEX TOA and surface radiative flux assessment activities. One of the assessment objectives is to examine decadal variability and define the accuracy of TOA and surface data. The long-term goal is to merge TOA, atmosphere, and surface data sets. Observation system requirements are driven by the climate model natural variability, which defines the limits of observing system accuracy. Key issues include climate radiative forcing, cloud feedback, and aerosol indirect effect. The long-term goal is climate-prediction uncertainty-driven requirements.

Terra/Aqua Instruments and Calibrations

Kory Priestley (LaRC) presented the operational and calibration/validation status of the four CERES instruments on Aqua and Terra. The CERES Terra/Aqua instruments are functioning nominally. Edition2 Bi-directional Scan (BDS) and Earth Radiation Budget Experiment (ERBE)-Like products are available through December 2003 for Terra and June 2004 for Aqua. All radiometric goals have been met for these Edition2 products. Time series analyses demonstrate a negative trend in the shortwave radiation field for the Terra instruments. The CERES calibration/validation protocol does not recognize this trend as being an instrument calibration issue. The sensitivity of the atmospheric window channels to scene brightness has been accounted for in all Aqua Edition2 data products and in Terra Edition2 data products for July 2003 and onward. Un-

precedented stability levels of ~0.1%/yr have been achieved for several products in the CERES climate record.

Cloud Properties

Patrick Minnis (LaRC) presented CERES cloud algorithms and results. The objective is to provide a consistent cloud-properties data set from the Tropical Rainfall Measuring Mission (TRMM), Terra, and Aqua to relate cloud properties to the radiation budget, and provide data to initialize and validate climate and weather-prediction models. He summarized the extensive ongoing intercalibration efforts and algorithm improvements for Aqua. Terra and Aqua cloud fractions are now very consistent in pattern and magnitude. Aqua has more, higher ice clouds, probably thin cirrus, and lower water-cloud heights. Future research will include multilayer cloud detection, improvement of nighttime/twilight results, continued validation using ARM and CALIPSO, multiangle studies using geostationary satellites, and *in situ* icing data; and estimation of sub-pixel cloud amounts.

Simple Surface Fluxes

David Kratz (LaRC) presented validation of surface shortwave (SW) and longwave (LW) fluxes for single-scanner footprint (SSF) data derived with simpler surface flux algorithms that are based on TOA-to-surface transfer methods or fast radiation parameterizations. Ground-based fluxes for validation were obtained from a number of sources such as the Baseline Surface Radiation Network (BSRN) and SURFace RADiation Network (SURFRAD). Clear-sky SW errors were within acceptable range in most cases, but all-sky SW errors were larger. LW errors for clear-sky and for all-sky were within the desired range.

Terra CRS

Thomas Charlock (LaRC) described the accuracy of surface fluxes from Terra CERES Cloud and Radiation Swath (CRS) Edition 2A and 2B. CRS is the Surface and Atmospheric Radiation Budget (SARB) product. Retrieved fluxes are routinely compared with surface observations at over 50 sites (over half of which subscribe to rigorous BSRN calibration standards); no surface radiometric data are used in the retrieval. Twenty months of Terra CRS Edition 2A, an ungridded and high volume SARB product, are on archive. Biases of all-sky downwelling surfaces fluxes are 4 W/m^2 for LW and 12 W/m^2 for SW at the Terra overpass times. For March 25, 2000, global net all-sky SW+LW aerosol forcing was –0.5 W/m^2 at TOA, +5.3 W/m^2 for the atmosphere, and –5.9 W/m^2 for the surface. For a theoretically clear globe, the respective aerosol forcings are –1.8 W/m^2, 5.0 W/m^2, and –6.7 W/m^2. A more-advanced Edition 2B will begin to enter the archive shortly.

Merged CERES/GEO Time Sampling

Dave Doelling (Analytical Services & Materials, Inc., AS&M) highlighted the achievements of the CERES Temporal Interpolation and Spatial Averaging (TISA) group in the implementation of geostationary (GEO) data into the CERES gridded product. He showed that the inclusion of GEO-derived longwave fluxes in the time-space-averaged product removed most diurnal features resulting from Terra's sampling pattern. For the SW, an empirical angular narrowband-to-broadband radiance model was developed using coincident MODIS and CERES data. This model was enhanced using theoretical radiances for all the GEO satellites.

Data Management

Mike Little (LaRC) reviewed the CERES Data Management status including an overview of available documentation and a summary of data product releases. **Ed Kizer** (SAIC) of the Atmospheric Sciences Data Center (ASDC) reviewed available user services and data products. The ASDC delivered about 20 TBytes of CERES data in FY04.

Outreach

Susan Moore (SAIC) gave an overview of the CERES education and public outreach effort, the Students' Cloud Observations On-Line (S'COOL) Project. S'COOL now has 1752 registered participants in 65 countries. The S'COOL newsletter is published in English, French, and Spanish.

Terra ERBE-Like Fluxes

Takmeng Wong (LaRC) gave a presentation showing both the interannual variability of Earth radiation budget (LW, SW, and net) and the time series analyses of tropical mean, mid-latitude mean, polar mean, and global mean Earth radiation fields using the first 4 years of CERES/Terra ERBE-Like data. The interannual variability of Earth radiation budget showed interesting features relating to El Niño events. Time series analyses showed a negative trend in the SW radiation field, pointing to a possible instrument calibration problem.

Terra Surface Shortwave Flux (SSF) Fluxes and Clouds

Norman Loeb (Hampton University [HU]) presented results from an analysis of deseasonalized anomalies in CERES SSF parameters based on four years of CERES and MODIS Terra measurements. SW TOA fluxes from both FM1 and FM2 instruments decreased by 2% between March 2000 and December 2003 for all-sky, clear ocean, and clear desert scenes. The decrease is closer to 1% for deep convective clouds. SW fluxes and cloud properties inferred from MODIS retrievals show no systematic change between March 2000 and December 2003. FM1 and FM2 nadir SW radiances are consistent from March 2000 to August 2002, but begin to deviate after August 2002. By December 2003, the two instruments differ by 1%.

Fred Rose (AS&M) presented comparisons of Terra CRS/SSF calculations and observations at TOA. He conjectured that the untuned albedo biases were attributed to improper treatment of aerosols, inadequate retrieval of multi-layer clouds, cloud 3-D effects, and cloud optics. He noted that the observed drift in SW bias was consistent with CERES dimming, and the drift in LW bias was mostly over clear-sky land scenes. The untuned SW bias was greatest over overcast ocean.

Bruce Wielicki examined a number of outstanding science issues using CERES data. He analyzed interannual variations of radiation from CERES and other data sets and found that the diverse data sets from the Earth Radiation Budget Satellite (ERBS), International Satellite Cloud Climatology Project (ISCCP), Advanced Very High Resolution Radiometer (AVHRR), High-resolution Infra-red Radiation Sounder (HIRS), Stratospheric Aerosol and Gas Experiment (SAGE), and CERES are consistent for detecting trends. Weilicki also discovered that TOA flux trends from the late 1980s to the mid 1990s are positive for outgoing LW and positive for net flux to warm the planet. He showed that CERES observations do not support the Earthshine results of *Palle et al.* and noted several concerns with the Earthshine analysis. In another study, he showed that estimates of ocean heat storage tracked well with ERBS/CERES global net radiation anomalies over the past decade. He noted that ocean heat storage is consistent with climate model predictions of global warming ocean heating.

Invited Presentations

Gary Rottman (University of Colorado) presented early results from the SOlar Radiation and Climate Experiment (SORCE), which is dedicated to the measurement of total and spectral solar irradiance. In addition to the total irradiance monitor (TIM), and spectral irradiance monitor (SIM), the spacecraft also carries the Solar Stellar Irradiance Comparison Experiment (SOLSTICE), and the XUV Photometer System (XPS) for monitoring other parts of the solar spectrum. A record of total solar irradiance (TSI) from March 2003 to October 2004 showed large variability associated with solar flares and other events. An **important and surprising finding** from this limited though highly accurate dataset is that TSI is around 1361 W/m^2, about 4 W/m^2 less than the consensus value of 1365 W/m^2 from several earlier experiments.

Investigator Presentation Highlights

Amy Clement (University of Miami) presented results of simulations to examine the possibility of reproducing the decadal changes in tropical mean TOA fluxes reported by *Wielicki et al. (2002)*. Two mechanisms were examined as possible causes: 1) changes in tropical circulation and 2) changes in cloud microphysics. For the first hypothesis, changes in the strength of Hadley circulation were analyzed using simulations with a Geophysical Fluid Dynamics Laboratory (GFDL) model and three other Global Climate Models (GCMs). The second hypothesis was examined in GFDL simulations only. The strength of the Hadley circulation had to almost double in order to reproduce the observed changes. Simulations for the second hypothesis showed that a minor change in precipitation efficiency would reproduce the observed changes. Clement concluded that a combination of the two mechanisms might be a likely solution.

Robert Cess (State University of New York at Stony Brook) presented a comparative assessment of the performance of ERBE and CERES cloud identification (cloud ID) algorithms over snow/ice surfaces. He obtained ERBE-like reflected SW and outgoing LW; corresponding Terra SSF products for CERES and examined them vis-a-vis ground-based measurements from the South Pole Observatory. Cess determined that MODIS-based CERES cloud ID is greatly improved over snow/ice surfaces compared to the ERBE results. An independent analysis showed that for polar regions we should expect a positive greenhouse effect over surfaces without temperature inversions and negative greenhouse effect over surfaces with temperature inversions near the surface.

James Coakley (Oregon State University) presented an assessment of the methods used to estimate indirect radiative forcing by aerosols through their effects on clouds. The first kind of indirect forcing is caused by an increase in the number of cloud droplets and a decrease in droplet size while liquid water path (LWP) remains constant. A second kind is caused when drizzle is suppressed and LWP increases. A third kind may be caused when absorbing aerosols suppress cloud growth. Coakley concluded that uncertainties in the current methods are large and realistic estimates of indirect radiative forcing are hampered by the lack of understanding of the effects of pollution on LWP and cloud amount.

Fu-Lung Chang (University of Maryland, College Park [UMCP]) presented a new method using MODIS data for deriving cloud properties for both layers when high cirrus clouds were present over low clouds. Results from the current method were compared with standard MODIS retrievals as well as with traditional visible-infrared (ISCCP-type) retrievals. For several case studies, and for global retrievals, it was shown that MODIS retrievals overestimated high clouds while ISCCP retrievals overestimated low clouds. Chang's results showed better agreement with multi-sensor products on cloud vertical structure from the ARM Southern Great Plains (SGP) site.

