Earth Observing System

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In this issue

EDITOR'S CORNER

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EOS Senior Project Scientist

Mr. A. Rick Obenschain, ESDIS Project Manager for the past two years, has agreed to become the first Center Chief of the Electrical Systems Center in the Applied Engineering and Technology Directorate (AETD) at Goddard, one of the largest of the engineering centers within AETD. This assignment will bring Rick's experience and capability to bear in a role that will have a very significant impact on a broad scope of Goddard's engineering activities.

To replace Rick in the ESDIS Project, Ms. Dorothy (Dolly) Perkins, currently the Deputy Director of AETD, has been appointed Deputy Associate Director of Flight Projects for EOS Operations, which includes management of the ESDIS Project. Dolly previously was responsible for information and operation systems at Goddard, and chaired the EOSDIS team during the Biennial Review of EOS in 1997. She will work with Chris Scolese, the Associate Director of Flight Projects for EOS, to manage the entire scope of the EOS project activity at Goddard Space Flight Center.

An Investigators Working Group (IWG) meeting is scheduled for October 19-21 at the New England Conference Center, University of New Hampshire, Durham, New Hampshire. The primary focus of this meeting is to learn of recent progress and exciting accomplishments obtained thus far by various EOS and related Earth science investigations, and to assess plans and expectations for EOS and EOSDIS over the next couple of years. In particular, science sessions will be organized around the following themes: (i) early science results and lessons learned in processing and distribution of data from the Tropical Rainfall Measuring Mission (TRMM), (ii) multidisciplinary aspects of El Niño, including modeling, observations, and human dimensions, (iii) recent results from moderate-resolution scatterometer measurements over land and ice surfaces, (iv) science results and lessons learned in data distribution from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS), (v) early results from the Joint Global Ocean Flux Study (JGOFS) Synthesis and Modeling Project, and (vi) climate change and public policy.

(Continued on page 2)

In anticipation of the launch next year of the EOS AM-1 spacecraft, the Project Science Office, in consultation with the cognizant science teams and scientific community, has completed and published brochures on AM-1, ASTER, and MISR. A MODIS and a Landsat brochure were previously completed. These documents are available from the Project Science Office and viewable from the EOS web site at http://eos.nasa.gov.

In July a new team started work in the Project Science Office to increase press coverage of the important global change research being conducted by EOS scientists. The Science News & Information team is headed by Steve Cole, former managing editor of the American Chemical Society's journal *Environmental Science & Technology* and the American Geophysical Union's Eos newspaper. Steve and his team will work closely with the *EOS* scientific community to identify potential news stories, write press materials and articles, and collaborate with public information offices both inside and outside NASA to disseminate this material to the media. The team will concentrate on identifying newsworthy research results moving toward journal publication or slated for talks at scientific meetings; major field campaigns also will be an early emphasis. They are already at work investigating topics and papers slated for the AGU Fall Meeting this December. Steve will be at the IWG meeting in October, so many of you will have a chance to meet him and welcome him onboard. See the box at right for more details on the Science News & Information team.

EOS Scientists in the News

— Steve Cole, EOS Science News & Information

◊ "Global Warming Assertions Enhanced," *Washington Post* (Aug. 13). **Frank J. Wentz** and Matthias Schabel (Remote Sensing Systems, Calif.) challenge the accuracy of a 17-year record of satellite measurements developed by **John Christy** (Univ. of Alabama) and others that shows no warming in the lower troposphere. The Wentz/Schabel *Nature* paper is also discussed by **James Hansen, Andrew Lacis** (NASA GISS), and coauthors in a "Perspectives" column in *Science* (Aug. 14, pp. 930-932).

◊ "West Antarctica's Weak Underbelly Giving Way?," *Science* (July 24, pp. 499-500). **Richard Alley** (Penn State Univ.) and **Mark Fahnestock** (Univ. of Maryland) discuss new research by Eric Rignot (NASA JPL) indicating weakening of the West Antarctic's Pine Island Glacier.

◊ "Coming to Grips With the World's Greenhouse Gases," *Science* (July 24, pp. 504-507). Researchers including **Dennis Baldocchi** (NOAA) and **Michael Apps** (Forestry Canada) discuss the state-of-the-science of the carbon cycle and implications for the international Kyoto climate change treaty. A related story on carbon dioxide monitoring towers includes comments by **David Hollinger** (USDA Forest Service), **David Schimel** (NCAR), **Riccardo Valentini** (Univ. of Tuscia), and **Steven Wofsy** (Harvard Univ.).

◊ "Fire Towers in Space," *Los Angeles Times*, July 16. Gene C. Feldman and **Jay R. Herman** (NASA Goddard) discuss the role of Earth-observing satellites in monitoring and combatting fires, including the recent fires in Florida.

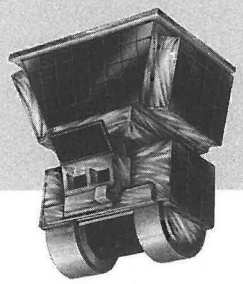
Other Recent Publications

A special **EOS AM-1** issue of the *IEEE Transactions on Geoscience and Remote Sensing* was published recently (vol. 36, no. 4, July 1998). The issue contains 24 articles on the platform and instruments, algorithms, calibration and validation, and science data analysis.

Send notices of recent media coverage in which you have been involved, and noteworthy new research results to Steve Cole, EOS Project Science Office, Goddard Space Flight Center, Code 900, Greenbelt, MD 20771; tel. 301-441-4146; fax 301-441-2432; email: scole@pop900.gsfc.nasa.gov.

Clouds and the Earth's Radiant Energy System (CERES) Science Team Meeting

— *Gary G. Gibson (g.g.gibson@larc.nasa.gov), NASA Langley Research Center*



The 17th Clouds and the Earth's Radiant Energy System (CERES) Science Team meeting was held at the NASA Langley Research Center (LaRC) in Hampton, VA on April 21-23, 1998. The major topics included an assessment of CERES and Visible Infrared Scanner (VIRS) data from the Tropical Rainfall Measuring Mission (TRMM) spacecraft, launched in November 1997; a review of progress on the validation for each subsystem; and CERES launch readiness for the first Earth Observing System (EOS) satellite.

Bruce Wielicki (LaRC), CERES Co-Principal Investigator, opened the meeting with an EOS program status report. The CERES instruments for EOS-AM and EOS-PM are on schedule. A slip in the EOS-AM launch schedule of at least 9 months is likely due to spacecraft control software problems. EOS follow-on mission concepts are due to the EOS Project in June. CERES will propose flying 6-spectral-channel instruments on small spacecraft with a downsized Moderate Resolution Imaging Spectroradiometer (MODIS) instrument in the same orbits as EOS-AM and -PM plus an orbit inclined at 67 degrees.

Bruce Barkstrom (LaRC), CERES Co-Principal Investigator, reviewed the processing strategy for getting CERES data into the archive. CERES will do all processing for TRMM and EOS-AM on the Langley TRMM Information System (LaTIS). Barkstrom outlined two options. Option 1 calls for full production of BDS (BiDirectional Scan), ES8 (ERBE-like S8 data product), ES9, ES4, and SSF (Single Satellite Footprint) products with immediate public access. Option 2 is to put BDS in full production now and provide validation month samples of ES8, ES9, and ES4, and validation-day samples of SSF. The Science Team endorsed the second option because it focuses on getting out the highest quality data.

CERES Instrument Status: TRMM and EOS-AM

Jack Cooper (LaRC) presented the instrument status report. The CERES instrument on the TRMM spacecraft is operating as expected with no problems. The two EOS-AM Flight Models (FM1 and FM2) completed thermal vacuum testing in March. FM1 performed nominally throughout the test, but FM2 experienced unexpected watchdog timer resets during the testing. The FM2 instrument was removed from the spacecraft and investigation into the problem continues. Delivery of FM3 and FM4 for EOS-PM is scheduled for December 1, 1998.

Robert B. Lee III (LaRC) confirmed that the Level-1 geolocated filtered radiances from the CERES instrument on TRMM meet accuracy requirements and recommended that these data be archived. Kory Priestley (LaRC) reported that the CERES zero-radiance offsets are an order of magnitude less than those for the Earth Radiation Budget Experiment (ERBE). The numerical filter designed to account for a slow transient found during instrument testing is now operational. The sensors and calibration sources are stable within 0.5% of the TRW ground calibrations.

CERES ERBE-like Data and Validation

The CERES instrument Level-1b data are ready to archive, but Level-2 ERBE-like data products are not ready. The ERBE-like-versus-VIRS scene identification results are currently inconsistent and require further validation. Studies have been prioritized to validate ERBE-like products by July 1998.

Bruce Wielicki reported on a recent presentation to the Department of Energy Atmospheric Radiation Measurement (ARM) Science Team on the need for continuous cloud and radiative flux data sets at the ARM sites to determine remote-sensing errors for a complete range of cloud and satellite viewing conditions. ARM surface sites for measurement of cloud properties and radiative fluxes are the most critical source of CERES ground truth data.

Richard Green (LaRC) presented validation results for the ERBE-like ES8 product. The processing uses the same code, Angular Distribution Models (ADMs), and Maximum Likelihood Estimation (MLE) technique as ERBE. The only changes are: the longwave (LW)

channel is replaced by a window channel, new spectral correction coefficients, and a smaller field of view. An examination of the data showed that LW at night is significantly higher than from the Earth Radiation Budget Satellite (ERBS). One possible cause for the difference could be the current El Niño event.

Norman Loeb (Hampton University) noted that the CERES ERBE-like MLE appears to overestimate daytime clear-sky frequency of occurrence relative to ERBE and VIRS. A comparison of SW radiance showed good agreement between CERES, ERBS, and the Scanner for Radiation Budget (ScaRaB) over the oceans after spectral correction change for clear scenes and CERES footprint degradation. Over land and desert, CERES was up to 10% lower than ERBS for clear scenes. The CERES spectral correction was shown to be highly sensitive to aerosol optical depth and surface reflectance over ocean due to a decrease in the spectral response function between 0.3 and 0.4 μm. The average SW clear-sky albedo over the tropics changes by about 5% due to differences in CERES and ERBS footprint size.

Kory Priestley showed 3-channel intercomparisons for CERES. He simulated the LW broadband (BB) radiance from the window channel measurements for high, cold cloud conditions. Results of the intercomparisons implied an inconsistency between the SW channel and the SW portion of the total channel. David Kratz (LaRC) used line-by-line and correlated k-distribution models to calculate top-of-atmosphere (TOA) radiances. A comparison of these results with linear fits to unfiltered total and filtered window channel data showed a discrepancy between the theory and measurements that could not be reconciled even by extreme changes to atmospheric ozone and water vapor abundance and temperature. Confidence in the simulated LW BB radiance remains low until this issue is resolved.

David Young (LaRC) validated the CERES ERBE-like monthly mean products using comparisons to other data sources. The monthly mean comparisons are consistent with inversion studies. CERES-derived clear-sky albedos that are 4.5% lower than ERBS over oceans and 6.5% lower over land were attributed, in part, to temporal sampling deficiencies. Differences in other LW and SW radiances were within the ERBE-like uncertainty limits.

Takmeng Wong (LaRC) examined the effects of the El Niño event on the outgoing clear-sky LW flux. The Fu-Liou radiative transfer model did reproduce the basic El Niño signal in the observed 1998 clear-sky LW radiation field using Reynolds sea-surface temperatures and National Centers for Environmental Prediction (NCEP) atmospheric parameters. The observed 1998 clear-sky LW anomaly is consistent with the temperature and moisture anomalies that accompany an El Niño event. Very little correlation was observed between changes in sea-surface temperature and the clear-sky LW El Niño anomaly.

Patrick Minnis (LaRC) gave an overview of the cloud mask and cloud property retrieval algorithms. Cloud retrieval using VIRS is still problematic, but a great deal of progress has been made. The VIRS thermal infrared calibration looks good. Work is continuing to unscramble problems with solar channel calibrations (still inconsistencies at 10% level, negative night time data). A fix to the VIRS 1.6-μm thermal leak is underway. The leak should not be a problem for cloud retrieval, but may be a significant problem for aerosol retrieval. Validation against ARM data in the Tropical Western Pacific (TWP) site has been delayed by ARM cloud lidar failure for January through March.

Data Systems: EOSDIS, LaRC DAAC, and CERES DMS

Robert Seals (LaRC) presented the status of the Langley TRMM Information System (LaTIS) for CERES data processing at the Langley Distributed Active Archive Center (DAAC). He discussed the wide range of DAAC services for producing, archiving, and distributing Earth science data.

Jim Kibler (LaRC) presented the CERES Data Management System (DMS) status. The CERES Release 2 DMS deliveries to the DAAC were completed before the TRMM launch. The TRMM Instrument Support Terminal worked well for monitoring post-launch operations. The instrument and ERBE-like subsystems are running continuously at the DAAC using the LaTIS. A decision has been made to use LaTIS for EOS-AM processing for CERES. Quick-look data from TRMM were posted on the World Wide Web on 12/31/97, only 4 days after the contamination covers were opened. The BDS data were made available to team members on 2/13/98, and the ES8 data were available on 3/13/98.