Seiji Kato (HU) presented an error analysis of the irradiance derived from Terra snow/sea ice angular-distribution models (ADMs). Clear-sky permanent snow albedos over Antarctica estimated

from two independent ADMs are consistent to within 0.6%. The estimated mean relative albedo error is 1% for very dark sea ice and 0.1% for very bright sea ice. The estimated regional root-mean-square (RMS) relative albedo errors are 5.6% and 2.6% for regions with very dark and very bright sea ice, respectively.

Steven Dewitte (Royal Meteorological Institute of Belgium) presented a validation of Geostationary Earth Radiation Budget (GERB) LW fluxes using corresponding CERES fluxes for January-June 2004. He presented scatterplots between coincident GERB and CERES LW data. GERB fluxes showed a small underestimation that could be represented by a linear fit. GERB fluxes also showed some dependence on the view zenith angle that was also represented by an analytical fit with an RMS difference of about 1%. Regionally and instantaneously, underestimations as large as 20 W/m^2 occurred frequently.

Xiquan Dong (University of North Dakota) presented a climatology of mid-latitude continental clouds derived from ground-based measurements at the ARM SGP site. Monthly averages of total cloud amount, amounts in the three height categories (low, middle, and high) and corresponding values of cloud radiative forcing gathered over a 6-year period (January 1997 – December 2002) were presented. Total and low clouds were more abundant during the winter months while high clouds were more abundant during summer. Cloud radiative forcing for total and low clouds was highest during spring and summer while that for high clouds peaked during summer.

Alexander Ignatov (NOAA National Environmental Satellite, Data, and Information Service [NESDIS]) presented the status of ocean aerosol products derived within the CERES project using MODIS data from Terra and Aqua and a comparison of those with corresponding products obtained directly from the MODIS project. CERES produces two products for each satellite: one using a MODIS-type algorithm and the other using an AVHRR-type (Stowe-Ignatov) algorithm. MODIS-type retrievals from Terra and Aqua showed considerable differences while AVHRR-type retrievals showed better agreement. AVHRR-type retrievals yielded higher values of aerosol optical depth (AOD) than MODIS-type retrievals. The two procedures also showed significant differences in correlations with cloud amount.

Istvan Laszlo (NOAA NESDIS) compared single- and multi-channel retrievals of AODs using the same input data set. The single channel retrievals were accomplished with the NOAA/NESDIS AVHRR-type algorithm at 644 and 1632 nm while multi-channel retrievals were done with a MODIS-type algorithm. The common input was the MODIS Atmosphere Parameters Subset Statistics (MAPSS) dataset. Comparisons were made at about 25 ocean locations. For both Terra and Aqua data, single-channel AODs were found to be slightly higher than the multi-channel values. Retrievals from the solar and anti-solar side of the satellites showed little differences. The differences between the two results also showed a slight dependence on the scattering angle.

Christina Hsu (UMBC) presented an algorithm for retrieving aerosol properties over bright reflecting regions using MODIS data where the standard MODIS algorithm currently does not work. Many such regions over Afro-Asian deserts, China, and India are major sources of atmospheric aerosols. The algorithm makes use of solar reflectances in the 412, 490, and 670 nm channels and is known as the *deep blue algorithm* because of its use of the 412 nm reflectance. Low reflectance of desert surfaces at 412 and 490 nm allows retrieval of AOD and Angstrom exponent over those surfaces. Efforts are underway to implement this algorithm into operational MODIS processing.

Laura Hinkelman (National Institute of Aerospace [NIA]) presented a talk on spatial matching error in comparisons of satellite and surface fluxes. She outlined new efforts to understand the limitations of using ground-based radiometer measurements to evaluate surface shortwave fluxes retrieved for CERES SSF. Differences between ground- and satellite-viewing geometry such as field of view size, surface location, and sensor position relative to the Sun were described. Plans to quantify these differences for comparisons between CERES and radiometer fluxes were outlined.

Lou Smith (NIA) made a two-part presentation. The first part was a review of the comparison of measurements from Earth radiation budget instruments which have flown over the last 29 years. The second part discussed the NOAA-9 ERBE wide-field-of-view data set, which provided global coverage from February 1985 through 1992. The orbit precessed slowly and ERBE measurements could not be reliably processed to provide global coverage. However, at latitudes higher than 60°N, the NOAA-9 orbit covers near noon and complements the ERBS coverage. The NOAA-10 orbit gives Southern Hemisphere coverage near noon at high latitudes. Thus, ERBE data from these two spacecraft together with the ERBS satellite provide global coverage as originally planned for the ERBE mission.

Zhonghai Jin (AS&M) presented an analysis of model and observational results performed for determining if ocean surface albedos for SARB validation can be derived from SW flux measurements made at the CERES Ocean Validation Experiment (COVE) site. Both model results and observations indicated that ocean surface albedo for overcast condition show low variability with solar zenith angle (SZA) as well as sea state. Jin also reported that low values of upward and downward fluxes resulted in large uncertainties in computed surface albedos.

Joint CERES/GCSS/ARM Session

Bruce Wielicki gave an overview of CERES as a provider of climate quality integrated data for radiation, cloud, and aerosol research. He showed that CERES is 2 to 10 times more accurate than ERBE with capability for deriving TOA, surface, and atmospheric fluxes. CERES has made advances in calibration, angular sampling, temporal sampling, and the determination of clear-sky fluxes, surface and atmospheric fluxes, and cloud properties (from MODIS). CERES offers a range of scales and variables for testing models and overlaps with ERBE and other data sets to improve the quality of the radiation record through the 1980s and 1990s. Merging CERES data with vertical measurements from CALIPSO and CloudSat starting in mid 2005 will provide unprecedented opportunities for studying the radiative effects of clouds. The CERES Working Group leads presented overviews of data products and issues of particular interest to the ARM and GCSS teams. ARM researchers briefed the CERES team on their modeling efforts and field experiments including potential collaborations for the upcoming Tropical Warm Pool - International Cloud Experiment (TWP-ICE).

Jon Petch (Meteorological Office, U.K.) presented an overview of the activities of GCSS Working Group 4 (WG4) who are tasked to work on improving the parameterizations for precipitating convective cloud systems in GCMs and numerical weather prediction (NWP) models through an improved scientific understanding of cloud system processes. The group participants pursue these objectives by refining cloud-resolving model (CRM) and single-column model (SCM) simulations with observational data and transferring those refinements to the large-scale models. Petch outlined the objectives and plans for the next WG4 project, which aims to understand the processes involved in the observed transition of tropical convection between active and suppressed conditions.

George Tselioudis (Goddard Institute for Space Studies [GISS]) presented an overview of the current activities of GCSS WG3, whose focus is on improving the representation of extratropical layer clouds in GCMs and NWP models. The scope of activities includes improvements to boundary layer, convective, cirrus, and some polar clouds. Tselioudis presented results from an exercise to identify the deficiencies in the models by comparing GISS GCM and ECMWF NWP model results with ISCCP observations. He also presented results from an experiment in which ARM data were used to evaluate model results and improve parameterizations. Differences in ice concentration and ice microphysical properties were identified as important contributors to the deficiencies.

The joint session closed with a discussion of data needs, joint activities, and analyses, TWP-ICE collaborations, and the opportunities presented when the A-train becomes reality.

On the northwestern coast of Madagascar, the salty waters of the Mozambique Channel penetrate inland to join with the freshwater outflow of the Betsiboka River, forming Bombetoka Bay.

This image from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) on NASA's Terra satellite shows Bombetoka Bay just upstream of where it opens up into the Mozambique Channel, which separates Madagascar from Africa to the west.

NASA image courtesy the U.S./Japan ASTER Science Team, NASA/GSFC/METI/ERSDAC/JAROS.

Announcement

NASA DAAC Annual Publication Celebrates 10 Years

The 10th Anniversary edition of the NASA DAAC Annual, titled "Distributed Active Archive Centers: Supporting Earth Observing Science 2004," is now available from the National Snow and Ice Data Center DAAC. The DAAC Annual is a yearly, multidisciplinary publication that highlights applications and research uses of data from NASA's Earth Observing System satellites.

The 2004 edition highlights recent research on atmospheric and cryospheric processes, natural hazards, oceanography, and human influences on the environment and urban landscape. This edition also features a special 10th Anniversary section, which includes color-data images that illustrate improvements in instrumentation, DAAC product-user statistics, and an index of all DAAC articles published from 1994-2004.

Researchers working with data archived at the NASA DAACs are invited to contact the editor at *daaceditor@nsidc.org* to explore possibilities for developing a future DAAC article. For a free copy of the Annual, contact NSIDC User Services at *nsidc@nsidc.org*. A PDF version is also available online at *nasadaacs.eos.nasa.gov/articles/index.html*.

MISR Science Team Meeting

— David J. Diner, djd@jord.jpl.nasa.gov, NASA JPL
— Graham Bothwell, gwb@jord.jpl.nasa.gov, NASA JPL
— Roger Davies, roger@jord.jpl.nasa.gov, NASA JPL
— Ralph A. Kahn, kahn@jord.jpl.nasa.gov, NASA JPL
— John V. Martonchik, jvm@jord.jpl.nasa.gov, NASA JPL

A meeting of the Multi-angle Imaging Spectroradiometer (MISR) Science Team was held December 7-10, 2004 at the Pasadena Convention Center in Pasadena, CA. It provided an excellent opportunity to review enormous scientific progress made during the intervening year since the previous meeting, and was notable for the number of participants who attended a MISR Science-Team gathering for the first time.

The first afternoon of the meeting was devoted to parallel working groups involved with validating the top-of-atmosphere cloud (TC) products and aerosol/surface (AS) products. **David Diner** and **Kyle Miller** (JPL) introduced the sessions with a charge to the working groups and a presentation on Level 1 software status, respectively. In the TC session, presentations were made by **Catherine Moroney**, **Roger Davies**, and **Dominic Mazzoni** (JPL), **Larry Di Girolamo** (University of Illinois), **Jan-Peter Muller** (University College London), **Catherine Naud** (GISS), and **Gabriela Seiz** (ETH, Zurich). Highlights included the comparison of cloud heights with surface site observations, showing generally excellent agreement. Occasional differences were attributed to the presence of multilevel clouds and to thin cirrus. A low bias of about 600 m was noted in the MISR heights for some single cloud layers that may be related to the physics of multiple scattering. Anecdotal reports of high-latitude anomalies in cloud height were shown to be due to occasional high wind-speed blunders, or to the presence of thin cirrus, and not specifically to the latitude. Cloud masks agreed well against expert labeling and comparisons using Support Vector Machines. In the AS session, presentations were made by **Michael Bull**, **Ralph Kahn**, **John Martonchik**, and **Wedad Abdou** (JPL), **Alexei Lyapustin** (GSFC), **Hongliang Fang** (University of Maryland), **Bernard Pinty** (EC Joint Research Centre), and **Yuri Knyazikhin** (Boston University). Much of the discussion dealt with land surface property retrievals, which are performed self-consistently with MISR aerosol retrievals over land. Comparisons of MISR atmospherically corrected surface bidirectional reflectances have been compared with similar products derived using Aerosol Robotic Network (AERONET) aerosol retrievals applied to MISR radiances, and with AirMISR, Cloud Absorption Radiometer (CAR) and Portable Apparatus for Rapid Acquisition of Bidirectional Observations of Land and Atmosphere (PARABOLA III) surface products, with very good consistency. Additional validation studies included a comparison of MISR, MODIS, and Meteosat surface albedo products for Southern Europe and Africa, that showed very good agreement among the products and a limited comparison of MISR Leaf Area Index (LAI) with field measurements at selected EOS core validation sites.

The plenary session of the meeting convened for the next two-and-a-half days. **David Diner** (JPL) welcomed the participants, and introduced the meeting with a presentation recapping the tremendous and diverse accomplishments of the MISR team and its associates during the past five years. The instrument continues to work superbly, and multiangle, multispectral data products are being generated with excellent radiometric and geometric calibration. MISR takes unique approaches to measuring many Earth system parameters. Its cloud heights, for example, are insensitive to atmospheric temperature profiles and cloud emissivities, and its aerosol retrievals are highly accurate over land for the range of common particle types, making these important products for climate observing and air quality monitoring. MISR's ability to sense cloud and aerosol-plume heights, vegetation structure, and ice-surface roughness also makes it a unique complement to active sensors. MISR's many capabilities, and excellent instrument health, are now poised for extending the data record for studying long-term trends. Diner thanked the science and engineering team and their associates for their excellent work and dedication over the course of the mission.

Overall project status was presented by **Graham Bothwell** (JPL). During 2004, MISR obtained Local Mode data (highest resolution imagery in all channels) for several field campaigns, including the International Chemical Transport Experiment (INTEX-NA), the New England Air Quality Study (NEAQS-ITCD), and the Central Mediterranean Aerosol and Radiation Experiment (C-MARE). Special regional products and web-based data displays and access capabilities were provided for the United Arab Emirates Aerosol Experiment (UAE-2) and for the Rain In Cumulus over Ocean (RICO) campaigns. The number of peer-reviewed publications doubled since 2003. Based on an independent peer review, MISR's *Where on Earth…? Mystery Quizzes* are now an official part of NASA's Digital Library

for Earth System Education. In 2003 and 2004, respectively, the MISR TC and AS software teams each received a NASA Space Act Award from the NASA Inventions and Contributions Board. MISR's airborne counterpart, AirMISR, has been an invaluable tool in MISR calibration/validation and research since the start of the mission, but due to funding cutbacks was retired at the end of the 2004 flight season. Recent special deployments included data collections in support of the North American Carbon Program over several New England forests.

Terra Project Scientist **Jon Ranson** (GSFC) presented highlights from each of the instruments on the platform. Terra has completed more than 25,000 orbits, and there is a large user community. Currently, solid-state recorder anomalies have reduced recording capacity to the minimum needed to maintain the baseline science data collection rate. A plan to recycle power to the Solid-State Recorder (SSR) boards has been presented to NASA HQ. Ranson spent some time discussing the upcoming NASA *senior review* of Earth science missions. This will be used to define an implementation strategy and give programmatic direction for the next 2-4 fiscal years to those missions that have already reached or will shortly reach their nominal design life. **Diane Wickland** (NASA HQ) noted the importance of results that speak to impacts and/or outcomes for end users and that uniquely feature NASA's role.

John Martonchik (JPL) summarized the results from the surface-product validation session of the previous afternoon and recommended that the validation level of the surface radiometric products be upgraded from provisional to validated. It was agreed that the MISR surface albedos, determined from a single overpass, constitute an independent standard for cross-validating MODIS albedos, which require compositing about two weeks of data. The MISR Leaf Area Index/Fraction of Photosynthetically Active Radiation (LAI/FPAR) products are to be kept at the provisional level of validation for the time being since studies are still in progress at Boston University and University of Maryland.

The next few presentations focused on application of MISR products to specific science problems.

Bernard Pinty (JRC) discussed how multiangle surface-reflectance data, interpreted in terms of the Rahman-Pinty-Verstraete (RPV) bidirectional reflectance factor (BRF) model, could be used to infer certain canopy architecture parameters such as ground fractional cover and canopy gap fraction. **Anne Nolin** (Oregon State University) showed results of applying the RPV model to snow-covered forested areas, obtaining a good correlation between forest cover density and the *k* (bowl- or bell-shaped BRF) parameter of the RPV model. **Ranga Myneni** (Boston University) reviewed the higher scientific value of a variety of specific surface geophysical products when they are derived using simultaneous multi-angle measurements. These include:

- Surface albedo: An instantaneous measurement at a single solar zenith angle;
- Broadleaf forest LAI: Less prone to saturation;
- LAI/FPAR (in semi-arid ecosystems): Useful for detecting seasonal changes;
- FPAR: More accurate when the effects of diffuse light are included;
- Land cover classification: More accurate when angular-signature information is included;
- Biomass: Based on BRFs, which are more accurate using multi-angle measurements;
- Understory and ground FPAR: Improves heat budget calculations in climate models; and
- Normalised Difference Vegetation Index (NDVI): View angle independence.

Mark Chopping (Montclair State University) discussed using multiangle data to map community types and cover amount in large areas of the semi-arid southwestern U.S., with eventual emphasis on estimating the above- and below-ground carbon pools for these areas.

Leal Mertes (University of California at Santa Barbara [UCSB]) discussed the use of MISR data in the study of marsh-land dynamics, with the potential of providing information on water quality and sediment concentration, inundation extent, and identification of inundated vegetation and other surface types.

Julian Jenkins (University of New Hampshire) described his group's work using AirMISR data and neural-net analyses to predict forest-cover distributions, basal area and biomass, with the results compared against field measurements. These promising results indicate that an optical multiangle instrument should be included in any remote sensing instrument suite aimed at forest characterization.

Jon Ranson (GSFC) described a study where the Laser Vegetation Imaging Sensor (LVIS) provided forest canopy heights, and AirMISR data were used in a neural-net analysis to predict the canopy height. In light of encouraging results, the study has expanded to include MISR and GLAS comparisons, again with good correlations.

Nancy Ritchey (NASA LaRC) presented the Atmospheric Sciences Data Center (ASDC) User Services report for MISR. During 2004, the number of customers for MISR data increased to 252, and the number of organizations receiving MISR data has doubled, spread to over 25 states and 29 foreign countries. The volume of data distributed was 89 TB. A MISR Data User's Workshop is planned for the Spring AGU in New Orleans (May 23-27 2005). **Jeff Walter** (NASA LaRC) and **Earl Hansen** (JPL) presented ASDC production operations, archiving, and

data-reprocessing status and plans. Processing completion rates are close to 100%, and ASDC reprocesses MISR data at a rate of approximately 3.5 data years/year. There are no near-term archive space problems, but longer-term issues still need to be addressed. **Ken McDonald** (GSFC) provided an update on discussions leading to a plan to deal with this issue.

Carol Bruegge (JPL) reported on radiometric calibration status. The MISR absolute calibration has been tied to a 2000 vicarious calibration and verified using annual follow-on campaigns. Instrument stability has been maintained at the 1% level over mission life, using bimonthly activations of the on-board calibrator. Cross-comparisons with other sensors show the absolute radiometric scales to be typically within 4%. Improvements to the MISR band-to-band and camera-to-camera calibration were made during the past year, and this work has brought MISR radiometry to a mature state of development at all light levels. **Veljko Jovanovic** (JPL) discussed geometric calibration and georectification. For eight of MISR's nine cameras, image geolocation and co-registration are well within requirements. The 70°-backward viewing camera has been showing episodic pointing drifts, though a detailed investigation could not isolate a particular cause. Due to these pointing issues, this one camera has not been used within stereo wind-retrieval processing. An algorithm has been developed that should make the geolocation stability of this camera consistent with the other eight, and will enable using it as part of stereo wind retrievals.

The MISR aerosol optical depth product is at a high level of maturity as a result of many activities during the past year. Several presentations reviewed recent papers describing this body of work, covered work in progress to validate MISR-retrieved particle properties, and discussed applications of these products to terrestrial problems. **Ralph Kahn** (JPL) presented an overview of the MISR aerosol product-validation effort, the quantitative constraints placed on optical depth accuracy based on comparisons with coincident Aerosol Robotic Network (AERONET) data, initial steps and plans for aerosol microphysical property validation, and current upgrades to the MISR standard aerosol retrieval's aerosol climatology resulting from the validation work. **Olga Kalashnikova** (JPL) followed with a detailed presentation on new mineral-dust optical models, and resulting improvements in MISR aerosol retrieval coverage and accuracy. **Wei-Ting Chen** (Caltech) reviewed her work analyzing MISR sensitivity to size and single-scattering albedo for biomass burning type particles, and validation analysis underway using Brazilian field data from the Smoke Aerosols, Clouds, Rainfall and Climate (SMOCC) Campaign.

The discussion of applications began with **Yang Liu** (ENVIRON International Corporation) explaining how the combination of MISR column aerosol optical depth and aerosol vertical distributions predicted by the GEOS-CHEM chemical transport model are used to determine near-surface aerosol pollution (PM2.5) concentrations across North America. The results compared favorably with direct measurements made at Environmental Protection Agency monitoring sites.

Bin Yu (UC Berkeley) presented the initial steps of an international collaboration to monitor and predict particulate pollution in the vicinity of Beijing, China, first by correlating MISR aerosol optical depth results with *in situ* and sun photometer surface measurements, and then using MISR data to condition a regional aerosol transport model.

Larry Di Girolamo (University of Illinois) showed how MISR optical depth observations over India, during the winter months between 2001 and 2004, reveal a concentration of aerosol pollution in the state of Bihar, home to some 100 million people. He argued that a combination of topography, seasonal winds, population density, and fuel use conspire to produce this pollution cloud. Di Girolamo also discussed MISR participation the Rain in Cumulus over Oceans (RICO) field campaign, taking place in the western Atlantic near Antigua, and aimed at observing trade cumulus and their interactions with transported aerosols. He showed examples of how the data can be used to validate MISR cloud height determinations, and mentioned that the multi-platform data will also be used to study indirect effects of aerosols on clouds. Later in the day, Di Girolamo summarized the state of the various MISR cloud masks, noting good agreement and useful synergy among the various masks.