Invited Presentations

Bill Collins (National Center for Atmospheric Research, NCAR) compared satellite observations of visible and near-infrared radiation reflected by the ocean and atmosphere to fluxes calculated with a general circulation model. The Nimbus satellite data and model simulation are global and extend from 1979 to 1987. Under clear-sky conditions, the observed

and modeled spectral albedos are nearly identical. The observations and simulations diverge with increasing cloud albedo and cloud amount, regardless of cloud type or cloud phase. The differences between the model and satellite data occur for all tropical and mid-latitude ocean regions and exhibit minimal seasonal and interannual variability.

Lin Chambers (LaRC) gave an update on the CERES Students' Cloud Observations On-Line (S'COOL) Project. The S'COOL project has been selected for use in a joint French/U.S. demonstration of science education cooperation during a May visit by Mrs. Clinton to France. Dan Goldin and Bruce Barkstrom will be at a school in the Washington area. Schools in New York and France will also participate. [Ed. note: The demonstration took place as planned and was very successful.]

Working Group Reports

Instrument Working Group: Robert B. Lee III led the Instrument Working Group meeting in discussions of the accuracy of the CERES instrument on TRMM. Measurement accuracy and precision goals have been satisfied. The Working Group recommended that Level 1 filtered geolocated radiances be archived. On-orbit solar calibrations indicate sensor measurement precisions of the order of ±0.3%. On-orbit internal calibration results indicate measurement precisions of the order of ±0.7%. The flight offset variations are less than 1.5 counts. No coefficient changes will be made unless the validated gain changes are derived above 0.5% for LW radiances and 1.0% for SW.

Cloud Working Group: Patrick Minnis led the discussion of cloud retrieval, archival, data dissemination, and validation issues. He presented a long list of candidate algorithm improvements. The group unanimously agreed that Barkstrom's Option #2 was desirable, i.e., releasing oceanic cloud amounts and heights in July. The Cloud Working Group is still on track for validation of the cloud product by 2 years after launch.

Jim Coakley (Oregon State University) and Ron Welch (University of Alabama-Huntsville) will examine the gross characteristics of both the cloud mask and parameter retrievals when the data sets become available. Coakley is a member of the Indian Ocean Experiment (INDOEX) Science Team and will request that CERES have access to lidar imagery for validation purposes. Jennifer Francis (Rutgers University) initiated discussion about using alternative input data sources for constructing independent validation data. Xiquan Dong of Analytical Services and Materials, Inc. (AS&M) discussed the validation of CERES cloud products using ground-based measurements and retrievals. Jay Mace (University of Utah) presented results from lidar/radar retrievals for cloud properties. A full year of Southern Great Plains (SGP) retrievals is available for validation activities. Ron Welch showed automated regional and global contrail detection results from the Advanced Very High Resolution Radiometer (AVHRR). He also presented Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) validation sites that could be used for CERES.

Surface and Atmospheric Radiation Budget (SARB) Working Group: A joint meeting of the SARB and Surface-only Working Groups co-chaired by **Tom Charlock** (LaRC) and **David Kratz** addressed algorithm and validation issues. Several presentations focused on applications of radiative transfer codes to problems related to SARB and its validation. Charlock explained that the SARB system is an application of the Fu-Liou radiative transfer code to the Meteorology, Ozone, and Aerosol (MOA) data in which the computed fluxes are constrained by CERES TOA measurements. The latest version of Subsystem 5.0 was delivered to the DAAC on April 10, 1998, and results from test runs are already available.

Jim Stobie (GSFC/Data Assimilation Office, DAO) discussed the status and quality of Goddard Earth Observing System (GEOS)-2 products. Charlock suggested that DAO consider direct assimilation of Tiros Operational Vertical Sounder (TOVS) water vapor channel radiances into their system to improve the upper tropospheric humidity (UTH). Shi-Keng Yang (NOAA/NCEP) reviewed the status of the Stratospheric Monitoring-group Ozone Blended Analysis (SMOBA), which is used as the primary source of ozone data for CERES processing. Comparisons with other ozone products demonstrate that the vertical distribution, and temporal and horizontal variabilities of ozone are well captured by SMOBA.

V. Ramanathan (Scripps) presented the information available from the Indian Ocean Experiment (INDOEX) which can potentially be used for validation of CERES results. Nitchie Smith (AS&M) outlined the CERES ARM Validation Experiment (CAVE), a continuing program for validation of CERES results in the Oklahoma/Kansas region surrounding the ARM SGP site. CERES retrievals will be validated with site-measured values and those derived from radiative transfer models.

Fred Rose (AS&M) presented results of a study in which radiance computations

made with MODTRAN code and European Centre for Medium-Range Weather Forecasts (ECMWF) inputs were used to examine CERES/TRMM results. Differences were calculated between CERES measurements and MODTRAN computations for clear-sky filtered radiances for the window channel, and unfiltered radiances for broadband LW for a 1-hour swath over the eastern tropical Pacific Ocean. These differences were found to be very small for the filtered window radiance, but larger and negative for the unfiltered broadband radiance. Slight cloud contamination of CERES clear scenes was indicated. Rose also showed the dependence of the differences in unfiltered broadband radiances on the UTH.

David Kratz described an effort to revive and document the Staylor SW model for deriving surface albedos from CERES TOA measurements. These albedos will be used to convert the surface net SW retrievals made with the Li-Leighton algorithm into surface insolation. Anne Wilber (AS&M) presented global maps of surface emissivity for the CERES window channel, broadband LW, and the 12 bands of the Fu-Liou radiative transfer code. These maps were developed from available laboratory and field measurements of emissivities of various surface/soil/vegetation types.

Yong Hu (Hampton University) presented a method being developed for computing equivalent albedos of ocean surface as a function of solar zenith angle, wind speed, and cloud optical depth. The method uses the Cox-Munk wind speed-wave pattern relations and the DISORT radiative transfer code for simulating a large database of spectral radiances for a wide range of conditions. The radiance database will be used to develop parameterizations for equivalent surface albedo in terms of solar zenith angle, wind speed, and cloud optical depth.

Time Interpolation and Spatial Averaging (TISA) Working Group: David Young led discussions of software development, current temporal and spatial averaging studies, and ongoing CERES ERBE-like validation efforts. There was general agreement that the ERBE-like TISA algorithm is functioning properly. Currently, only Subsystem 3 (ERBE-like monthly) and Subsystem 11 (Grid Geostationary) have been tested and run at the Langley DAAC. All other Subsystems have been delivered and are awaiting data for testing. Doug Spangenberg (AS&M) presented results from an analytical method for estimating temporal sampling errors developed for testing ERBE non-scanner monthly mean fluxes. A discussion of possible uses of this technique for CERES raised the possibility of adapting the method for estimating the errors from poor temporal sampling of clear-sky fluxes. Lou Smith (Virginia Tech) and Bob Kandel (CNES, France) of the ScaRaB Science Team raised the possibility of producing a combined CERES/ ScaRaB monthly mean product once the second ScaRaB instrument is launched.

Investigator Presentation Highlights

Tim Alberta of AS&M (representing Tom Charlock) examined the transmission of SW radiation to the surface. CERES/ARM/GEWEX, Global Energy and Water-Budget Experiment (CAGEX) calculated clear-sky insolation is significantly higher than that measured by ARM instrumentation. A relationship between the bias between calculated and measured surface insolation and the humidity path length was not evident in CAGEX Version 2; however, a strong relationship exists between this bias and aerosol path length. **Robert Cess** (State University of New York at Stony Brook) compared atmospheric clear-sky SW radiation models to collocated ERBS and surface insolation measurements for 24 stations in southern Canada. The goal was to determine whether or not the results indicate anomalous clear-sky SW absorption. The two models are a satellite-to-surface algorithm for net surface SW and a column radiation model from the NCAR Community Climate Model (CCM3). Both models were in excellent agreement with the surface insolation measurements and there was no evidence that the models incorrectly portray any important physical processes.

Jim Coakley (Oregon State University) examined cloud layer structure from the Lidar In-Space Technology Experiment (LITE) and from AVHRR observations using a spatial coherence analysis method. He determined the frequencies of cloud-free, single-layered, and multi-layered cloud systems when viewed at different spatial scales. At an 8-km scale over ocean scenes, LITE results and spatial coherence analysis were in good agreement.

Steven Dewitte of the Royal Meteorological Institute of Belgium (representing Dominique Crommelynck) reported on the real-time radiation budget processing of METEOSAT data and suggested a strategy for comparison with CERES data from TRMM.

Leo Donner (GFDL) addressed cloud-ice sedimentation rates and the implications for cloud-radiative interactions. Current estimates show that the range of ice-terminal speeds is quite large with correspondingly large ranges in microphysical and radiative properties of convection. There is significant uncer-

tainty in estimates of ice fall speeds. High priority should be given to resolving this issue which is important for both cloud-system models and General Circulation Models (GCMs).

Qingyuan Han of University of Alabama-Huntsville (representing Ron Welch) summarized the varying definitions of effective particle size and their effects on satellite retrievals, particularly with respect to ice particles. The effect of assuming different shapes of crystals was also examined including the applicability of various definitions of effective particle size for these shapes.

Alexander Ignatov, UCAR Visiting Scientist (representing Larry Stowe, NOAA/NESDIS) presented results of a preliminary analysis of aerosol retrievals from TRMM/VIRS. They retrieved aerosol optical depth at 0.63 μm using the AVHRR channel-1 algorithm, and at 1.6 μm using an AVHRR channel-1-consistent algorithm with a correction for the 5-μm leak.

Anand Inamdar of Scripps (representing V. Ramanathan) reported on tropical- and global-scale interactions between water vapor, atmospheric greenhouse effect, and surface temperature. Their data do not support the suggestion that increases in tropical or global mean surface temperature would lead to a decrease in water vapor greenhouse effect by drying the mid to upper atmosphere. The global-scale sensitivity derived from the annual cycle is consistent with the magnitude of the positive feedback obtained by GCMs.

Bing Lin of Hampton University (representing Patrick Minnis) used SSM/I data, ARM ground observations, and a microwave radiative transfer model to investigate the temporal variations of land surface microwave emissivities and their relationships with soil moisture.

David Randall (Colorado State University, CSU) presented results from tests of a coupled ocean-atmosphere-land surface model. Problems due to cloud feedbacks developed when the model was coupled with the CSU GCM.

Nitchie Smith of AS&M (representing Lou Smith) showed the effects of randomness of radiation anisotropy on empirical bidirectional reflectance models. Bidirectional reflectance distribution functions (BRDFs) computed by dividing the average grid radiances by average albedo are in error due to a correlation between BRDF and albedo.

Shi-Keng Yang of Research and Data Systems Corporation (representing Jim Miller, NOAA/NCEP) presented recent modifications to the NCEP Reanalysis including a new SW code and surface albedo. Improvements to the NCEP model are still needed in several areas.

Science Team Logistics

The next CERES Science Team meeting is scheduled for September 15-17, 1998 at the State University of New York at Stony Brook, NY. Major topics will include assessment of CERES and VIRS data from TRMM, data validation and archiving, and CERES launch readiness for EOS-AM.

KUDOS

The following members of the EOS community were among the 36 distinguished scientists to be selected AGU Fellows in 1998:

Moustafa T. Chahine, Jet Propulsion Laboratory, Team Leader for the AIRS/AMSU/HSB instruments, "for creative research and scientific leadership in the remote sensing of atmospheres from space and in the study of the hydrologic cycle's role in global change."

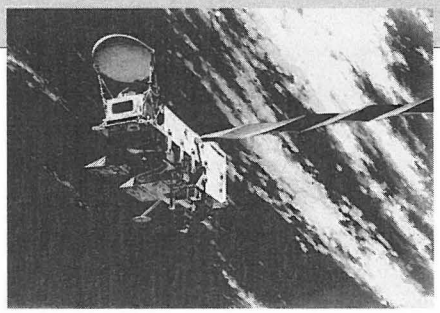
William B. Rossow, Goddard Institute for Space Studies, a co-investigator on the EOSP instrument and an EOS Interdisciplinary Investigation, "for fundamental contributions to the remote sensing of clouds from satellites and for his leadership in the development of the International Satellite Cloud Climatology Project."

Thomas J. Schmugge, U. S. Department of Agriculture, a team member of the ASTER Instrument Team, "for fundamental contributions in the theory and application of microwave and thermal infrared radiative transfer in the context of remote sensing of soil moisture and land surface temperature, and for outstanding leadership in large-scale hydrologic experimentation."

The Earth Observer staff and the EOS community would like to congratulate these people on their outstanding accomplishments.