Alexander Sinyuk and **Oleg Dubovik** (GSFC) showed how they are combining AERONET data with MISR and POLDER radiances to retrieve a combination of aerosol and surface properties simultaneously. Constraining the retrieval with both upward and downward-looking observations leads to results that can reproduce all the observed radiances, and produces surface models very different from those currently assumed in the standard AERONET retrieval. Aerosol size distributions and single-scattering albedos are also altered for the fine-mode and non-spherical dust cases studied, over dark and bright surfaces, respectively.

Jens Redemann (NASA Ames) gave a detailed comparison between MISR and airborne sunphotometer spectral aerosol optical depth data for the INTEX campaign during summer 2004, and a more general comparison of MISR and MODIS Level 3 aerosol optical depth maps and zonal trends across the Pacific Ocean. For INTEX, the comparisons were well within uncertainties reported by other studies, whereas the Level 3 study showed significant differences, which he attributed to a combination of differences in sampling and in cloud

screening, coupled with retrieval differences that were systematically more pronounced when mineral dust was a significant component of the column aerosol mix.

Roger Davies (JPL) presented highlights of an improved height-resolved wind-retrieval algorithm, showing potential accuracies of 2 m/sec rms. He continued with a presentation of albedo differences over the four years of MISR data. Accounting for operational stability in the MISR radiometric calibration, the MISR spectral albedos appear very consistent over time, with any overall trend appearing to be less than 1%. This was followed by **Norman Loeb** (NASA LaRC), who presented results from a joint MISR-Clouds and the Earth's Radiant Energy System (CERES) study on albedos. He addressed the need to understand albedo uncertainty and the significance of cloud radiative forcing. The synergy between MISR and CERES, initially through narrow-broadband radiance relations, and then through multiangle analysis of variations in TOA albedos was also highlighted.

Ákos Horváth (JPL) presented results from a comparison of cloud liquid water retrieved using coincident MISR, MODIS and Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI) measurements. Agreement was reasonable for thinner water clouds, but the correlations were poor for thicker clouds, where heterogeneity, saturation and uncertain effective radius all present challenges to the retrieval techniques.

Gabriela Seiz (ETH, Zurich) presented results from a comparison of MISR and ASTER cloud height and 3-D reconstructions using advanced stereo-photogrammetric techniques. The operational MISR cloud heights were in excellent agreement with the more precise, localized ASTER retrievals for a case study over Switzerland. The use of all nine MISR angles was also demonstrated in reconstructing the profile of cumulus congestus over the ocean. **Céline Cornet** (JPL) continued the description of the same cumulus congestus case study, showing how the profile determined by Seiz could be used not only to describe the 3-D cloud geometry but also to reproject the MISR radiances onto the cloud surface as a prelude to comparison with three-dimensional radiative-transfer models.

Several **poster sessions** took place during the meeting, providing an opportunity for more informal interactions among the participants. Among the presentations: a study of scaling forest canopy carbon uptake using multiangular and hyperspectral remote sensing and ecological modeling by **Julian Jenkins** (University of New Hampshire); studies of recent changes in albedo on a Greenland outlet glacier and on the use of MISR to map forest-cover density over snow in Glacier National Park by **Anne Nolin** (Oregon State University); making existing surface albedo products compatible with the needs of land-surface models by **Bernard Pinty** (EC Joint Research Centre); a summary of MISR activities and preliminary results in Australian surface science applications by **Clare Averill** (Raytheon ITSS/JPL); a presentation on SpecNet (Spectral Network), a tool for satellite validation by **John Gamon** and **Yufu Cheng** (Cal State LA); detection of subpixel human-induced surface change using MISR multiangle imaging (reporting on work funded by the National Reconnaissance Office), case studies on upper tropospheric and lower stratospheric aerosols, and a sampling of news items about MISR in 2004 by **David Diner** (JPL); a study on what MISR observations from space can tell us about winds over ocean, making use of multiangle sun glint observations by **Enrique Gonzalez** and **David Fox** (JPL); investigation of microphysics vs. 3-D effects in cumulus clouds by **Paquita Zuidema** (RSMAS, University of Miami); improving polar-cloud detection by fusing MISR and MODIS information by **Tao Shi** (UC Berkeley); MISR cloud top height validation using ARM data by **Roger Marchand** (PNNL); using MISR data in the Intercomparison of 3D Radiative Codes (I3RC) project by **Tamas Varnai** (JCET, UMBC); field aerosol measurements needed to complement satellite multiangle aerosol observations by **Ralph Kahn** (JPL); aerosol strata in the troposphere over southern Africa by **J. J. Cumbane** (Rand Afrikaans Univ.); the Transport Atmospheric Pollutants Model and satellite/sunphotometer aerosol optical depths by **Alexander de Meij** (EC Joint Research Centre); using support vector machines and pattern recognition to classify aerosols and detect plumes by **Dominic Mazzoni** (JPL); and an innovative approach to data access for a diverse group of atmospheric scientists by **Nancy Ritchey** (NASA LaRC). A MISR tools demonstration was given by **Linda Hunt** (NASA LaRC), and a demonstration of the MISR data browser and analysis tool misr_view version 5.0 was given by **Charles Thompson** and **Tom Thaller** (JPL).

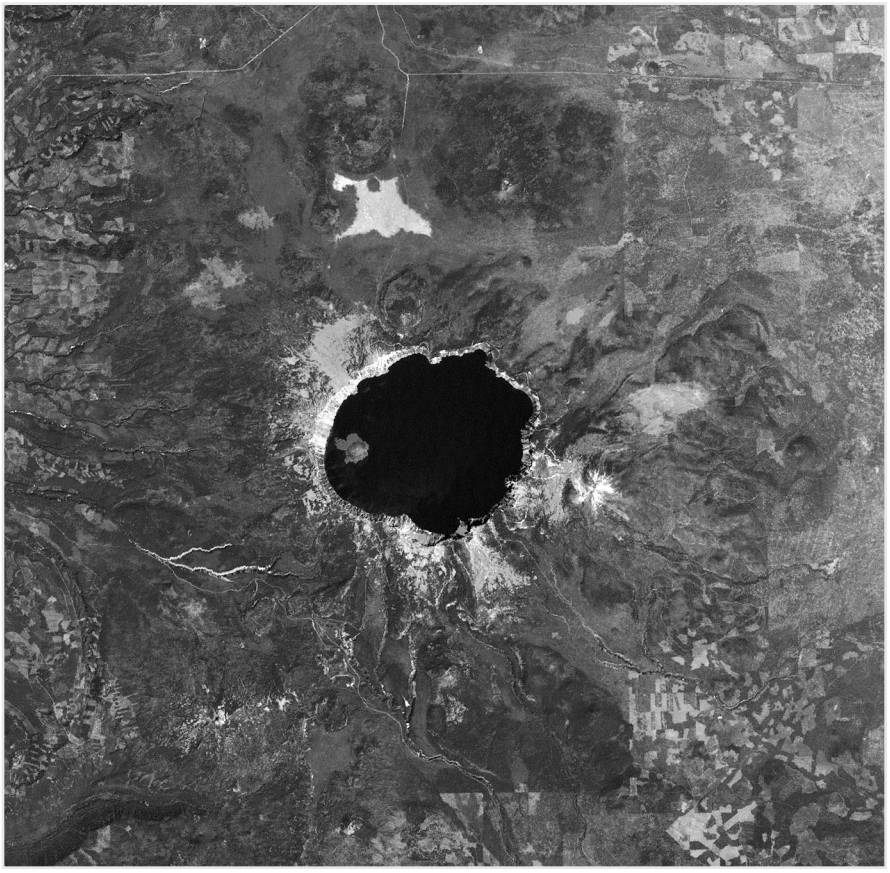
Kyle Miller (JPL) introduced a discussion on improvements to product formats and data access. **Michael Bull** (JPL) described the status of the simplified *summary product* capability, which involves new data ordering interfaces at NASA LaRC. During the past year, the subsetting/reformatting interface was upgraded so that users can order MISR data in conventional HDF-EOS format, i.e., without the MISR-specific stacked-block configuration. A joint effort currently under way by JPL and LaRC is to put in place a unified ordering/subsetting/reformatting interface. LaRC is building the web interface and archive search/retrieval system, and JPL is implementing the conversion and subsetting processes. Initial release is expected in early 2005. A discussion of additional capabilities for future upgrades was held, including the need for a multi-instrument matchup tool. **Brian Rheingans** (JPL) discussed new data analysis tools that are available for MISR. For example, a tool is now available (at *eosweb.larc.nasa.govPRODOCS/misr/tools/envi_tool.html*) that imports MISR Level 1B2 Ellipsoid and Terrain

stacked-block data into the Environment for Visualizing Images (ENVI) program. The data are automatically geolocated and the band information is correctly interpreted. The tool consists of a set of routines written in IDL that implements an ENVI User Function for working with MISR L1B2 data. Rheingans also described the concept of a software applications toolkit that users could exploit for codes they are developing, to assist with manipulating large amounts of data stored in MISR products. This application program interface (API) tookit would include routines for conversion and mapping, data query, data access, and map projection. Overall the concept was well received.

Michael Smyth (JPL) presented the Level 3 software and product status. Work is in progress for making globally-gridded aerosol particle properties and cloud albedos public. Regionally-mapped products were made available in support of the UAE-2 campaign. The Level 3 web page now has a Java applet that allows data to be viewed on a globe that can be rotated by computer mouse movements. Plans for the next quarter include a conversion capability from HDF-EOS to netCDF, and continuation of prototyping work on a MISR-based ISCCP-like product.

Thomas Ackerman (PNNL) discussed cloud data and climate models, focusing in particular on the question of how to use data to evaluate model performance. In general, modelers do not use cloud data at their native resolution. New directions are heading toward generation of frequency plots and multivariate (joint) distributions, statistically robust hypothesis testing, classification by dynamical regime, focusing on physical processes, and working at high resolution in both data and models. One motivation for generating a MISR *ISCCP-like* product is that ISCCP cloud-top heights are emissivity based, whereas MISR geometric heights can help resolve whether differences between ISCCP data and models are due to data or model problems. Members of the modeling community have been identified who are interested in collaborating on this development. Futher details on this activity were presented by **Amy Braverman** (JPL) and **Roger Marchand** (PNNL). Plans for the next six months include comparisons between MISR data and ISCCP DX data over the Pacific Ocean. These presentations were followed by a discussion on strengthening the connection to the modeling community.