EOS PM-1 Science Data Validation Workshop

– David Starr (starr@climate.gsfc.nasa.gov), NASA Goddard Space Flight Center
– Tim Suttles (tim.suttles@gsfc.nasa.gov), Raytheon Corporation



The EOS PM-1 Science Data Validation Workshop was held at the University of Maryland Inn & Conference Center during April 1-2, 1998. The purpose of the workshop was to help maximize the value and cost-effectiveness of the validation program for the PM-1 and SeaWinds missions by encouraging and facilitating coordination among the PM-1 and SeaWinds Science Teams. The workshop especially emphasized the new data products associated with AIRS/AMSU/HSB, AMSR-E, and SeaWinds and the potential synergy within and between those teams and with the MODIS and CERES teams as regards data product validation. The Jason-1 (altimeter) team also participated. Approximately 75 scientists attended.

Introduction

The background and programmatic context for the workshop were presented by Pierre Morel and James Dodge of the NASA Headquarters Earth Science Enterprise and by David Starr, EOS Validation Scientist.

The charge to the workshop was to generate information to assist in the development of a more-integrated and effective program by:

a) identifying requirements and planned activities that may be mutually beneficial for multiple teams and/or more than one data product, i.e., seek areas where synergy is likely and cooperative efforts advantageous, and

b) developing specific plans to compare related data products from different instruments.

The workshop began with plenary presentations on the draft PM-1 Instrument Data Validation Plans and several relevant EOS Interdisciplinary Science (IDS) investigations. Invited presentations were also given by community science programs having strong interfaces with the EOS PM-1 science studies. Instrument Validation Plans were presented by the AIRS/AMSU/HSB, AMSR-E, SeaWinds, and Jason-1 teams. Brief Validation Plan updates were later given in panel sessions by the MODIS-Atmosphere, MODIS-Land, and CERES teams. Presentations were given on the validation activities of the Data Assimilation Office and IDS Teams involving Soil Moisture (Thomas Jackson), Hydrology (Eric Wood), Cryosphere (Anne Walker of Goodison's Team), Ocean Surface (Tim Liu), and Clouds (Bryan Baum of Wielicki's Team). Invited presentations were given on the National Centers for Environmental Prediction Re-Analysis program (Glen White), the DOE Atmospheric Radiation Measurement (ARM) program (Ted Cress), the Global Energy and Water Experiment (GEWEX) Continental-Scale International Project (John Leese), GEWEX International Campaigns (Toshio Koike), and Buoy Programs (Peter Niiler).

Subsequent sessions of the workshop were organized into four Discipline Panels covering EOS data products for Meteorology, Hydrology and Snow, Cloud and Radiation, and Ocean and Sea Ice. These panels met during the afternoon of April 1 and morning of April 2 and gave summary reports in plenary session during the afternoon of April 2. This article summarizes the results from the Discipline Panel sessions. More-detailed reports prepared by the session Chairs and Rapporteurs are available from the EOS Project Science Office Validation internet site (http://eospso.gsfc.nasa.gov/validation.html).

Hydrology Products Panel

The Hydrology Products Panel was led by Dennis Lettenmaier, Chair, and Prasad Gogineni, Rapporteur. The panel identified data products to be produced from EOS PM-1 sensors of potential use in hydrologic studies. These are: surface (skin) temperature, surface air temperature, precipitation, surface soil wetness, snow-water equivalent, and snow areal extent. The panel discussions focused on the instruments from which the products will be derived, the anticipated nature of the products, current status of validation plans, opportunities and needs, and potential opportunities for inter-instrument comparisons. The precipitation

product (AMSR-E) was not addressed in detail in lieu of the intense validation activity presently occurring with the Tropical Rainfall Measuring Mission (TRMM).

Surface (effective skin) temperature (from AIRS)—Current validation plans involve using surface (point) measurements [via Atmospheric Emitted Radiance Interferometer (AERI)] of radiative temperature and emissivity, and HIS/MAS airborne measurements (to be flown on the ER-2). Pre-launch field observations at the Southern Great Plains (SGP) Cloud and Radiation Testbed (CART)/ARM site are planned for October-November, 1998. Similar post-launch activities are planned. Greater emphasis needs to be placed on ground-based spatial variability studies—there is some doubt that planned surface and airborne validation data will be sufficient to assess the impact of subgrid variability. Coordination with planned soil-moisture validation activities (e.g., SGP follow-on, see below) is apparently absent, notwithstanding that the same or similar sites are planned to be used for both. The possibility of comparisons/evaluations with a MODIS-derived effective temperature should be explored.

Surface air temperature (from AIRS)—Surface air temperature is used in hydrologic models for computation of evapotranspiration and (somewhat less commonly) for estimation of surface sensible heat flux. It is also useful as a surrogate for estimation of downward longwave radiation. Little information was available to the group about this product. However, there is an extensive global surface air temperature network, which presumably would be used for validation. Comparisons between the AIRS surface air temperature data product and similar products derived from the NOAA Polar-orbiting Operational Environmental Satellite (POES) sounders should be done.

Surface soil wetness (from AMSR-E)—Some pre-launch evaluation is possible via retrospective analysis of SMMR, which had an appropriate spectral band (currently operating SSM/I does not). More-effective C-band tests are expected to be possible once a C-band instrument is available for aircraft-based testing (expected within the next year). Completion of the simulator development and conduct of appropriate field observations are a high priority. Post-launch validation is planned via a SGP field campaign, perhaps similar to SGP-97, tentatively planned for 2001 or 2002. In addition, validation possibilities may exist with the GEWEX Hydrometeorology Panel transferability studies planned for the GEWEX Asian Monsoon Experiment (GAME) Tibet, where the current plan is to fly a Japanese AMSR simulator.

There is a need to develop a global stratification of areas with vegetation mass less than the apparent upper limit for C-band surface moisture estimation. Tom Jackson (USDA) has produced a map which could be a starting point for such a classification. Analysis of the vegetation data, along with other relevant factors (i.e., precipitation climatology, topography, and soil characteristics) could form the basis for identification of global "end points" for validation studies. Comparisons with data from a similar instrument to be flown on ADEOS-II should be conducted. Opportunities for comparison with other more-independent satellite measurements do not presently exist.

Snow areal extent (from MODIS and AMSR-E)—MODIS will be flown on EOS-AM as well as PM, and validation plans have been developed in connection with EOS-AM. Field campaigns will include intensive observations (primarily using aerial photography) over New England and the Midwestern U.S. Target test sites have been selected to provide contrast in subpixel vegetation characteristics, which are important at the MODIS resolution (approximately 0.5 km for snow products). Current plans for AMSR-E validation of snow-extent products are to use MODIS product intercomparisons.

There is some question as to whether validation using MODIS products will be sufficient for evaluation of AMSR-E snow extent, particularly given the differences in footprints. Such a validation approach is subject to any uncertainties associated with the MODIS product. In any event, there is a need for a well-thought-out AMSR-E snow-extent validation strategy. There is an opportunity for AMSR-E-MODIS product intercomparisons. An opportunity also exists for pre-launch comparisons for AVHRR and SSM/I snow-extent products.

Snow-water equivalent (from AMSR-E)—During the pre-launch period, the primary validation sets are snow-water equivalent derived from SSM/I, NOAA aircraft transects (primarily Midwestern U.S.) using gamma radiation sensors, and point observations from such sources as the National Resources Conservation Service (NRCS) Snow-water-equivalent Telemetered data (SNOTEL) network (western U.S. only) and Russian observations. In the post-launch period, the main validation data sets are expected to be derived from NOAA gamma flights, and perhaps, as yet unspecified, field campaigns.

There is a strong need for development of a comprehensive post-launch validation plan. This could be based on global stratification of areas where passive

microwave sensing is expected to be most useful (e.g., absence of wet snow). It is essential that the relatively large footprint be taken into account. This probably means manual transects, e.g., following the lead of the Canadians in collecting data for testing and validation of SSM/I algorithms. Coordination with other ongoing, large-scale hydrological activities, such as the Coordinated Extended Observing Periods (CEOPs) of the relevant GEWEX continental-scale experiments [Mackenzie GEWEX Study (MAGS), GAME-Siberia, GEWEX Continental-scale International Project (GCIP), Baltic Sea Experiment (BALTEX)] should be undertaken. Comparisons with data from a similar instrument to be flown on ADEOS-II should be conducted. Opportunities for comparison with other more-independent satellite measurements do not presently exist.

Cloud and Radiation Products Panel

The Cloud and Radiation Products Panel was led by Robert Curran, Chair, and Ming-Dah Chou, Rapporteur. The cloud and radiation products to be produced by the relevant PM-1 instrument teams are:

CERES: Upward, downward, and net longwave and shortwave fluxes at the top of the atmosphere, in the atmosphere, and at the surface; cloud cover, cloud top height, cloud top temperature, visible optical thickness, 11-μm emissivity, liquid or ice water path, and effective particle size.

MODIS: cloud cover, cloud top height, cloud top temperature, visible optical thickness, 11-μm emissivity, cloud liquid or ice water path, and effective particle size for multiple cloud layers.

AIRS/AMSU/HSB: Cloud cover, cloud top height, cloud top temperature, cloud liquid water path, and spectral longwave emissivity.

AMSR-E: Cloud liquid water path

The panel identified four areas as critical for validating the PM-1 global cloud and radiation products:

1. Validation using long-term intercomparisons of products retrieved from measurements made on PM-1 and measurements made at a growing number of surface sites;
2. Use of measurements from intensive field campaigns to provide physical process tests, characterize surface measurements and establish the validation linkage between individual satellite observations and measurements made at individual surface sites;
3. Intercomparison of products common to two or more PM-1 instrument teams; and
4. Validation using new active and passive satellite remote-sensing systems potentially available during the time frame of PM-1.

Long-term intercomparisons using surface sites—The surface radiation and cloud/aerosol measurement networks important for PM-1 validation include: DOE's Atmospheric Radiation Measurement (ARM) sites, the Aerosol Robotic Network (AERONET), World Climate Research Program's (WCRP's) Baseline Surface Radiation Network (BSRN) and Global Energy Balance Archive (GEBA), and NOAA's Surface Radiation (SURFRAD) network. NASA EOS is a major funding source for AERONET and contributes to BSRN and SURFRAD. In addition, Flux Networks for Validating EOS Terrestrial Carbon, Water, and Energy Budgets (FLUXNET), Long-Term CO_2 Flux Measurements of the Americas (AMERIFLUX), and other surface characterization sites with appropriate radiometric capability also provide useful data, some with NASA EOS funding support. CERES and other EOS teams also maintain other validation sites with very useful observations.

The panel recommends an increased number of sites, enhancements in the capabilities of existing sites, and operation of the sites to include all PM-1 satellite overpasses to greatly improve the validation of the cloud and radiation products. The lidar, cloud radar, and shortwave and longwave radiometers at the 3 existing ARM sites provide an excellent basis for validation. Similar sites in unrepresented climate regimes would significantly augment the present validation capability. This could be at least partially accomplished by the judicious enhancement of several AERONET sites to include the lidar, cloud radar, and irradiance measurements. Additional surface sites are required, especially in subtropical, mid- and high-latitude oceanic regimes. These additional sites might also be achieved by inviting the involvement of NOAA research ships and through international cooperation.

Intensive field campaigns—There are several near-term field experiments important to cloud and radiation validations prior to the launch of PM-1, which include: The First ISCCP Regional Experiment (FIRE) Arctic Cloud Experiment (May-June 1998)—collocated and concomitant with the Surface Heat Budget in the Arctic (SHEBA) experiment sponsored by NSF, and the GEWEX Asian Monsoon Experiment (GAME) in May 1998. Similar GAME experiments are planned for the 2001-2005 time period and the FIRE-Cirrus Regional Study of Tropical Anvils and Layers (CRYSTAL)

experiment is planned for the summer of 2001. Both the FIRE III Arctic Cloud Experiment and the CRYSTAL experiment are conducted in collaboration with DOE ARM sites, and the ARM program has planned a continuing series of intensive field observation experiments (IOPs) related to clouds and radiation. In the case of CRYSTAL, current plans also call for deployment of a floating ARM site, NOAA's R/V Ron Brown. MODIS and other EOS AM-1 teams plan a series of validation field experiments over the ARM site in Oklahoma that will likely continue into the PM-1 time period. These will typically be coordinated with ARM IOPs as with the recent MOPITT activity at the SGP site.

The panel recommends continued strong collaboration with field experiments to validate cloud profile information to be obtained by lidar, radar, and radiometers at the ARM and other sites which have these measurement capabilities. Additional airborne validation measurements would enhance the veracity of the measurements made at these surface sites. Future EOS/ARM field campaigns need to be planned to add to the validation database.

Intercomparison of PM-1 instrument team products—There are many cloud parameters which are produced by one or more of the PM-1 instruments. Since all of the instruments are on the same spacecraft, spatial and temporal matching of the common products should be relatively straightforward. The panel recommends that it is absolutely essential that the products from the various EOS teams be intercompared for accuracy, consistency, spatial resolution, and temporal resolution. The investigations to be conducted should include statistics of discrepancy among the products from different teams, nature of the discrepancy, and sources of discrepancy for various temporal and spatial scales. The scales should include daily, monthly, seasonal, interannual, regional, zonal, climatic regimes, and global.