David Diner polled the team on publications status and plans, upcoming meetings, and workshops. A list of relevant conferences in 2005 has been compiled, with abstract due dates. This is designed to help the team in planning for communicating MISR results at meetings. The meeting concluded with a discussion of how to further increase engagement with the science community.



Crater Lake National Park is one of the oldest parks in the United States, created in 1902 by President Theodore Roosevelt. The first lodge in the park opened in 1915, and the Rim Drive around the lake gave the public easy access to the entire lake in 1918. Soundings of the lake show it is exceedingly deep, reaching as low as 1,943 feet (592 meters), making it the deepest lake in the United States. The lake is in the former caldera of Mount Mazama, which erupted around 7,700 years ago. Native American legends from the area include accounts of this eruption.

This Landsat 7 image of Crater Lake National Park shows the lake from an unusual perspective: directly above. In the western (left) side of the lake, the small island visible is Wizard Island. Wizard Island is a cone that was rebuilt by volcanic processes in the mountain after the eruption that formed the caldera. Utlimately, the volcano became dormant, with no measured activity in the past several thousand years. East of the lake, (a little south of 3 o'clock), is the other summit peak in the image, Mt. Scott, which has just a trace of snow on its peak. The rim wall of Crater Lake is a natural barrier over which no river reaches. All the water in the lake comes from rainfall or snow that fell directly into the crater and accumulated over time. The only way water leaves the lake is through evaporation.

NASA image created by Jesse Allen, Earth Observatory, using data obtained from the University of Maryland's Global Land Cover Facility.

Decadal Study—Request for Information (RFI) from Community

— Rick Anthes, anthes@ucar.edu, University Corporation for Atmospheric Research
— Berrien Moore, b.moore@unh.edu, University of New Hampshire

As you may know, the Space Studies Board, in consultation with other units of the National Research Council (NRC), has begun a study to generate prioritized recommendations from the Earth and environmental science and applications community regarding a systems approach to the space-based and ancillary observations that encompass the research programs of NASA and the related operational programs of NOAA. The study will also consider such cross-agency issues as the development of an operational capability for land remote sensing.

The study, which will be carried out over a two-year period and organized in a manner similar to other NRC *decadal surveys*, seeks to establish plans and priorities within the sub-disciplines of the Earth sciences as well as an integrated vision and plan for the Earth sciences as a whole. It will also consider Earth observations requirements for research and for a range of applications with direct links to societal objectives. We have been appointed by the NRC as study co-chairs.

An open web site *qp.nas.edu/decadalsurvey* has been created to describe the study and to provide an opportunity for community input throughout the study process. In addition, a number of outreach activities are planned, including community forums. A forum was held at the Fall 2004 AGU meeting and at the January 2005 meeting of the American Meteorological Society (AMS). In addition, forums will be planned at the Fall 2005 AGU and the January 2006 AMS.

In order to obtain the greatest possible input of ideas from the community about potential mission concepts addressing Earth Science research and applications, we are soliciting input from the broad community. We are especially seeking ideas for missions or programs that are directly linked to societal needs and benefits.

The ideas and concepts received will be reviewed by one or more of the Survey's seven study panels, which are addressing the following themes:

1. Earth Science Applications and Societal Needs
2. Land-use Change, Ecosystem Dynamics, and Biodiversity
3. Weather (including chemical weather and space weather)
4. Climate Variability and Change
5. Water Resources and the Global Hydrologic Cycle
6. Human Health and Security
7. Solid-Earth Hazards, Resources, and Dynamics

Based on their potential to contribute to research and/or applications and societal needs, each panel may select one or more of the concepts for further technical and cost assessments. The panels will recommend, in priority order, a number of proposed missions for carrying out over the period 2005-2015, taking into account a set of established criteria as described below. The Executive Committee of the Decadal Study will interleave the panel recommendations, to produce a final set of recommended missions, in priority order.

Three categories of missions are solicited, following the approximate total (over lifetime of mission) cost guidelines:

1. Small missions that cost less than $200 M.
2. Medium-size missions that cost between $200 M and $500 M.
3. Large missions that cost more than $500 M.

Each of the proposed missions may contribute to research or operations, or both. **Note**: Mission costs refer to costs that would be incurred by NASA in current (FY05) dollars.

We invite you to write a concept paper for a new space-based mission or measurement, from existing or new vantage points, that promises to advance an existing or new scientific objective, contribute to fundamental understanding of the Earth system, and/or facilitate the connection between Earth observations and societal needs. We anticipate concepts that will range from free-flying spacecraft to instruments that might be included in follow-ons or as additions to the NPOESS and GOES series of spacecraft. Constellations of spacecraft or spacecraft that fly in formation with existing, planned, or future satellites may also be considered.

All responses will be considered non-proprietary public information for distribution with attribution. The concept papers should be no longer than ten pages in length and provide the following information, if possible:

1. A summary of the mission concept, including the observational variable(s) to be measured, the characteristics of the measurement if known (horizontal, vertical and temporal resolution), and domain of the Earth system (e.g., troposphere, upper-ocean, land surface).

2. A description of how the proposed mission will help advance Earth science and/or applications, or provide a

needed operational capability, for the next decade and beyond.

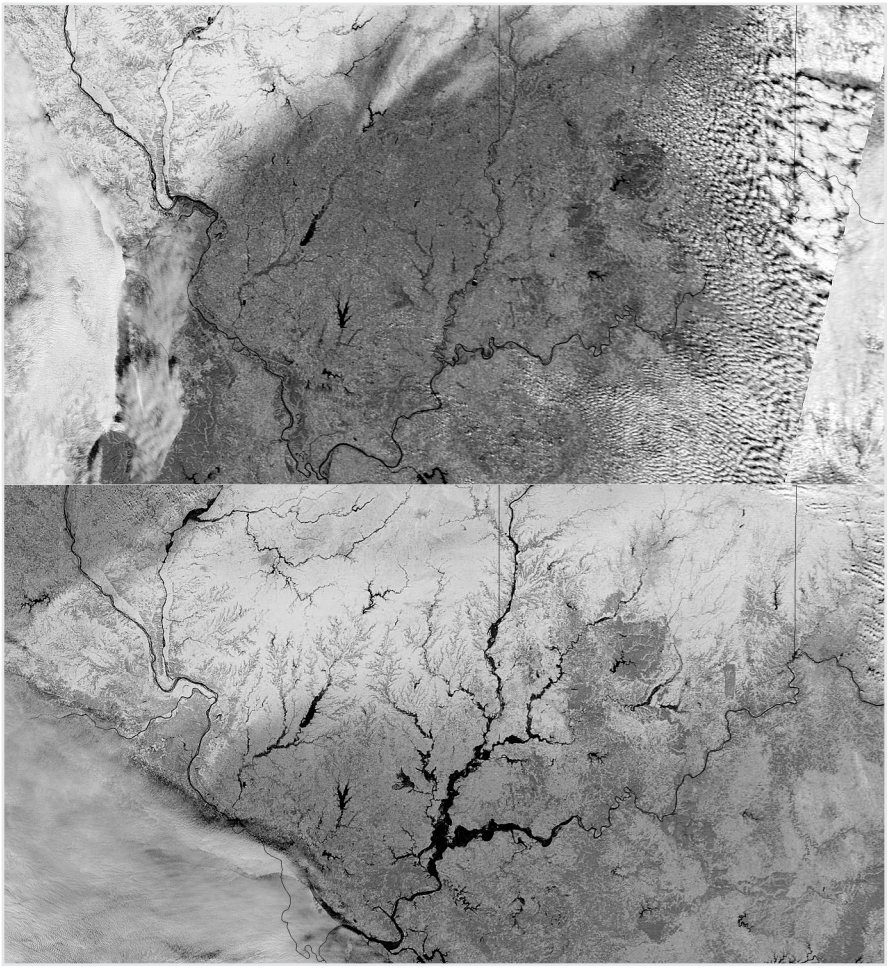
3. A rough estimate of the total cost (large, medium, or small as defined above) of the proposed mission over ten years. For operational missions the costs should include one-time costs associated with building the instrument and launch and ongoing operational costs.

4. A description of how the proposed mission meets one or more of the following criteria, which will be used to evaluate and prioritize the candidate proposals:

   a. Identified as a high priority or requirement in previous studies, for example NRC and WMO reports and existing planning efforts such as the International Working Group on Earth Observations (IWGEO: *iwgeo.ssc.nasa.gov*);
   b. Makes a significant contribution to more than one of the seven panel themes;
   c. Questions facing Earth sciences today (scientific merit, discovery, exploration);
   d. Contributes to applications and/or policy making (operations, applications, societal benefits);
   e. Contributes to long-term monitoring of the Earth;
   f. Complements other observational systems;
   g. Affordable (cost-benefit);
   h. Degree of readiness (technical, resources, people);
   i. Risk mitigation and strategic redundancy (backup of other critical systems);
   j. Fits with other national and international plans and activities.

Describe each proposed mission in terms of its contributions to science and applications, how the mission meets the above prioritization criteria, its benefits to society, technical aspects, schedule and rough estimate of costs. The description should provide enough detail that the potential value and feasibility of the mission can be evaluated by an independent group of experts.

For full consideration, please submit the concept paper by *April 15, 2005* via e-mail to: *rfi@nas.edu*. Questions about the RFI may be directed to the study director, Art Charo (*acharo@nas.edu*), or to us: (*anthes@ucar.edu*); (*b.moore@unh.edu*). You can also contact Dr. Charo by telephone at (202) 334-3477, or by fax at (202) 334-3701.

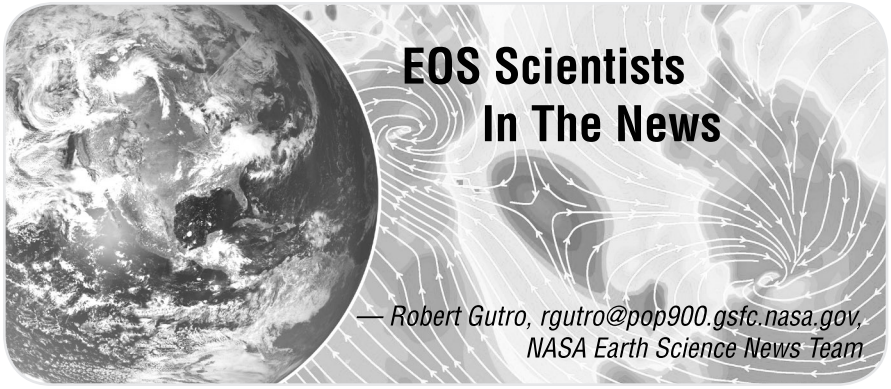


Heavy rain and snow have swollen the rivers of Indiana, Illinois, and Kentucky, pushing many past flood stage during the first two weeks of January 2005. The flooding occurred after several days of rain and snow fell on the already saturated ground of the U.S. Midwest. Since the water could not be absorbed into the soaked ground, it ran off as flood water. The storms were followed by warm temperatures, which melted the snow and produced further flooding. By January 17, some of the flooding had started to recede, but large tracts of land along the Ohio and Wabash Rivers were still under water.