Use of new active and passive satellite remote sensing—The best global sampling of cloud top height, cloud overlap, physical thickness, and ice water path (IWP) will come from new active and passive remote-sensing technologies as part of future Earth System Science Pathfinder (ESSP) and other, international, programs. Examples are improved measurements of cloud overlap using cloud lidar and radar, as well as improved measurements of ice cloud properties (IWP, effective particle radius). The panel recommends that, to the greatest extent possible, comparisons of spatially- and temporally-coincident measurements made by these new satellite systems should be made with appropriate PM-1 cloud and radiation products.

Ocean and Sea Ice Products Panel

The Ocean and Sea Ice Products Panel split into an Ocean section, led by Chet Koblinsky, Chair, and Michael Freilich, Rapporteur, and a Sea Ice section led by Claire Parkinson. Discussions were held on ocean data products from AMSR-E, MODIS, AIRS/AMSU/HSB, SeaWinds, and Jason-1. Also, ocean-related EOS IDS investigations were represented by Tim Liu, Peter Niiler, and Mike Freilich. Sea-ice related EOS IDS investigations were represented by Anne Walker. Specific data products discussed were sea-surface temperature, surface vector winds, sea-surface height, and sea-ice concentration, sea-ice temperature, and snow depth on ice.

Sea-Surface Temperature (MODIS, AIRS, AMSR-E)—Several complementary data sets are needed to provide an adequate sampling of the marine atmospheric conditions, principally water vapor, and sea-surface temperature (SST) for validating the MODIS and AIRS infrared channel measurements and derived SST fields. The validation strategy is two-fold: 1) highly-focused field expeditions using state-of-the-art calibrated spectral radiometers supported by extensive instrument suites to determine the state of the atmosphere to understand the atmospheric and oceanic processes that limit the accuracy of the derived SST, and 2) long-time-period, global-scale data sets to provide a monitoring capability that would reveal calibration drift and the consequences of sudden or extreme atmospheric events, such as volcanic eruptions, transoceanic transport of terrestrial aerosols, cold-air outbreaks, etc., on the global SST product.

Advantage will be taken of field programs occurring in the pre-launch and post-launch periods. In particular, the DOE ARM sites in the Tropical Western Pacific Ocean (TWP) and North Slope of Alaska and Adjacent Arctic Ocean (NSA-AAO) provide a valuable framework for MODIS validation. In addition to these long-term sites, use will be made of supplementary oceanic ARM sites that are intended to be operated on a short-term basis, or intermittently for specific research campaigns. Sites include the eastern North Pacific or Atlantic Oceans (probably the Azores), the Gulf Stream off the eastern U.S.A., and the Bering or Greenland Seas. Opportunities with other oceanic and marine atmospheric campaigns using ships, buoys, fixed platforms, aircraft, and island stations should be grasped as funding and resources allow. In particular, initialization cruises for ocean color (biology) conducted by MODIS-Ocean will provide excellent opportunities for SST validation.

Suitable EOS instruments for intercomparisons are ASTER, AMSR-E, and AIRS. Preliminary discussions have started with the ASTER team about cross-validation on the AM-1 platform. Coordinated validation of SST measurements needs to be worked with the AMSR-E and AIRS teams. Many other opportunities exist for cross-platform validation. For example, the Advanced Very High Resolution Radiometer (AVHRR) on the NOAA satellites, the Along-Track Scanning Radiometer (ATSR) on the ERS-2 satellite, the Advanced ATSR on the European Polar Platform of the Envisat-1 Mission, and the Global Imager (GLI) on the ADEOS-II satellite should all provide SST observations during the AM/PM missions.

Surface Vector Winds (QuikSCAT, SeaWinds)—The QuikSCAT and ADEOS-II SeaWinds scatterometers acquire direct measurements of global backscatter (ocean, ice, and land) from which near-surface vector winds over the ice-free oceans are calculated. Validation plans were discussed in the context of NSCAT experience, which included calibration and validation of backscatter and vector winds for the Seasat, ERS-1/2, and NSCAT scatterometer data sets. Initial SeaWinds validation will follow the NSCAT model. In this approach, measurements are quantified independently by analyses of data from distributed stable (isotropic) land targets, analyses of open-ocean data (i.e., buoy and ship data) in conjunction with operational surface wind products from the European Centre for Medium-range Weather Forecasts (ECMWF) and the National Centers for Environmental Prediction (NCEP), and directly by measurements from one or two specially deployed calibration surface stations.

Although microwave scatterometers are presently the only instruments that can accurately measure vector winds from space, multichannel microwave radiometers such as AMSR-E and altimeters such as Jason-1 can measure near-surface wind speed. Both the radiometers and altimeters also acquire additional environmental information (such as integrated atmospheric water vapor and surface wave height) that is useful for complete validation of the scatterometer velocity data over the full range of parameters. The presence of AMSR and SeaWinds on the ADEOS-II spacecraft will allow direct intercomparison opportunities.

In addition to the planned QuikSCAT and ADEOS-II SeaWinds validation, three scientifically-important validation-related activities must be addressed:

(1) Quantification of the accuracy of spatially- and temporally-gridded products (Level 3) developed from swath scatterometer (and other instrument) measurements;
(2) Validation of algorithms and multi-instrument backscatter corrections and wind data, especially for joint scatterometer/microwave radiometer retrievals; and
(3) Determination of the effects of subsidiary geophysical quantities (such as non-equilibrium long waves, surface films, and atmospheric surface layer stratification) on the accuracy of the scatterometer measurements.

Of these, validation of the Level-3 products is by far the most important and scientifically challenging. The participation of IDS teams and other non-instrument scientists in the development of proper Level 3 requirements is essential. The development and validation of low-cost drifting buoys, and their dense deployment during initial satellite post-launch validation periods, may allow issues related to small-scale spatial variability to be addressed directly. In addition, acquisition and interpretation of comparison data for extreme wind conditions, both high (> 20 m/s) and low (< 3 m/s) wind speeds, is very important for the validation of the satellite measurements over the full range of climatically-important conditions.

Sea Ice (AMSR-E and MODIS)—AMSR-E passive-microwave measurements will allow daily calculation of sea-ice coverage under most weather conditions at a horizontal resolution of about 20 km. Planned standard AMSR-E products include sea-ice concentration and temperature and snow depth on sea ice. MODIS visible and infrared measurements will allow a much finer (1 km) resolution than the AMSR-E products, but will be hindered by clouds, thereby limiting determination of the sea-ice coverage to cloud-free locations. The MODIS sea-ice product will be an indication of the presence or absence of ice in each 1-km cloud-free polar-ocean pixel.

Validation of the sea ice products will include *in situ*, aircraft, and especially inter-satellite comparisons. Pre-launch algorithm validation will use SSM/I data and take advantage of two major field expeditions, including the 1998 FIRE-III Arctic Cloud Experiment and the 1999 Antarctic Zonal Experiment (ANZONE). Pre-launch inter-satellite comparisons for validating the derived SSM/I sea-ice concentrations will be made with NOAA Advanced Very High Resolution Radiometer (AVHRR) and Canadian Radarsat measurements. In the case of MODIS, the plan is to validate EOS AM-1 MODIS sea-ice measurements with *in situ* measurements in the Southern Ocean in January and February 1999 in conjunction with a National Science Foundation (NSF)-

sponsored cruise. Due to the delay in AM-1 launch, this effort will necessarily rely on validation transfer via AVHRR on NOAA POES. Additional post-launch opportunities will be sought. Comparisons will also be made with observations from the Landsat-7 Enhanced Thematic Mapper Plus (ETM+), the European ERS-2 Synthetic Aperture Radar (SAR), and the Canadian Radarsat.

Post launch, the primary initial validation of the AMSR-E sea-ice products will be through comparisons with the continuing SSM/I measurements. There will also be comparisons with the ADEOS-II AMSR, expected to be launched in the same time frame as the PM-1 AMSR-E, and with the ADEOS-II Global Imager (GLI). Validation of the PM-1 MODIS sea-ice measurements will begin with comparisons to the AM-1 MODIS measurements and the corresponding Landsat ETM+, SAR, and Radarsat measurements. During this workshop, an important coordinated activity was initiated between the MODIS and AMSR-E sea-ice teams. A MODIS Airborne Simulator image, developed by the MODIS team, immediately suggested to the passive-microwave team the possibility of using the MODIS sea-ice product as validation for the AMSR-E sea-ice concentrations.

The present plan concentrates on validating the sea-ice concentration product. The AMSR-E sea-ice temperature and snow depth on sea-ice products must also be validated. In the case of snow depths, the working-group consensus was that the best means of validating snow depths would be through aircraft flights with as-yet-undeveloped step-frequency radars and laser altimeters, in conjunction with *in situ* surface measurements. In the case of AMSR-E-derived ice temperatures, comparisons should also be made with *in situ* surface measurements and with AVHRR- and MODIS-derived surface temperatures, although these will require the development of appropriate functional relationships between these satellite-derived surface temperatures and the actual ice temperatures. In view of the current emphasis of the AMSR-E team members on the validation of the ice-concentration product, it is felt that the validation of sea-ice temperatures and snow depth on sea ice would be particularly relevant for the planned PM-1 Validation NASA Research Announcement.

Sea Surface Height—Studies have shown that the mean surface height from TOPEX/Poseidon (T/P) and Jason-1 can be validated at the cm level using data from a fully instrumented oil platform (Harvest) located directly in the path of the repeating satellite ground track off the coast of central California. Using data from the Harvest facility, studies have successfully explained bias and drift in the T/P sea-height measurements as being associated with the on-board radiometer data which are used to correct the altimeter range for the effects of wet tropospheric path delay. Thus, a coordinated effort at calibration and validation of water-vapor measurements during the EOS PM era is needed. A focused cross-instrument sub-team should meet within the next year to outline a strategy for meeting the needs of all instruments. A secondary issue is the potential for measuring surface currents by combining geostrophic flow estimates from Jason-1 with winds derived from QuikSCAT and ADEOS-II SeaWinds. A combined group of Jason-1 and SeaWinds investigators will be working on this problem. Validation of this effort should be addressed in the EOS PM Validation NASA Research Announcement.

A primary concern is the longevity of the primary verification site at Harvest, data from which have been collected continuously since 1992. The Jason-1 project will work on this issue, and will explore alternative means for maintaining a permanent validation presence at or near this location. In addition, the impact on validation of the differences between *in situ* point measurements (e.g., tide gauges) vs. satellite spot averages (e.g., altimeter footprint) requires attention. Ensuring adequate funding for this validation component within the Jason-1 instrument team is a concern.

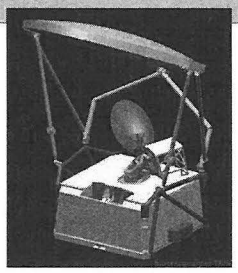
Recent comparisons of surface-height estimates from ocean-circulation models, including assimilated temperature data, with T/P for the tropical Pacific show that model-based and altimetric measurements are quite comparable. Typical differences of monthly-averaged values over 100-to-200 km squares are within 3 cm rms, whereas altimeter validation with tide gauges is at 2-to-3 cm rms in this region. Clearly, an accurate representation of the gridded field is required, as well as its error covariance, in order to provide added value to assimilation systems or to use independently to assess the accuracy in ocean estimates. Efforts to validate and assess the accuracy of Level-3 altimeter products have been limited.

Conclusion

The participants agreed that the workshop was very fruitful and had already stimulated new collaborative activities among the EOS Instrument Teams. David Starr, EOS Validation Scientist, and Claire Parkinson, PM-1 Platform Scientist, were very pleased with results of the workshop and expressed their gratitude for the excellent contributions of the attendees.

EOS PM-1 Advanced Microwave Scanning Radiometer (AMSR-E) Science Team Meeting

— E. Lobl (elena.lobl@msfc.nasa.gov), AMSR-E Science Team Coordinator, Earth System Science Laboratory, University of Alabama in Huntsville; EOS PM-1 AMSR-E homepage: wwwghcc.msfc.nasa.gov/AMSR



An AMSR-E Science Team meeting was held on July 7, 1998 at the Sheraton Hotel, Seattle, WA, in parallel with IGARSS. The main purpose of the meeting was to give our team members a chance to present their latest research results. Besides usual team business, there was a presentation on ice sheets by D. Winebrenner, Applied Physics Laboratory (APL), University of Washington, Seattle, WA, and on the status of the Polarimetric Scanning Radiometer (PSR) by A. Gasiewski, NOAA Environmental Technology Laboratory (ETL), Boulder, CO.

Paul Hwang (EOS PM Project Office) gave the status of the PM project, including the status of the instruments that will fly on the PM-1 spacecraft. The successful completion of the common spacecraft Critical Design Review (CDR), at TRW, in Redondo Beach, CA, allows an on-schedule start of the instruments integration and test, in June 1999. All instruments are on schedule for delivery to TRW. NASDA held a delta CDR for AMSR-E in early July, with the instrument delivery dependent on the outcome out of delta CDR.

Dawn Conway (AMSR-E Software Integrator) showed a revised data products diagram, a Level 2 product software summary, and a listing of all needed ancillary data files. AMSR-E data processing, which will be done at the Marshall Science Investigator-led Processing System (SIPS), will consist of 3 sub-processes. These sub-processes will be running independently of each other, with their eventual merging into one process by launch time.

D. Winebrenner (University of Washington) presented results of his recent research on snow accumulation rates in Antarctica using the 4.5-cm emission: the annual snow deposition in Antarctica is equivalent to 5-7-mm change in the world sea level. He is anxiously awaiting the AMSR-E data, the first 4.5-cm microwave data since SMMR in 1987, to confirm his analysis and to observe any changes that occurred in the region.

The Science Data Validation Plan summary was discussed briefly. The new version of the plan will be online in August.

A. Gasiewski (NOAA ETL, Boulder, CO) presented the status of the PSR, the instrument that he designed while a professor at Georgia Tech. He also showed some preliminary data taken with the instrument over the Labrador Sea in March 1997. Since that flight, Gasiewski has replaced the warm calibration target, and will fly the PSR on the DC-8 during CAMEX-3, out of Patrick AFB.

A. Chang (Goddard Space Flight Center) discussed a new approach for the snow retrieval algorithm. He plans to use a 'snowpack ensemble' approach where ensemble brightness temperature is generated based on snowpack profiles (depth, density, grain size, and temperature). The processing will be done on a gridded data set (Azimuthal Equal-area with a good aspect ratio: 1:1 at 90° and 2:1 at the equator), mainly for easy matching with the ancillary data that will be used.

J. Comiso (Goddard Space Flight Center) focused on the current status of the analysis of the FIRE-3/ER-2 aircraft validation program over the Arctic. There were eleven ER-2 overflights during the May/June period, nine of which made it all the way to the Surface Heat Budget of the Arctic Ocean (SHEBA) camp (that included a research ship), where scientists have been collecting surface and atmospheric data since October 1997. Preliminary analysis shows good spatial coherence of the MODIS and the Advanced Microwave Precipitation Radiometer (AMPR) images. The time periods of good data are also coincident with rapidly changing ice surface characteristics due to the onset of spring melt as revealed by SSM/I data. The repeat track scheme was shown to have been successfully implemented thereby enabling the collection of coregistered vertically and horizontally polarized data from AMPR. Both data sets (MODIS and AMPR) will be used for testing and validating the sea-ice-retrieval algorithms.

D. Cavalieri (Goddard Space Flight Center) presented a modified version of the NASA team sea-ice algorithm developed in collaboration with Thorsten Markus, an AMSR-E Team research associate at Goddard. The modified NASA Team algorithm makes use of three radiance ratios: the polarization ratio (PR) at 19 GHz and the gradient ratios (GR) between 37 GHz and 19 GHz for both vertical (V) and horizontal (H) polarizations. This modification maintains the temperature independence, the spatial resolution, and the dynamic range of the original NASA Team algorithm. The purpose of the modification was to eliminate the low-ice-concentration bias found in some areas around Antarctica.

T. Wilheit (Texas A&M University) had one of his students, J. Huang, present his research. Huang found that TRMM observations fit the Wilheit et al. (1977) precipitation model after some modifications to the freezing levels and the rain drop distribution are made.

R. Ferraro (NOAA/NESDIS) reported on his activities involving rain-over-land retrieval algorithm. The main issue is the transition of the operational SSM/I land retrieval algorithm into the GPROF framework. (GPROF is the Goddard PROFiling algorithm for instantaneous rain retrieval and has been used for both SSM/I and TRMM.) A new database of hydrometeor profiles and corresponding forward-calculated brightness temperatures which match the empirically derived database of radar and SSM/I measurements can be inserted into GPROF. This data set is based on cloud model simulations and radiative transfer calculations. In this way, both retrieval methods should be virtually identical. However, the advantage of the GPROF scheme is that the hydrometeor profiles can be rederived for a variety of sensor configurations (e.g., frequency, footprint size, etc.). It is hoped that in AMSR-E era, with higher spatial resolution and more channels than SSM/I, hydrometeor profiles can be retrieved over land. Ferraro showed a case study where he compares the new "model" database retrieval output with results from the operational SSM/I retrieval, NEXRAD radar, and current GPROF retrieval. The model and SSM/I retrievals are very close, and show a greater dynamic range than the current GPROF.

E. Njoku (Jet Propulsion Laboratory) presented details on his Level 2 land products retrieval algorithm. Inputs coming from the AMSR-E Main program are, besides the Level 2A AMSR-E science data, sets of static and dynamic ancillary data and a set of program parameters. The Level 2A data are processed first by a gridding module (quality-controlled and registered to the 25-km global cylindrical Equal Area SSM/I Earth (EASE) grid), and then together with the ancillary data, by the Land Surface Parameter Retrieval module. After the iterative retrieval processing and the generation of flags, the output HDF objects are created and the output is sent to the Main program. Njoku also showed some comparisons between Scanning Multichannel Microwave Radiometer (SMMR) and National Centers for Environmental Prediction (NCEP) data.

F. Wentz (Remote Sensing Systems) has been analyzing TMI data to gain insight into its differences with SSM/I. One astonishing finding was the difference in the brightness temperatures measured by the two instruments over the same area: 11.6 K for the V-pol and 8.5 K for the H-pol. TRMM had executed a maneuver where the spacecraft was turned upside down, and the TMI reflector was actually observing cold sky. Wentz found differences of the order of 10 K to 13 K between the observations of the cold sky with the main reflector and with the cold calibration target (cold sky mirror). Two other notes of interest were RFI "hot spots" detected with the 10.7-GHz channel and the diminishing of the El Niño shown by monthly SST maps created from TMI data.

C. Kummerow (Goddard Space Flight Center) tested his TMI rainfall retrieval algorithm and compared it to the output of the TRMM Precipitation Radar and SSM/I. After the additional constraint of "distance to convection" was added to the retrieval algorithm, a significant improvement was achieved in the stratiform rainfall retrievals. Another improvement made to the model in the retrieval algorithm was the decrease of the Marshall-Palmer (M-P) hydrometeor profile intercept (which puts more small droplets into the hydrometeor profile), which brought the retrieval much closer to the observations.

The next meeting will be a Joint AMSR Science team meeting in November, in Tokyo, Japan.

KUDOS

William L. Chameides, a Regents' Professor in the School of Earth and Atmospheric Sciences at the Georgia Institute of Technology, was recently elected a member of the National Academy of Sciences. Dr. Chameides is a Principal Investigator on an EOS Interdisciplinary Investigation. The Earth Observer staff and the EOS community would like to congratulate Dr. Chameides on this outstanding accomplishment.

Moderate Resolution Imaging Spectroradiometer (MODIS) Science Team Meeting Summary

— *Bob Kannenberg*
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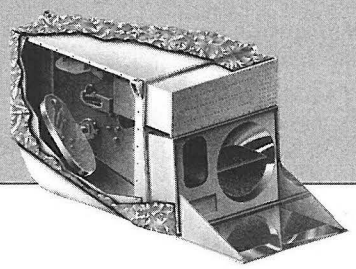


The complete set of these minutes and attachments is available in Portable Document Format (PDF) on the MODIS Home Page at http://modarch.gsfc.nasa.gov/MODIS/MODIS.html.

Introduction

The MODIS Science Team meeting was held June 24-26 at the Greenbelt Marriott near Goddard Space Flight Center (GSFC). Team Leader Vince Salomonson welcomed participants and stated that originally we thought we would be near launch at this time, but launch has been delayed and there are still some challenges to be met. These challenges include fixing the Flight Operations Segment (FOS) software, resolving the MODIS instrument's electronic crosstalk issue, and formulating a PI-led adaptive processing plan for MODIS AM-1 data.

AM-1 Status

Salomonson introduced Kevin Grady, who replaced Chris Scolese as the EOS AM-1 Project Manager. (Scolese is now the Associate Director for EOS at GSFC in the Flight Projects Directorate.) Grady announced that the AM-1 spacecraft will not launch for at least another 6 months, and more specific information will not be available until July. At present all of the instruments, equipment modules, and major assemblies have been successfully tested, delivered, and integrated onto the spacecraft. Grady noted that modifications are being made to the flight software in order to perform the calibration maneuver, which is critical for MODIS. Grady reviewed a "top ten" list of concerns, and number one on that list is the FOS software which, at present, does not support a flight-ready configuration. Rick Obenschain and his team are in the process of cleaning up this software, as well as developing an alternative system, the AM Mission Operations Center (AMOC) which, so far, looks promising. Salomonson commended the entire AM-1 Project on a job well-done.

ESDIS Status

FOS Status

Obenschain reviewed the Earth Science Data and Information System (ESDIS) status and provided an overview of the FOS situation. In March it became apparent that the FOS software had significant stability problems that would preclude a launch in the September timeframe. To resolve these difficulties the EOS Core System (ECS) developer (Raytheon) has, among other things, brought in additional staff and expanded the software testing program so as to uncover problems as soon as possible. The developer is working to an internal schedule reflecting a launch date of January 30, 1999.

AMOC Status

As Grady mentioned earlier, the AMOC is being developed as an alternative to the FOS. The FOS was intended to control all of the EOS spacecraft, whereas the AMOC would be used exclusively to control the AM-1 spacecraft. A prototype AMOC is now operating in GSFC Building 32, and Obenschain anticipates that the finished product will be available sometime during the second quarter of 1999. So far thermal vacuum spacecraft data have been flowed successfully from the EOS Data and Operations System (EDOS) to the AMOC.

ECS Status

Obenschain asked Mike Moore to discuss ECS status from a MODIS perspective. Moore reported that delayed production rules will in turn delay Science Software Integration and Test (SSI&T) activities needed to resolve integration issues; delay end-to-end testing across Distributed Active Archive Centers (DAAC); and potentially increase the Operations load due to workarounds. ECS will attempt to mitigate these situations in several ways. On-going SSI&T will be performed in the mini-DAAC. The Ocean Data Day rule will be accelerated to the L7/NCR Patch. An October 1998 patch is planned to provide basic Land Tiling, and a January 1999 patch is planned to provide remaining production rules.

Moore pointed out that the Version 0 interface does not support Quality Assurance (QA) very well. The selection of products for science QA is difficult, and additional DAAC operations support is required. In the near-term, ECS is initiating an effort to enhance the Version 0 Client; for the long-term, ECS is studying the feasibility of independent

Client and Data Management elements. Moore was asked about the status of certification testing, and he replied that certification testing is being treated as a set of end-to-end system tests. ECS is building up to a data day test with whatever data are available at that time. After that the DAACs will perform additional operational readiness testing, and ramp up to performing a 3-day test. Moore asserted that there is no intention on the part of ESDIS to set a hard deadline to say that if something is not ready for certification testing, then it cannot go to launch.

MODIS Instrument Status

Protoflight Model (PFM) Instrument

Bruce Guenther reported that the Protoflight Model (PFM) instrument has completed all of its spacecraft thermal vacuum testing and is integrated aboard the AM-1 platform now at Valley Forge. Remaining PFM sensor concerns are as follows: electronic crosstalk (formerly known as the Shortwave Infrared [SWIR] second sub-frame problem); Thermal Model and operating temperature; and Electronically Erasable Programmable Read Only Memory (EEPROM). The MODIS Characterization Support Team (MCST) and Santa Barbara Remote Sensing (SBRS) continue to work these issues. (Guenther presented a detailed presentation on electronic crosstalk later during the Closed Door portion of the meeting.) Regarding operating temperature, Guenther indicated that the instrument is likely to be running roughly 10 degrees colder than originally anticipated. Modeling indicates that blanketing the main electronics module (MEM) should allow us to raise the temperature of the electronics without significantly raising the temperature of the optics (it is important that the blackbody not get too cold, or the thermistors can saturate). Finally Guenther stated that fixes have been implemented to eliminate the potential for blown fuses due to phantom commands. The fixes include a software change and rewiring of two circuit card assemblies (CCA) in the forward analog module (FAM).

Flight Model 1 (FM1) Instrument

Guenther reviewed fixes made to the FM1 instrument. The fix to eliminate phantom commands was somewhat more substantial on the FM1 instrument; in addition to rewiring the FAM, the CCAs in the main electronics module (MEM) were reworked. The SWMIR out-of-band light leak in the 5.3-μm region has been eliminated by adding a blocking filter coating to the cold window above the SWMIR focal plane assembly (FPA). SWMIR light leaks affecting Bands 24, 25, and 26, and potentially Band 5 have been incorporated; four stripes were painted on the FPA mask and one stripe on the Intermediate Filter Assembly (IFA) mask near Band 6. A reduced-scatter scan mirror has been integrated on FM1, and this mirror should result in improved sea surface temperature (SST) data for the MODIS Ocean (MOCEAN) Group. Guenther indicated that he will discuss the FM1 test program off line with Otis Brown.