The Moderate Resolution Imaging Spectroradiometer (MODIS) flying aboard NASA's Aqua satellite captured the bottom image of the flooded rivers on January 17. The Ohio and Wabash Rivers are the most noticeably flooded, but many other rivers are also much larger than they were on November 25, 2004. On November 25 (top), the Wabash River measured less than 3 pixels across in the 500-meter-resolution MODIS image. On January 17, the river spanned 18 pixels at its widest point, increasing its width from approximately 1.5 kilometers to 9 kilometers. The Ohio River similarly grew to a width of 13.5 kilometers in the top image.

Floods along the Ohio are not unusual, but the timing of this flood is. The Ohio River and its tributaries often flood in the spring when winter's snow melts and runs into regional rivers. This flood is occurring in the middle of the winter, which is unusual.

NASA images courtesy of the MODIS Rapid Response Team at NASA GSFC.



EOS Scientists In The News

— *Robert Gutro, rgutro@pop900.gsfc.nasa.gov, NASA Earth Science News Team*

Earth Gets a Warm Feeling All Over, February 8; *ABC Network News, Australian Broadcasting Corp., AlJazeera, Bloomberg News, CNN, Reuters, UPI,* and more. **Jim Hansen** and **Makiko Sato** (both of NASA/GISS) concluded that 2004 was the fourth warmest year in over a century. **Drew Shindell** and **Gavin Schmidt** (both NASA GISS) were also quoted in several articles on the study.

Get Ready for Rain Maybe, February 10; *Inland Valley Daily Bulletin, Pasadena Star-News*. **Bill Patzert** (NASA JPL) interviewed with Leo Greene, staff writer about the rains in California.

Soggy Season. Storm Drops More Rain on Saturated Southland, February 12; *Pasadena Star-News*. **Bill Patzert** (NASA/JPL) interviewed with Kimm Groshong, staff writer with the Pasadena Star-News, for a front-page article on California's rainy season.

Changes in the Arctic: Consequences for the World, February 6; *All American Patriots, Climate Change.com, Climnet, Hindustan Times* (India). **Jiping Liu** (Georgia Institute of Technology) discovered that the total Arctic sea ice extent and area decreased, respectively, by 11,910 and 13,660 square miles per year using ice data between 1978 and 2002. The feature also highlighted a study led by **Kevin Arrigo** (Stanford University). Arrigo surveyed the impact of declining sea ice on marine ecosystems in the Canadian Arctic.

NASA Research to Aid Federal Invasive Species Council Efforts, February 5; *Astronomie* (France), *Headliner News, Hospitals Worldwide Network, Moreover.com,* and more. Invasive species of plants and insects now have a new enemy: NASA satellites. Recently, NASA accepted an invitation to join the National Invasive Species Council (NISC) to help 12 other Federal agencies combat invasive species across the country by providing information from satellites. **Ed Sheffner** (NASA HQ) was quoted.

International Science Team Measures Arctic's Atmosphere, February 4; *Portsmouth Herald Local News* (NH), *Space Weekly, Spacewire, Spatial News*, and more. An international team of scientists embarked on a journey to improve modeling of global-scale air quality and climate change predictions by conducting high quality measurements of the Arctic region's atmosphere. The Polar Aura Validation Experiment (PAVE) gathered information to validate data from NASA's Aura satellite. **Michael Kurylo**, Program Scientist (NASA Headquarters), was quoted.

Siberian Fires Most Common Near People, February 3; *Earth System Scholars, EIN News, Physorg, SciCentral*, and more. Until now, most researchers assumed that lightning caused most of the fires that burned in Siberia. But a new study by **Katalin Kovacs** (NASA GSFC) and others used a NASA satellite to map where and when fires lit up over a three year period. The satellite showed that Siberian fires burned mostly near people.

NASA Research Balloon Makes Record-Breaking Flight, January 28; *Antarctic Connection, Interspace News, Science Daily,* and more. A NASA scientific balloon broke the flight record for duration and distance. It soared for nearly 42 days, making three orbits around the South Pole. **David Pierce**, Chief of the Balloon Program Office (NASA GSFC, Wallops Island, Va.) said the balloon carried the Cosmic Ray Energetics And Mass (CREAM) experiment designed to explore the supernova acceleration limit of cosmic rays, the relativistic gas of protons, electrons and heavy nuclei arriving at Earth from outside the solar system.

Scientists Studying Wintry Ice in Summer Clouds, January 28; Edmonton Observers Group (Canada), *Newmexicostate.Com, Noticias Info* (Spain), *Spacedaily*, and more. Scientists showed that their instruments can identify the ice crystals in clouds and now they can begin to classify the crystals. By learning to classify the ice crystals, these scientists like **Vincent Noel** (NASA Langley), hope to contribute to improving weather and climate models, the complex computer programs used to show future atmospheric conditions.

Scientists Take Big Steps to Measure Sunlight Reflected by Earth, January 19, *earthobservatory.nasa.gov*. **Michael King**, Earth Observing System Senior Project Scientist (NASA/GSFC), discussed his work to create snow-free albedo measurements of Earth's surface for the entire globe.

Satellite Data to Track Wildlife: Elephants in Space, January 17; Scientists from the Bronx Zoo-based Wildlife Conservation Society (WCS) in New York City have been monitoring endangered wildlife populations for more than 100 years. The WCS' recent use of satellite technology, sponsored by NASA, may revolutionize the way endangered wildlife in remote areas of the world are counted and monitored. **Eric Sanderson**, a WCS landscape ecologist, and

Richard L. Lattis, General Director of WCS' zoos and aquarium were quoted.

Students get NASA Lesson on Weather, January 14; *The Record, Northern New Jersey*. **Louis Nguyen** (NASA Langley), research scientist, gave a video conference lecture to students in Camden, New Jersey. The lecture, "Satellites: Tracking Weather to Your Front Door," taught the students how NASA scientists use weather satellites to gather and collect data about cloud cover, temperature, pollution and other phenomena. Nguyen is quoted: "I definitely enjoy what I do and want to share that information with the kids so that I can promote science. Hopefully they will grow up to be the leaders of tomorrow."

Watching Earth's Climate Change in the Classroom, January 10; *Forbes, Morien Institute, Night Sky Observer, Yahoo!News,* and more. Slashdot inspired over 9,000 downloads of the software, and crashed GISS servers! College and high school students can now see how Earth's climate is changing without leaving their computers. NASA and other organizations use NASA's global climate computer model (GCM) to see how Earth's climate is changing. **Mark Chandler** (NASA GISS) was quoted.

Saharan Dust Affects Thunderstorm Behavior in Florida, January 10; *Earth Changes TV, Mysan De* (Germany), *Space Times, Weather Outlook, WTOP-AM/FM Newsradio, Washington, DC, Yahoo! News*, and more. **Susan C. van den Heever** (Colorado State University) and colleagues found that dust affects the size of a thunderstorm's "anvil" or top, the strength and number of warm updrafts, and the amount of rain that builds up and falls from the convective thunderstorms.

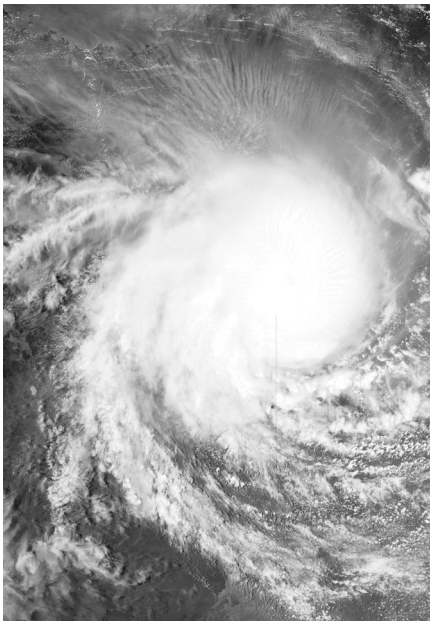
Record California Rainfall In January, January 2005; *ABC News Network, CBS News various Affiliates, Daily Breeze* (LAX to L.A. Harbor), *KPCC's* (89.3 FM radio) *Talk of the City program, KABC-TV, KNBC-TV and KUTV-TV (*Los Angeles), *KNX, KFWB and KABC Radio* (Los Angeles), *WCCO-TV* (Minneapolis), *La Canada Valley Sun, Lompoc Record, Los Angeles Daily News, Los Angeles Times, New York Times, Pasadena Weekly, San Diego Tribune, Santa Barbara Press-News, SpaceRef, USAToday, Weather Notebook Radio Network,* and many more. January brought torrential rains in Southern California, and by Tuesday, January 11th, 19 people had died. **Bill Patzert** (NASA/JPL) was presenting at the American Meteorological Society conference in San Diego at that time, and was "deluged" by reporters before, during and after the meeting.

Earthquake Affected Earth's Rotation, Day, Shape and North Pole, January 7; *Al Jazeera-TV, Assai Shim* (Japan), *Atlanta Journal Constitution, Baltimore Sun, Canadian TV Network, Discovery.com, the Hindu* (India), and more. NASA scientists like **Ben Chao** (NASA GSFC) and **Richard Gross** (NASA/JPL) using data from the Indonesian earthquake calculated it affected Earth's rotation, decreased the length of day, slightly changed the planet's shape, and shifted the North Pole by centimeters.

NASA Satellites See Gorillas In The Midst Of Extinction, January 6; A*frican Conservation, Haiti Sun, Science Recruitment, WTOP-AM/FM News radio, Washington, D.C.,* and more. NASA is now providing satellite imagery and funds to help conservationists track remote wild areas where until now it has been close to impossible to get information on land cover and land-use change. **Nadine Laborite**, head of the Africa Program at WHRC was quoted.

Changes In The Earth's Shape Could Be Tied To Climate Swings, January 6; *Big News Network, National Geosciences Database of Iran, Red Nova, UK Weather World,* and more. **Minkang Cheng** and **Byron Tapley** (University of Texas at Austin) used NASA satellite data and found the shape of the Earth appears to be influenced by big climate events that cause changes in the mass of water stored in oceans, continents and atmosphere.