MODIS Emergency Backup System (MEBS)

Masuoka provided an overview of MEBS capabilities. He noted that MEBS will soon be folded into the Team Leader Computing Facility (TLCF). MEBS will be able to generate all at-launch products in sufficient quantities to enable the Science Team to test, debug, and validate its algorithms. (Coverage goal is 100% of Level 1 and 25% of Level 2 products and above.) Masuoka announced that MEBS intends to conduct a "week-in-the-life" test with Product Generation Executives (PGEs) from all 3 disciplines producing both Level 2 and Level 3 products in the August or September time frame. He reviewed processing hardware now on the floor. MODLAND QA requires additional storage space, and the additional tape library is in the SDST budget for FY99. Science products can be ordered through the MEBS Web site located at http://modisdm.nascom. nasa.gov. Salomonson indicated that at launch we should definitely have Level 1 products, and enough processing capability to make higher-order products for validation, but, as far as serving the community and interfacing with ECS goes, we are not there yet.

GSFC DAAC (GDAAC) Status

Wharton reported that PGEs 01, 02, and 03 have been fully integrated and tested, and a chain test of these three PGEs has been completed. The GDAAC is looking at how to run production processing so as to maximize the system capability and minimize run times. PGEs 04, 07, 08, and 11 have been integrated and successfully run in the ECS Production Data Processing System (PDPS). Wharton stressed that the GDAAC needs test data to benchmark Level 1 and Level 2 processing (at a minimum 6 hours of data are necessary, although optimally the GDAAC would like to have 24 hours of data).

NSIDC DAAC Status

Greg Scharfen reported that ECS Version 2 Drop 4.05 was installed at the National Snow and Ice Data Center (NSIDC) DAAC in April. Drop 4p is expected to be installed in August. Staffing, training, and SSI&T at NSIDC are on schedule. A MODIS-NSIDC Technical Interchange Meeting (TIM) was held in Boulder in May. Issues discussed included network

capacity and production planning. Scharfen noted that EBNet will be used for DAAC-to-DAAC data transfer.

MOCE/SeaWiFS Initialization Results

Howard Gordon presented results of the Marine Optical Characterization Experiment (MOCE)/Sea-viewing Wide Field-of-view Sensor (SeaWiFS) initialization cruise, led by Dennis Clark. Gordon stated that on-orbit adjustment of the sensor calibration is based on a comprehensive suite of surface measurements (vicarious calibration). Calibration will be maintained thereafter by less intensive means, including the solar diffuser, lunar views and the Marine Optical Buoy (MOBY). The SeaWiFS initialization cruise served as a "dry run" for MODIS. Gordon presented various plots depicting data gathered during the cruise. He concluded that overall the initialization exercise was a success. Preliminary calibration of all SeaWiFS bands relative to 865 nm was completed.

Atmosphere Products Results Obtained Using MAS Data

Steve Ackerman indicated that the MODIS Airborne Simulator (MAS) has flown often on the ER-2 aircraft, most recently this past May and June as part of the First ISCCP Regional Experiment (FIRE) Arctic Cloud Experiment (ACE) conducted in Alaska. Ackerman showed the instrument configuration flown aboard the ER-2 during ACE, and pointed out that it was very similar to the configuration slated to fly aboard the AM-1 and PM-1 platforms. He presented a number of images from the ACE experiment, including stratus-type clouds over open water. Michael King added that the MODIS cloud particle retrieval algorithm was run with MAS data during ACE. Ackerman presented MAS data from the WINDS experiment which suggests that the MODIS Cloud Mask is working well. The Cloud Mask also compares well with Lidar data. Ackerman reported that MAS images from the Subsonic Aircraft Contrail and Cloud Effects Special Study (SUCCESS) indicate that CO_2 slicing is working well.

EOS AM-1 Earth Observatory Web Space/Public Relations

Outreach Team and Executive Committee for Science Outreach (ECSO) Concept

Herring announced that he has formed the EOS AM-1 Outreach Team, which is based at GSFC and comprised of visualizers and science writers who will contribute to the EOS AM-1 Earth Observatory Web Space and "tell the stories" suggested by data from the instruments aboard the AM-1 platform. Ultimately, Herring intends to extend the AM-1 Outreach Team to include visualizers, writers, and other potential contributors at other NASA centers, universities, the DAACs, etc. Right now he is trying to establish a closer working relationship between the Outreach Team and the MODIS science community; in the long term, he hopes that the Outreach Team will be able to effectively "showcase" AM-1 scientists' work in the public media, as well as render data products easily accessible and understandable to public "translators" (like educators, media writers, and environmental awareness groups). Herring discussed the ECSO concept. Comprised of senior and prominent EOS scientists, the ECSO was formed to harvest new science results and amplify media play, as well as to provide peer review while helping to temper the messages conveyed by the results. While the ECSO will meet regularly to discuss new results and stories for publication, it will also have to react as necessary to political decisions (e.g., the Kyoto agreement) and natural disasters (e.g., volcanoes, wildfires, etc.). Herring encouraged Science Team members to contact him or ECSO members if they feel they have a story to tell. The ECSO can then link principal investigators (PI) with AM-1 writers and visualizers in order to produce press releases and publish the story in the Earth Observatory Web space.

Visualizations

Herring introduced AM-1 Outreach Team members Mark Sutton and Rob Simmon, who will be producing visualizations of AM-1 data for the Earth Observatory. They demonstrated several animations similar to those that they envision producing with MODIS and other AM-1 instrument data. Sutton noted that he is particularly interested in creating data-fusion animations, overlaying data from two different instruments.

Earth Observatory Web Space

Sutton presented a tour of the prototype Earth Observatory Web space, still very much a work in progress, which is designed according to a "room" concept. Rooms that the user can enter include a site overview, study, tour, indices, site map, library, laboratory, and related links. The target date for establishing a working prototype online is September 1. Sutton asked Science Team members to think about what they might contribute to the Earth Observatory and contact him at: sutton@agnes.gsfc.nasa.gov. Herring reviewed some candidate AM-1 global data sets (global biosphere [MODIS], fires and fire susceptibility, etc.). He stated that he would like feedback from Science Team members as to what products will be ready in the first 60 days after launch, and respective priorities for publicizing these products.

Global Fire Monitoring Web Site

Herring encouraged Science Team members to visit the Global Fire Monitoring site located at: *http://modarch.gsfc.nasa.gov/fire_atlas*. In late May the White House Office of Science and Technology Policy (OSTP) requested a rapid-response report on the Mexican fires, so in approximately three days (and a couple of nights) the Outreach Team constructed the Global Fire Monitoring site, which includes numerous creative visualizations of satellite fire data, accompanying explanatory text, and links to related sites. Ultimately, the information contained within this site will comprise a case study within the larger Earth Observatory Web space. The Fire Monitoring site received approximately 75,000 hits during its first 2 weeks, and has already garnered complimentary mentions in several publications.

Early Images/Web Products Meeting

Kannenberg reported that a MODIS Early Images/Web Products Meeting was held June 23 to bring together the outreach and visualization specialists with representatives from the discipline groups, MEBS, and the GDAAC to discuss early production plans (i.e., roughly the first six months after launch). Herring discussed the Earth Observatory, the ECSO concept, and the Global Fire Monitoring site. Simmon and Sutton presented some of the same visualizations that they did today. These visualizations typically require the use of several different software packages. As the Earth Observatory matures, Sutton would like to bring in a programmer to automate the visualization process as much as possible. George Serafino addressed that point by asserting that the GDAAC recognizes the need to subscribe to a full or channel-subsetted MODIS granule. Early image/Web product points of contact were designated for each of the discipline groups, MEBS, GDAAC, and the Earth Observatory.

Product Accuracy Summaries

Kaufman presented an example of a product accuracy summary, and proposed that MODIS PIs should draft summaries for their respective data products. Categories of information contained in the summary include optimal and non-optimal conditions for derivation from the EOS data, caveats, theoretical accuracy, pre-launch verification, post-launch verification, and references.

Remote Sensing of Smoke and Aerosol Forcing of Climate

Kaufman stated that radiative forcing of climate represents a major uncertainty over the last 160 years of climate change research. MODIS and other satellite data, used in conjunction with ground data and modeling, will enhance our understanding of both direct and indirect radiative forcing. Kaufman discussed indirect radiative forcing and presented plots depicting the effects of smoke particles on clouds. He suggested that there may be a relationship between how white a cloud appears and the amount of particulates it contains (i.e., polluted clouds with larger amounts of particulates will appear to be whiter). Kaufman explained that it is easier to understand the effects of direct, rather than indirect, radiative forcing. Above 1 μm, the effect of smoke on radiation is more pronounced. MODIS will allow us to resolve spectrally the surface and aerosol radiative forcing.

EOS PM-1 Status

George Morrow announced that he took over as PM Project Manager after Marty Donohoe retired last December. Morrow reviewed the PM organization chart, noting that Pete Pecori is now the Deputy Project Manager and Ken Anderson is the Instrument Systems Manager. Morrow reported that a Critical Design Review (CDR) of the spacecraft was just successfully completed. Integration and Test (I&T) is scheduled to start in June 1999. However, the PM Project is assessing the impact of the FOS delay on spacecraft I&T and developing a risk mitigation approach. Morrow indicated that the FOS problem will probably not affect the PM schedule, but it may affect the cost. PM-1 is still working toward a December 2000 launch date.

LAI-FPAR Algorithm

Ranga Myneni indicated that in January 1997 a decision was made to revise the Leaf Area Index (LAI)/Fraction of Photosynthetically Active Radiation (FPAR) algorithm. Myneni thanked Joe Glassy and University of Montana personnel for delivering the code for the new algorithm. Myneni summarized the development and status of the MODIS LAI/FPAR algorithm, which is based on a three-dimensional formulation of the radiative transfer process in vegetation canopies. It allows the use of information provided by the MODIS (single-angle and up to seven shortwave spectral bands) and Multi-angle Imaging Spectroradiometer (MISR) (nine angles and four shortwave spectral bands) instruments within one algorithm. The LAI/FPAR algorithm should allow us to more accurately evaluate the exchange of carbon between the atmosphere and terrestrial vegetation.

Atmosphere Group Summary

King reported that all Atmosphere PGEs are presently at Science Data Support Team (SDST) or the GDAAC. The

Atmosphere Group may take advantage of the additional launch delay time to add an aerosol correction in the September/October time frame. Atmosphere storage volume is currently 37.3 GB/day for Version 2. (The Version 1 delivery in May 1997 was 19.2 GB/day, and the ECS baseline of February 1996 was 31.8 GB/day.) Atmosphere processing requirements are 1634 MFLOPS/day. (The Version 1 delivery was 1836 MFLOPS, which includes the factor of 1.6, and the ECS baseline was 654 MFLOPS/day.) King reported that some issues and questions arose from the Atmosphere group's discussion of the AM-1 adaptive processing proposal. The Atmosphere Group is concerned that if MEBS is performing regular processing, then where does the backup capability reside? The group also raised the issue of software version control, especially as it pertains to the Cloud Mask; it appears that the Cloud Mask will be run at multiple locations (including the ECS mini-DAAC, the GDAAC, Miami, MEBS, and NOAA), so it will be necessary to ensure that software changes flow down to all of these locations. Turning to validation activities, King indicated that the Atmosphere Group recently participated in the Fire ACE experiment, and analysis of those data is ongoing. Finally the Atmosphere Validation Plan will be revised to reflect: the AM-1 launch delay; NASA Research Announcement (NRA) validation scientists' activities; EOS PM-1 needs; and rapid response to aerosol events (e.g., Mexican wildfires).

MODLAND Group Summary

Chris Justice indicated that instrument performance continues to be a MODIS Land (MODLAND) concern, although this should be addressed by continuing MODIS Characterization Support Team (MCST) analysis. The Geolocation schedule appears to be on track; right now we are waiting for ground control point data from EDC. Justice stated that MODLAND would like a schedule for MEBS Land product testing and Land production testing at the DAACs. Turning to the AM-1 adaptive processing proposal, he indicated that MODLAND endorses PI processing, assuming it is funded at a level to do the job properly. MODLAND will continue to work closely with SDST on a reorganization and staffing plan. He noted that if the proposal is approved, there remain MODIS/MISR processing issues to be addressed. John Townshend cautioned that without ESDIS to impose standards, the discipline groups will have to assume this responsibility to ensure compatibility. Justice indicated that MODLAND would like to see an aggressive pre-launch test (using simulated MODIS data) of Land product archive and distribution capabilities at the participating DAACs. He stated that the delayed launch raises contractual issues, and narrows the window to do science. With regard to the budget, he commented that last-minute cuts can be extremely difficult to accommodate, and MODLAND will need additional validation resources for the second half of 1999.