'Milestone in Humankind's Search for Life': Science Magazine Hails Twin Mars Rovers as Breakthrough of '04, January 6; *Richmond Times-Dispatch, Richmond, Virginia*. The article discusses Science magazine's announcement and its implications for future research and exploration. Quotes **Joel Levine** (NASA Langley) senior research scientist and PI for ARES, the proposed Mars airplane project: "Water is the key to life. For life to have originated and evolved on Mars, the presence of water was needed. Now there is chemical evidence that salty seas existed on Mars sometime in its early history."



This image from the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua satellite shows Cyclone Harvey in the Gulf of Carpentaria at 4:30 UTC on February 7, 2005. At the time, Harvey had maximum sustained winds of 58 mph (50 knots) with maximum gusts near 75 mph (65 knots) and was moving towards the southwest at 15 mph (13 knots).

NASA image courtesy the MODIS Rapid Response Team at NASA GSFC. The image is available in additional resolutions.

Earth Science Education Program Update

—Ming-Ying Wei, ming-ying.wei-1@nasa.gov, NASA Headquarters
—Diane Schweizer, diane.schweizer@nasa.gov, NASA Headquarters
—Theresa Schwerin, theresa_schwerin@strategies.org, Institute for Global Environmental Strategies

ESSE 21 ANNUAL MEETING AUG. 4-7, 2005, FAIRBANKS, ALASKA

Sponsored by NASA through the Universities Space Research Association, ESSE 21 (Earth System Science Education for the 21st Century) is a collaborative undergraduate/graduate education program offering small grants to colleges and universities to engage a diverse interdisciplinary community of faculty and scientists in the development of courses, curricula and degree programs and sharing of learning resources focused on the Earth system and the application of that understanding for the classroom and laboratory.

The ESSE 21 Annual Meeting is an opportunity for program participants and the community at large to come together and share ideas regarding Earth System Science in the classroom, learning from each other as well as from Earth system scientists and educators and other invited speakers. The annual three-day meeting offers formal and informal opportunities to make presentations, demonstrate capabilities and techniques, report on progress and offer hands-on tutorials to acquaint attendees with the most recent innovations in Earth science learning.

The University of Alaska Fairbanks will host the 2005 ESSE 21 Annual Meeting from August 4-6 with an optional field trip on August 7. The theme of this year's meeting will center on Earth System Science and education opportunities of the upcoming International Polar Year.

This is an open meeting. Space will be available for posters/demos/presentations of your Earth System Science Education related content/programs/materials. Additional information will be available in the coming weeks at *esse21.usra.edu*.

MY NASA DATA: WORKSHOP FOR REASONING THROUGH THE USE OF EARTH SCIENCE DATA SETS, July 25-29, 2005

Application Deadline: April 8, 2005

NASA Langley Research Center will host a hands-on workshop designed for the grade 6-12 educator. Earth science teachers are particularly encouraged to apply. The workshop will focus on the implementation and use of Earth Science data sets developed for student researchers in grades K-12 as part of the Research, Education, and Applications Solutions Network (REASoN) program. The data sets, which will center on atmospheric science, are derived from the archive of remotely sensed data retrieved from the myriad of NASA's Earth Observing System satellites. Participating teachers will explore topics in atmospheric science, educational application of data sets, use of weather measurements, and hands-on classroom activities. Participants will also explore how data sets can be used to enhance their curriculum and how students can utilize these data for inquiry-based learning and research.

For more information, visit *mynasadata.larc.nasa.gov* or email Joyce Fischer, *j.d.fischer@larc.nasa.gov.*

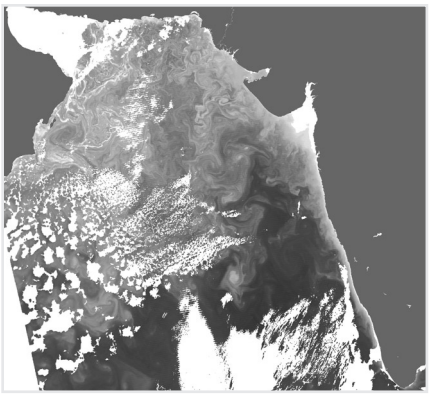
NASA FREE COMPUTER MODEL AVAILABLE TO CLASSROOMS

The Educational Global Climate Model (EdGCM), available for both Windows and Mac platforms, incorporates a 3-D climate model developed at NASA's Goddard Institute for Space Studies (GISS). It wraps complex computer modeling programs with a graphical interface familiar to most PC users.

The climate model runs on a desktop computer to allow teachers and students to conduct experiments identical to those scientists run on supercomputers to simulate past and future climate changes. EdGCM links the climate model to both a database and scientific visualization utilities, making it simpler to create and organize data and images. For more information about the EdGCM, visit: *www.edgcm.org*.

To download EdGCM software from the Internet, visit: *www.edgcm.org/EdGCMCooperative/Downloads.php*.

For more information about climate study in the classroom, please visit: *www.nasa.gov/vision/earth/everydaylife/climate_class.html.*



Ribbons and swirls trace out regions of high chlorophyll concentration in the Arabian Sea in this Moderate Resolution Imaging Spectroradiometer (MODIS) image, taken by NASA's Aqua satellite on February 22, 2005. High chlorophyll concentrations indicate that tiny ocean plants, called phytoplankton, are thriving near the ocean's surface. The plants can both nourish and destroy a marine ecosystem. NASA image courtesy Norman Kuring, MODIS Ocean Color Team.

Kudos

The American Meteorological Society bestowed awards on the following Earth-Sun System/EOS colleagues at its annual meeting held January 9-13 in San Diego.

Fellows

The honor of Fellow is given to an individual for recognition of outstanding contributions to the atmospheric or related oceanic or hydrologic sciences, or their applications, during a substantial period of years. Only two tenths of one percent of membership are approved as Fellows each year. In addition, winners of the AMS prestigious Rossby, Charney, Suomi, Sverdrup, Stommel, Brooks, and Abbe Awards are elected as Fellow. Following are Earth-Sun System/EOS colleagues elected.

- **Antonio J. Busalacchi Jr.**, Director, Earth System Science Interdisciplinary Center, University of Maryland
- **Thomas J. Jackson**, United States Department of Agriculture
- **Yoram J. Kaufman**, NASA Goddard Space Flight Center
- **Joan E. Rosenfield**, NASA Goddard Space Flight Center
- **William B. Rossow**, NASA Goddard Institute for Space Studies

Carl-Gustaf Rossby Research Medal

This award is presented to individuals on the basis of outstanding contributions to the understanding of the structure or behavior of the atmosphere. It represents the highest honor that the Society can bestow upon an atmospheric scientist. The award is in the form of a medallion. It was presented to the following Earth-Sun System/EOS colleague:

Jagadish Shukla, Professor, George Mason University, Fairfax, Virginia; President, Institute of Global Environment and Society, Inc., Calverton, Maryland "for fundamental contributions and inspired leadership in understanding the variability and predictability of the climate system on seasonal-to interannual time scales."

Jule G. Charney Award

This award is granted to individuals in recognition of highly significant research or development achievement in the atmospheric or hydrologic sciences. The award is in the form of a medallion. It was presented to the following Earth-Sun System/EOS colleague:

Graeme L. Stephens, Professor, Department of Atmospheric Science, Colorado State University, Ft. Collins, Colorado "for pioneering advances in radiation processes and their roles in climate."

Verner E. Suomi Award

This award is granted to individuals in recognition of highly significant technological achievement in the atmospheric or related oceanic and hydrologic sciences. The term *technological* is here used in the broadest sense; it encompasses the entire spectrum of observational, measurement, data transmission, and data analysis and synthesis methodologies. The award is in the form of a medallion. The following Earth-Sun System/EOS colleague was elected:

William B. Rossow, NASA Goddard Institute for Space Studies, New York, New York "for tireless efforts using multi-satellite observations to study clouds and their role in radiation and climate."

Clarence Leroy Meisinger Award

This award is given to an individual in recognition of research achievement that is, at least in part, aerological in character and concerns the observation, theory, and modeling of atmospheric motions on all scales. The award is given to young, promising atmospheric scientists who have recently shown outstanding ability and are under 40 years of age when nominated. The award was presented to the following Earth-Sun System/EOS colleague:

Steven C. Sherwood, Associate Professor, Department of Geology and Geophysics, Yale University, New Haven, Connecticut "for fundamental studies of the interactions among cumulus convection, aerosols and cloud microphysics, and large-scale dynamics."

Henry G. Houghton Award

This award is given to an individual in recognition of research achievement in the field of physical meteorology, including atmospheric chemistry. The award is given to young, promising atmospheric scientists who have recently shown outstanding ability and are under 40 years of age when nominated. The award was presented to the following Earth-Sun System/EOS colleague:

Mark Z. Jacobson, Associate Professor, Civil and Environmental Engineering, Stanford University, Stanford, California "for significant contributions to modeling aerosol chemistry and to understanding the role of soot and other carbon particles on climate."

The Award for Outstanding Achievement in Biometeorology

This award is given to an individual who has made outstanding contributions to the theory, teaching, and/or application of knowledge about interactions between the atmosphere and biological systems. Names of nominees are submitted by the Committee on Biometeorology and Aerobiology, with input from the Chair of the Agricultural and Forest Meteorology Committee, to the STAC Commissioner, who reviews the recommendations and then makes a recommendation to the Council for final approval. The award was presented to the following Earth-Sun System/EOS colleague:

John M. Norman, Professor, Soil Science and Atmospheric and Oceanic Science, University of Wisconsin-Madison, Madison, Wisconsin "for outstanding achievement in advancing the understanding of the soil, plant, atmospheric continuum, done in a spirit of generous cooperation with colleagues and students."

The Walter Orr Roberts Lecturer in Interdisciplinary Sciences

This award is given in recognition of significant contributions to the understanding of atmospheric processes through the effective interchange of knowledge between atmospheric science subdisciplines or between atmospheric scientists and scientists of other disciplines. The lecture is presented at an AMS Annual Meeting or an appropriate specialized conference and published in the *Bulletin*. Recommendation of a Lecturer is made by a panel composed of the chairpersons of the STAC committees providing nominations and a chair appointed by the STAC Commissioner. Nominations are solicited annually from the STAC committees by the STAC Commissioner. The award was presented to the following Earth-Sun System/EOS colleague:

Dennis P. Lettenmaier, Professor, Civil and Environmental Engineering, University of Washington, Seattle, Washington "for significant research contributions and leadership in fostering effective interchange of knowledge between atmospheric and hydrologic students."

The Editor's Award — *Monthly Weather Review*

This award is given to an individual who has contributed a referee's report of outstanding merit on a manuscript submitted for publication in one of the Society's journals. It draws attention to the fact that the quality of the Society's journals depends in a crucial way upon the reviewing process, and that this process is one to which a large segment of the scientific community contributes much time and painstaking effort, largely unheralded, in a spirit of selfless commitment to the ideals of accuracy and lucidity in scientific writing. The Publications Commissioner presents a list to the Council for approval. The award was presented to the following Earth-Sun System/EOS colleague:

T.N. Krishnamurti, Professor, Department of Meteorology, The Florida State University, Tallahassee, Florida "for consistently providing insightful and timely reviews that significantly benefited the *Monthly Weather Review* editorial process."

The Editor's Award — *Journal of Atmospheric and Oceanic Technology*

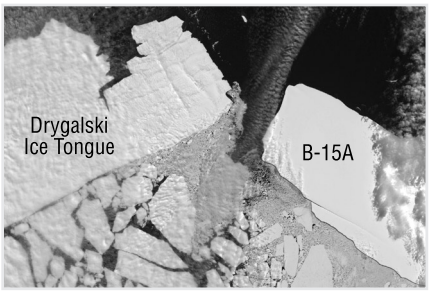
This award is given to an individual who has contributed a referee's report of outstanding merit on a manuscript submitted for publication in one of the Society's journals. It draws attention to the fact that the quality of the Society's journals depends in a crucial way upon the reviewing process, and that this process is one to which a large segment of the scientific community contributes much time and painstaking effort, largely unheralded, in a spirit of selfless commitment to the ideals of accuracy and lucidity in scientific writing. The Publications Commissioner presents a list to the Council for approval. The award was presented to the following Earth-Sun System/EOS colleague:

Lee-Lueng Fu, Senior Research Scientist, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California "for consistently thoughtful and detailed reviews, often returned well in advance of the requested due dates."

2005 American Meteorological Society President-Elect

Franco Einaudi, Director, Earth-Sun Exploration Division, NASA Goddard Space Flight Center

Franco Einaudi received his B.S. in electrical engineering from the Politecnico of Turin, Italy, and his M.S. and Ph.D. in electrical engineering (plasma physics) from Cornell University. He is presently the director of the Earth-Sun Exploration Division at the NASA Goddard Space Flight Center in Greenbelt, Maryland, where he also occupied the positions of head of the Severe Storms Branch (1988–90) and chief of the Laboratory for Atmospheres (1990–2000). As a NOAA employee, he served as a Fellow of the Cooperative Institute for Research in Environmental Sciences from 1969 to 1979. From 1979 until he joined NASA in 1987, he was a professor of geophysical sciences at the Georgia Institute of Technology. He has served the AMS on a variety of committees, including as a member and chair of the Committee on Atmospheric and Oceanic Waves and Stability, and as a member of the Committee on Mesoscale Processes. He has served our community in a number of assignments, including as a member of the Board on Atmospheric Sciences and Climate of the National Research Council. He is a Fellow of the AMS and the Royal Meteorological Society. He twice received the Meritorious Rank Award, a Presidential Rank Award in the Senior Executive Service.



In early January 2005, it appeared that the B-15A iceberg was on a collision course with the Drygalski Ice Tongue, the floating portion of a glacier flowing off the Scott Coast of Antarctica and into the Ross Sea. In mid- to late January, however, the berg's forward progress was arrested. After coming within just a few kilometers of collision, the big berg appears to have run aground in the shallow coastal waters and is no longer headed for Drygalski. NASA image created by Jesse Allen, Earth Observatory, using data provided courtesy of the Landsat Project Science Office and the USGS EROS Data Center.

EOS Science Calendar

March 22-24
MODIS Science Team Meeting, BWI Airport Marriott, Baltimore, MD. URL: *modis.gsfc.nasa.gov/sci_team/meetings/200503/index.html.*

May 3-5
AIRS Science Team Meeting, Pasadena, CA. Third Anniversary Meeting focusing on new results and capabilities. URL: *airs.jpl.nasa.gov*, click on Events/Meetings. Registration available in March.

May 3-5
CERES Science Team Meeting, Princeton, NJ. Contact: Gary Gibson, Gary.G.Gibson@nasa.gov.

May 17-18
ORNL DAAC User Working Group Meeting. Location TBD.

May 18-20
Earth Science Community Education Meeting, Orlando, FL. Contact: Theresa Schwerin, theresa_schwerin@strategies.org.

May 23-27
MISR Data User's Workshop, New Orleans, LA. Contact: Nancy Ritchey, N.A.Ritchey@larc.nasa.gov.

May 24-27
AVIRIS Science Workshop, Pasadena, CA. URL: *aviris.jpl.nasa.gov.*

October 3-7
International EOS/NPP Direct Broadcast Meeting, Benevento, Italy. Contact: *dbmeeting@backserv.gsfc.nasa.gov*

Global Change Calendar

April 24 - 29
European Geosciences Union General Assembly 2005. Vienna, Austria. URL: *www.copernicus.org/EGU/ga/egu05/index.htm*

May 16 - 18
Third International Workshop on the Analysis of Multi-temporal Remote Sensing Images (MultiTemp 2005). Biloxi, Mississippi. URL: *www.multitemp05.org*

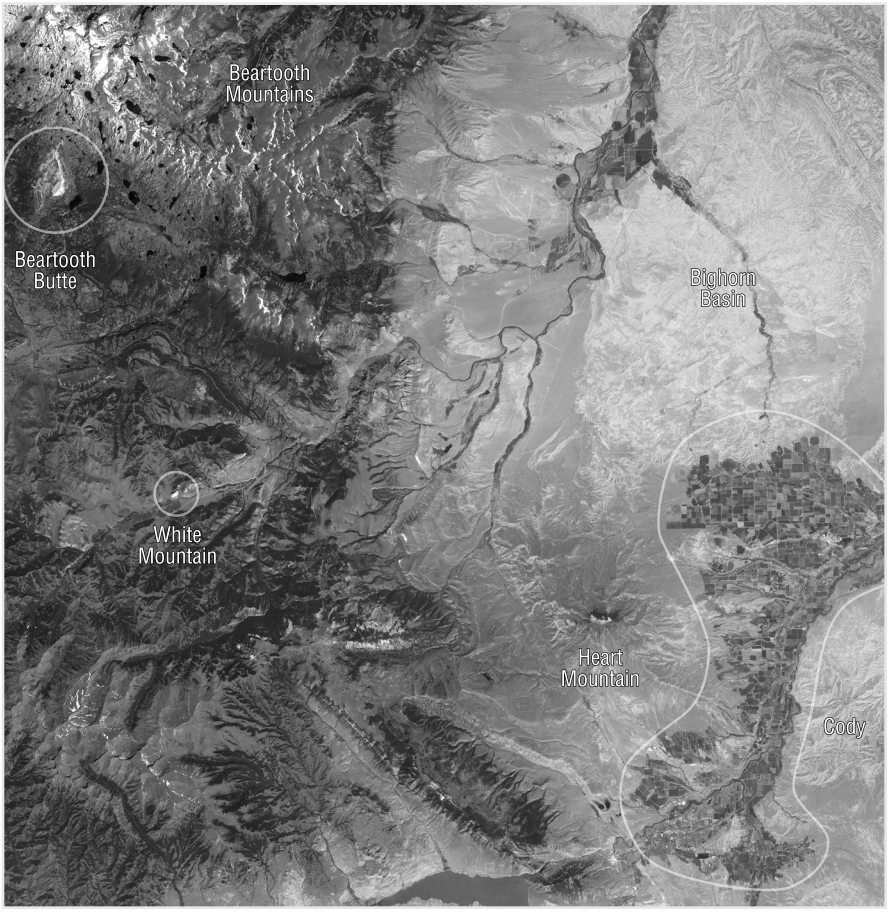
June 20 - 24
5th International Scientific Conference on the Global Energy & Water Cycle, Orange County, CA. URL *www.gewex.org/5thconf.html*

June 20 - 24
31st International Symposium on Remote Sensing of Environment, "Global Monitoring for Sustainability and Security," Saint Petersburg, Russia. Call for papers. URL: *www.niesrc.spb.ru/isrse/call_for_papers.shtm*

July 24 - July 29
Gordon Research Conference on Radiation and Climate. Colby College, Waterville, Maine. URL: *www.grc.uri.edu/*

July 31-August 4
SPIE's Earth Observing Systems X Conference. San Diego, California. URL: spie.org/conferences/calls/05/am/

September 19-22
Remote Sensing Europe 2005 Bruges, Belgium. Congress Ctr. SEC@Bruges. URL: *spie.org/conferences/calls/05/ers/*



Heart Mountain is a dramatic, 8,123-foot (2,476-meter) peak just north of Cody, Wyoming, on the floor of the Bighorn Basin. This image of Heart Mountain and the surrounding area was acquired on July 24, 2000, by the Enhanced Thematic Mapper plus aboard NASA's Landsat Satellite. NASA image by Robert Simmon, based on Landsat 7 data provided by the Global Land Cover Facility.

Code 900
National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

PRSRT STD
Postage and Fees Paid
National Aeronautics and
Space Administration
Permit G27

The NASA Vision

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

The NASA Mission

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

(affix mailing label here)

The Earth Observer

The Earth Observer is published by the EOS Project Science Office, Code 900, NASA Goddard Space Flight Center, Greenbelt, Maryland 20771, telephone (301) 614-5561, FAX (301) 614-6530, and is available on the World Wide Web at *eos.nasa.gov/earth_observer.php* or by writing to the above address. Articles, contributions to the meeting calendar, and suggestions are welcomed. Contributions to the calendars should contain location, person to contact, telephone number, and e-mail address. To subscribe to *The Earth Observer,* or to change your mailing address, please call Hannelore Parrish at (301) 867-2114, or send a message to hannelore_parrish@ssaihq.com, or write to the address above.

The Earth Observer Staff:

Executive Editor:	Steven Graham (steven.m.graham.2@gsfc.nasa.gov)
Technical Editors:	Renny Greenstone (rennygr@earthlink.net)
	Tim Suttles (4suttles@bellsouth.net)
	Alan Ward (alan_ward@ssaihq.com)
	Charlotte Griner (cgriner@pop900.gsfc.nasa.gov)
Design and Production:	Alex McClung (alexander_mcclung@ssaihq.com)
Distribution:	Hannelore Parrish (hannelore_parrish@ssaihq.com)

Notice

The Earth Observer will no longer be printed after the May-June 2005 issue. We will continue to produce new issues bi-monthly, but they will only be available on-line in PDF format at *eospso.gsfc.nasa.gov/earth_observer.php*.