MOCEAN Group Summary

Esaias indicated that MOCEAN's primary concern is the electronic crosstalk problem. If this problem can be fixed on the FM1 instrument (scheduled to fly aboard the PM-1 platform), MOCEAN is in favor of placing it aboard the AM-1 platform in place of the PFM instrument. (Other fixes made to the FM1 instrument, including a new scan mirror, would benefit the Ocean community.) Esaias reported that he was pleased with the results from the SeaWiFS initialization cruise; these results have increased confidence that MODIS has been properly scoped. Turning to the adaptive processing proposal, Esaias indicated that MOCEAN also approves and looks forward to PI-led processing. He addressed the comment that Townshend made about standards and compatibility by acknowledging that a certain amount of standardization is necessary but, in the immediate future, we need to deliver data products, and too many standards and protocols may impede rapid delivery. Esaias announced that MOCEAN intends to use a good deal of SeaWiFS data to test its processing system. (Necessary translators have been developed at Miami.) MOCEAN plans to update its validation plan in light of the launch delay and other factors. Esaias commended Herring and the AM-1 Outreach Team on their efforts so far, and added that MOCEAN has targeted fluorescence and SST as early images.

MCST Summary

Guenther reviewed action items currently being worked by MCST. He noted that processing speed at the GDAAC should not be an issue for the Version 2.1 Level 1B software. There has been some discussion about the best method to compute brightness temperatures, and Bob Murphy will attempt to get consensus on this issue. Guenther plans to discuss possible changes to the Level 1B code with the discipline group leaders. When making these changes, we would have to be careful not to impact Level 2 code. Guenther concluded that we need to do a better job on the planned verification of computed Level 1B products; some verification has been done, but more is needed.

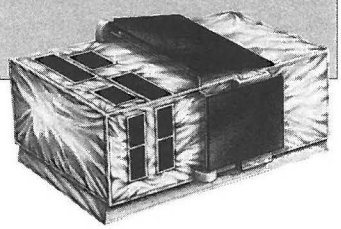
Closing Remarks

Salomonson thanked Science Team members for their cooperation with the

(Continued on page 34)

The Measurements Of Pollutants In The Troposphere (MOPITT) Airborne Test Radiometer (MATR)

— *Mark W. Smith (mwsmith@acd.ucar.edu), Stephen R. Shertz, and John C. Gille, Atmospheric Chemistry Division, National Center for Atmospheric Research, Boulder, CO*



The MOPITT Airborne Test Radiometer (MATR) is a 3-channel gas filter correlation radiometer that supports the Measurements Of Pollutants In The Troposphere (MOPITT) satellite program (Drummond 1992; Drummond et al. 1996). MATR was developed at the National Center for Atmospheric Research (NCAR) by Mark Smith and Steve Shertz, working under John Gille, lead U.S. Co-investigator for MOPITT.

MATR collects data to test and help improve the MOPITT retrieval algorithms (Pan et al. 1995; Pan et al. 1996; NCAR MOPITT Team 1996) and to help validate MOPITT data (Wang et al. 1996). MATR uses the same physical techniques as MOPITT (i.e., gas filter correlation radiometry with pressure modulation and length modulation) to remotely sense atmospheric CO profiles and CH_4 columns from an aircraft. General descriptions of gas filter correlation radiometry have been published previously, as well as specific analyses of using a pressure-modulated cell (PMC), and a length-modulated cell (LMC) (Houghton et al. 1984; Taylor 1983; Tolton and Drummond 1997) .

MATR has been developed in stages, starting with a breadboard version that could be operated only in a laboratory. Next, a single-channel MATR Mk I instrument was assembled and test flown in June and September 1996. A new three-channel MATR Mk II instrument was designed and built, based on these test-flight results. The MATR Mk II instrument is described here.

MATR has been kept relatively simple and uses a mix of off-the-shelf technology and items manufactured in-house at NCAR. MATR does not duplicate MOPITT technology and is not intended to reproduce exact MOPITT Level-0 (digital counts) data. MATR is not a prototype for MOPITT, and it has not been used to refine the design of MOPITT. The purpose of MATR is to test and improve our physical and mathematical understanding of how to convei atmospheric radiance values that have been acquired using an LMC and a PMC (MOPITT Level-1 type data) to atmospheric gas amounts (MOPITT Level-2 type data), and also to validate the MOPITT Level-2 data.

While MOPITT has 6 spectral channels for CO, MATR has only 3. However, because the MOPITT channels are partially redundant, the MATR channels provide almost as much vertical profile information as the MOPITT channels. Th MATR channels were chosen to span the three most important sounding components (column, mid-troposphere, and upper-troposphere) that go into the MOPITT data retrieval. Channel 1 has a spectral bandpass centered on 2.334 mm, and uses an LMC filled with CO to provide information about CO throughout an atmospheric column. Channel 2 has a spectral bandpass centered on 4.617 mm. It uses the same LMC as channel 1, but provides information about CO weighted in the mid-troposphere.

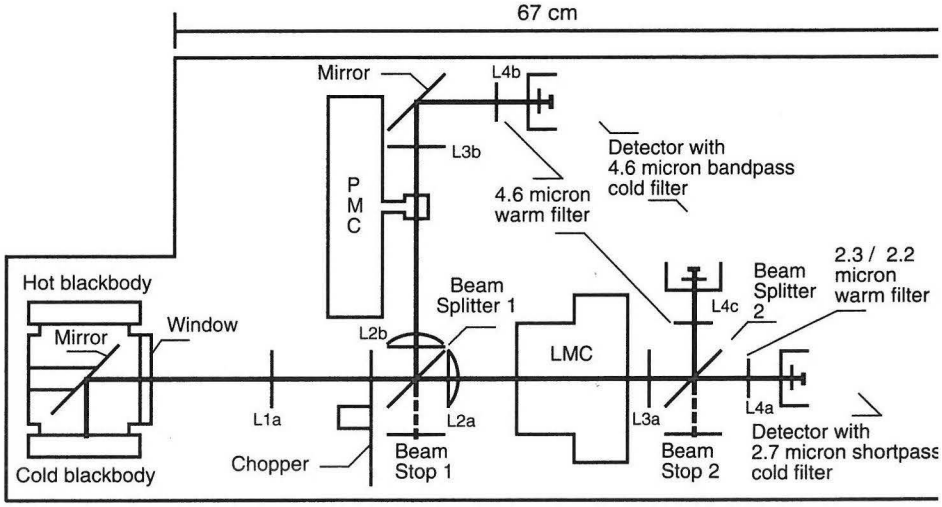


Fig. 1. Top view schematic of the MATR optical table.

Channel 3 is also centered on 4.617 mm, but it uses a PMC to provide information about CO weighted in the upper troposphere. With a typical flight altitude of 12 km, these 3 channels provide 4-km vertical resolution for the CO profile measurements. By changing a bandpass filter and the gas in the LMC, MATR can alternatively operate with a single channel centered on 2.269 mm to measure CH_4 column amounts.

Fig. 1 shows the layout of the MATR optical table. The overall size is 41-cm wide by 67-cm long by 39-cm high, including thermal and electrical controls, but not including the in-flight calibration assembly. A rotating input mirror, located in the calibration assembly, selects one of four sources of input radiance: scene, cold blackbody, hot blackbody, or tungsten lamp source. The mirror does not scan during data collection, it simply selects one of the four inputs. MATR operates with a nominally nadir view of the scene, except when the aircraft is pitched up or down or is banking.

The instrument full angle field of view (FOV) is approximately 0.1 radians. The ground instantaneous FOV is therefore about one tenth of the flight altitude above ground level. However, signal averaging causes the FOV to be smeared out along the direction the aircraft is traveling. At typical flight altitudes and speeds, data are averaged over a strip that is 1.2 km wide by 10- to 30-km long. A nadir-pointing video camera records scene imagery with a field of view about 2.5 times wider than that of MATR.

MATR is designed for use aboard a pressurized-cabin jet aircraft. An unavoidable consequence of operating a radiometer from inside a pressurized-cabin aircraft is that scene radiance must pass through a pressure-sealing window. This window will invariably modify the scene radiance by reflection, absorption, and re-emission. MATR uses a novel in-flight radiometric calibration assembly that places the calibration sources outside of the pressure-sealing window (so that window effects are included in the in-flight radiometric calibration), but which keeps air from blowing over the calibration sources (so that the sources can be maintained at stable temperatures). Fig. 2 shows a sketch of the calibration assembly.

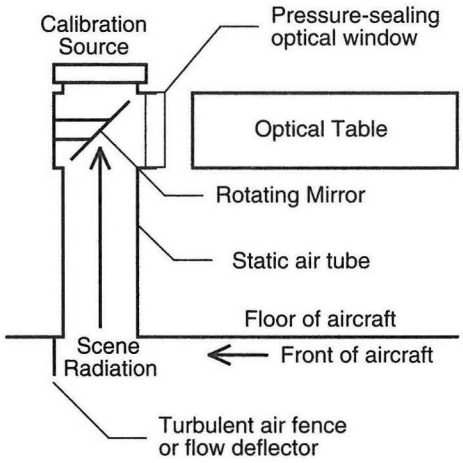


Fig. 2. Side view schematic of the MATR in-flight radiometric calibration assembly.

A set of flights was made with MATR in February and March 1998 as part of the Pre-MOPITT Oklahoma Validation Experiment (Pre-MOVE), centered at the Department of Energy's Atmospheric Radiation Measurement Program/Cloud and Radiation Testbed (DOE/ARM CART) site near Enid, Oklahoma. Pre-MOVE was a collaborative effort that involved several groups that will all work to validate MOPITT data. Data from these flights appear to be of good quality, but the data reduction and analysis are not yet complete. The retrieved CO values will be compared to results obtained simultaneously with ground-based spectrometers and from independent airborne *in situ* sampling. The MATR instrument was flown aboard a Cessna Citation II operated by the DOE Remote Sensing Laboratory. Fig. 3 shows a picture of MATR installed in the Citation.

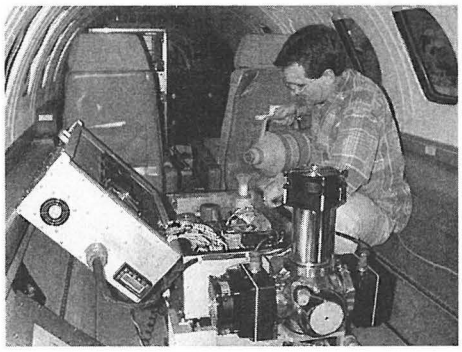


Fig. 3. Steve Shertz filling a detector Dewar with liquid nitrogen, with MATR installed in the DOE Cessna Citation II. Calibration assembly in foreground.

Future flight plans for MATR include a mission over Table Mountain Observatory in California or over Kitt Peak Observatory in Arizona in February 1999. CO values retrieved with MATR will again be compared to results from ground-based spectrometers as well as *in situ* sampling. Plans are also being developed to operate MATR as part of the SAFARI-2000 field campaign in southern Africa.

Acknowledgement

Project support is provided by NASA under contract NAS5-30888 administered through Dr. Michael King, the EOS Senior Project Scientist at NASA's Goddard Space Flight Center. The National Center for Atmospheric Research is operated by the University Corporation for Atmospheric Research under sponsorship of the National Science Foundation.

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NASA Awards 51 New Earth System Science Graduate Student Fellowships

— Ming-Ying Wei (mwei@hq.nasa.gov), NASA Headquarters, Washington, DC 20546

The review of the applications to the NASA 1998 Earth System Science Graduate Student Fellowship Program is complete. A total of 234 applications were received by the Office of Earth Science at NASA Headquarters in response to the announcement released in December, 1997. In all, over 86 universities and educational institutions from 40 states were represented. They represent 33 countries, however, they are all currently accepted/enrolled as full-time M.S. and Ph.D. graduate students at one of the 86 represented universities.

The applications were evaluated through a two-step peer review process: first through mail/panel review, and then by evaluation of a panel composed of members of academic institutions and research organizations, and representatives from the Educational Affairs Office and the Office of Earth Science at NASA Headquarters.

A total of 51 new students have been identified to receive the fellowships this year, pending acceptance by each applicant and the individual's institution. The purpose of the Fellowship Program is to train a pool of highly qualified scientists to help analyze and interpret the wealth of data generated by the Office of Earth Science programs. NASA understands that the future of Earth science rests with today's students, who will be tomorrow's scientists. Financial support for pursuing an advanced education obviously plays a vital role in securing the necessary talent to further Earth system science objectives. See list on pages 24-25.

Fellowships are given for an initial 1-year term and may be renewed annually for up to 3 years, based on satisfactory progress as reflected in academic performance and evaluations made by faculty advisors. The amount of the award is $20,000 per annum, which may be used to defray living expenses, tuition, fees, and other educational expenses. An additional $2,000 may be requested by the faculty advisor to support the student's research. Students receiving these stipends must not receive other Federal funding.

The names and affiliations of the recipients identified for this year and the titles of their proposals are given on pages 24-25 and at http://www.hq.nasa.gov/office/ese/nra/archive/1998_ESS_Winners.html. An announcement for the 1999-2000 Fellowships will be released in December 1998, and the deadline for submission of new applications to NASA is March 15, 1999.

Additional information about this program may be obtained from Dr. Ming-Ying Wei, Code YO, NASA Headquarters, Washington, DC 20546.

PI Name	Organization	Proposal Title	Advisor
Sharon L. Barker	Michigan Technological University	Temporal Analysis of Volcanic Aerosol and Ash Transport	Gregg J. Bluth
Dennis J. Barket	Purdue University	Development, Evaluation, and Application of a Fast Time Response Mass Spectrometric Model for Quantitative Monitoring of Tropospheric Ozone Precursors	Paul B. Shepson
Jeffrey B. Basara	University of Oklahoma	Investigation of Land-Atmosphere Interactions Using the Oklahoma Mesonet	Kenneth C. Crawford
Peter Colarco	University of Colorado Boulder	Comparisons of Three-Dimensional General Circulation Model Simulations of the Desert Aerosol Life Cycle with Satellite Observations	Owen B. Toon
Joseph Craine	University of California Berkeley	Aboveground and Belowground Plant Species Functional Traits and their Relation to Ecosystem Functioning	Francis S. Chapin
Richard I. Cullather	University of Colorado Boulder	Atmospheric Circulation and Regional Sea Ice Sensitivity in the Arctic	Amanda Lynch
Sarah Das	Pennsylvania State University	Integrated Satellite, Model, and Field-Based Studies of Controls on the Extent of Surface Melting in Antarctica: Long-Term Climate Variability and Mass Balance Implications	Richard Alley
Alex J. DeCaria	University of Maryland College Park	Convective Effects on Tropospheric Ozone Chemistry Studied with a Coupled Cloud/Chemistry Model	Kenneth E. Pickering
Diana M. Derubertis	University of California Berkeley	Regional Changes in Extreme Event Frequencies Within the United States	Orman E. Granger
Julianna E. Fessenden	University of California San Diego	Biospheric Influence on Atmospheric CO_2, Viewed from the Sigma 18O Signature	Martin Wahlen
Karen E. Fisher	Cornell University	Volumetric Assessment of Factors Governing Seasonal and Interannual Fluxes of Phytoplankton from Georges Bank 1994 - 1998 and Application to SeaWiFS Data for New Production Calculations	Charles H. Greene
Tara J. Fortin	University of Colorado Boulder	Laboratory Studies of Cirrus Cloud Formation Mechanisms	Margaret A. Tolbert
Tammy E. Foster	University of South Florida	Functional Grouping of Plants in Florida Scrub Habitat	Renee J. Brooks
Nancy H. F. French	Environ Research Inst of Michigan	The Use of Remote Sensing Methods for Studying Fire-Induced Land Cover Changes in Boreal Forests of Alaska	Charles E. Olson
Gregory P. Gerbi	California Institute of Technology	SAR Interferometric Constraints on Ice Cap Mass Balance and Dynamics in Iceland	Mark Simons
Nicholas J. Haan	Clark University	Linking Remote Sensing and Social Analysis: Casual Influences of Transitioning Economies on the Miombo Woodland of Tanzania	Billie L. Turner
Marshall L. Hayes	Duke University	Varying Eolian Dust Inputs and Spatiotemporal Patterns of Change on Caribbean Coral Reefs	Richard T. Barber
Anna M. Hersperger	Harvard University	The Effects of Adjacency Arrangements on Plant Diversity in the Aspen Parkland, Alberta: Field Study and Development of a GIS Model for Land-Cover Change	Richard T. T. Forman
Christina L. Holland	University of South Florida	El Niño/Southern Oscillation in the Antarctic Circumpolar Current	Gary T. Mitchum
Teresa A. Holloway	Princeton University	Transboundary Air Pollution in Asia	Hiram Levy
Pannirselvam Kanagaratnam	University of Kansas	Development of Radar System for Accumulation Measurements	Sivaprasad Gogineni
Theodore A. Kennedy	University of Minnesota	The Impacts of a Salt Cedar (Tamarix Ramosissima) Invasion on Communities, Ecosystem Processes, and Ecosystem Services in Desert Riparian Woodlands	Shahid Naeem
Ray Klimmek	University of Arizona	Synthetic Lahar Hazard Modeling Using Orbital Dem Data	Charles E. Glass
Paul S. Laris	Clark University	Identifying the Land-Management Institutions and Landscape Patterns Governing Savanna Fire Regimes in Mali	Billie L. Turner
Alejandro Leon	University of Arizona	Ecosystem Degradation and Household Vulnerability in the Semi-Arid Region of Chile	Charles F. Hutchinson
Alan P. Leonardi	Florida State University	Dynamics and Variability of the North Hawaiian Ridge Current from Satellite Altimetry and an Eddy Resolving General Circulation Model	James J. O'Brien
Laura T. Letendre	University of Pennsylvania	Development of a Time-Resolved Visible and Ultraviolet Spectroscopic Technique for Measuring Resonance Raman Cross Sections Needed for Remote Sensing Measurements	Hai-Lung Dai

PI Name	Organization	Proposal Title	Advisor
Xiang Li	University of Alabama Huntsville	Impact of Aerosols on the Clear Sky Shortwave Radiative Fluxes Over Biomass Burning Regions in South America	Roland M. Welch
John Lin	Harvard University	Biological and Physical Controls on Evapotranspiration in a Mid-Latitude Forest	Steven C. Wofsy
Marc Linderman	University of Wisconsin Madison	Mapping the Spatial Distribution of Bamboo in a Giant Panda Reserve: A Study of the Relationship of Understory Vegetation Percent Cover to Artificial Neural Network Activation Levels	Jianguo (Jack) Liu
Kelly MacGregor	University of California Santa Cruz	Erosion and Sediment Fluxes by Valley Glaciers through the Climate Cycle: Links Between Alpine Landscape Evolution and Climate	Robert S. Anderson
Sherri A. Mason	University of Montana	Modeling Novel FT-IR Spectroscopic Measurements of Oxygenated Hydrocarbon Levels From Biomass Combustion Emissions	Richard J. Field
Timothy L. Masterlark	University of Wisconsin Madison	Poroelastic Analysis of Coseismic and Postseismic Deformation Associated with the 1992 Landers, California Earthquake	Herbert F. Wang
Emilio Mayorga	University of Washington	Coupling Land-Surface and Riverine Water and Carbon Cycles in the Amazon Basin: Development of a Multi-Scale Model Driven by Remote Sensing Observations	Jeffrey E. Richey
Megan McGroddy	University of California Berkeley	Phosphorus Cycling Across a Land Use Gradient on Two Soil Textures in a Lowland Tropical Forest, In the State of Para, Brazil	Whendee Silver
Gustavo de Hess Negreiros	University of Washington	Modeling the Flammability of Brazillian Amazon Forests at the Forest-Savanna Ecotone	Thomas M. Hinckley
Gregory Okin	California Institute of Technology	Crucial Desertification Processes for Monitoring Arid Lands: A Remote Sensing Study	Bruce Murray
Karen R. Plaut	Massachusetts Institute of Technology	Two-Way Surface Water-Groundwater Interaction: Spatial Organization of Hydrologic Processes Over Complex Terrain	Dara Entekhabi
Mitchell Plummer	New Mexico Inst of Mining & Techlgy	Combined Simulation of Alpine Glaciers and Closed-Basin Lakes: The key to Determining the Long-Term Temperature and Precipation Changes Driving Fluctuations in the Alpine Glaciers	Fred Phillips
Sara A. Rauscher	University of Wisconsin Madison	Scale-Dependent Climate Change Due to Deforestation in Amazonia	Waltraud Brinkmann
Andrew L. Rice	University of California Irvine	Sigma D Measurement of Methane and Molecular Hydrogen in the Atmosphere	Ralph J. Cicerone
Matthew Rodell	University of Texas Austin	Estimating Changes in Continental Water Storage from Satellite Observations of the Time Dependent Gravity Field	James S. Famiglietti
Tapio Schneider	Princeton University	The Influence of the Troposphere's Static Stability on Climate Sensitivity	Isaac M. Held
Harper Simmons	Florida State University	Nonlinear Exchange Processes Between the Pacific and the Indian Ocean	Doron Nof
James B. Simpas	Pennsylvania State University	Studies of OH and HO_2 in the Presence of Cirrus Clouds Near the Tropopause	William H. Brune
Colm Sweeney	Columbia University	Variability of Biogeochemical Regimes in the Ross Sea: An Analysis Using High Resolution Sea Surface Measurements	Taro Takahashi
Michael A. Taylor	University of Maryland College Park	The Effect of Warm Tropical Atlantic SST on Early Season Caribbean Rainfall	Anandu Vernekar
Jonathan A. Warrick	University of California Santa Barbara	Mass Balance of Sediment Transport Across Coastal Margin Filters at the Base of the Transverse Ranges, CA	Leal A. K. Mertes
Sheryl Wilhelm	University of Washington	Combined Use of Remote Sensing and Biogeochemical Modeling to Estimate Primary Production and Carbon Gas Emissions on the Amazon River Floodplain: Establishing a Baseline for Assessment of Human Impacts	Jeffrey E. Richey
Andrew T. Wittenberg	Princeton University	Response of ENSO to Modulations in Tropical Climate	George H. Philander
Troy G. Wood	Stanford University	Global Lightning Detection and Location Using Long Range VLF Sferic Measurements	Umran S. Inan

First Meeting of the Alaska SAR Facility User Working Group Yields Results Fast

— *Harry Stern (harry@apl.washington.edu), Polar Science Center, Seattle, WA*

The Alaska Synthetic Aperture Radar (SAR) Facility (ASF) held the first meeting of its new ASF User Working Group (ASFUWG) on May 18-19 in Fairbanks. The 26 people in the ASF group are mostly SAR data users from the research and operational communities, representing a wide range of disciplines and institutions. Members also include experts on data systems and imaging radars, as well as the Chief Scientist of ASF (Verne Kaupp), the head of ASF Development at the Jet Propulsion Laboratory (David Nichols), and NASA's ASF Program Scientist (Prasad Gogineni), who is also the manager of NASA's Polar Research Program.

The purpose of this DAAC advisory group is to make recommendations to ASF and NASA in order to improve the products and services at ASF, and to ensure that the U.S. research and operational communities continue to have timely access to SAR data collected around the world by current and future spaceborne SARs. Toward this end, the most important result to come out of the meeting was the recommendation that NASA negotiate agreements with the European, Canadian, and Japanese space agencies for reception (at ASF) and access (worldwide) to SAR data from the instruments that those nations plan to put in orbit within the next five years. This recommendation is in the form of a 46-page white paper entitled "The Critical Role of SAR in Earth System Science," written by the ASFUWG in the weeks following the meeting. The paper is available on the ASFUWG web site at http://psc.apl.washington.edu/ASFUWG.

Many other important issues were discussed at the meeting. After a brief introduction to ASF and future SAR missions, the main topics from the meeting and the next ASF Science Plan are described below.

About ASF and Future SAR Missions

ASF is unique among NASA's DAACs in operating a ground receiving station as well as processing, archiving, and distributing the data it collects. In addition, SAR data acquired at McMurdo (Antarctica) and foreign ground stations are sent to ASF for processing. The four satellites that currently carry SARs are operated by foreign flight agencies: ERS-1 and ERS-2 (European), JERS-1 (Japanese), and Radarsat-1 (Canadian). This presents unique challenges for ASF in terms of scheduling and acquiring the SAR data requested by U.S. users. For example, for Radarsat-1 there is a strict limit on the number of minutes per 24-day cycle allocated to U.S. users without cost. Also, SAR data that are downlinked at foreign ground stations are not immediately accessible through the EOSDIS interface. These data must first be shipped to ASF and "scanned" or cataloged there.

Several new satellites carrying SARs are scheduled for launch in the next five years: the European ENVISAT-1 (2000), the Canadian Radarsat-2 (2001), the U.S. LightSAR (2002), and the Japanese ALOS (2003). While the European, Canadian, and Japanese missions may be thought of as continuations of the current generation of SARs, they all add important new capabilities: ENVISAT-1 Advanced SAR (ASAR) has a ScanSAR mode and dual polarization; Radarsat-2 has a ScanSAR mode like its predecessor and full quadrature polarization; LightSAR is fully polarimetric and is designed with interferometric applications in mind; ALOS has a ScanSAR mode, dual polarization, and is particularly well designed for land-cover mapping. U.S. scientists and operational agencies will benefit greatly from this next generation of advanced SARs.

Meeting Review / May 18

After welcoming remarks by the Chancellor of the University of Alaska Fairbanks and the Director of the Geophysical Institute, the acting director of ASF (Craig Lingle) gave an overview of recent scientific results accomplished with ASF data, and reported that ASF production levels are rising.

Prasad Gogineni reviewed the four major projects supported by data from ASF: The Radarsat Geophysical Processor System (RGPS), the Radarsat Antarctic Mapping Program (RAMP), boreal forest mapping,

and Amazon forest mapping. In addition to these projects there are 61 investigations selected through NASA Research Announcements and 91 other investigations that use data from ASF. The use of SAR interferometry for applications ranging from ice-sheet dynamics to topographic mapping is contributing to the increase in the number of SAR data users.

Members of the ASFUWG each gave five-minute presentations to introduce themselves and their research to the rest of the group.

Verne Kaupp discussed the functions he believes the ASFUWG should undertake: assess the current state of ASF; identify and prioritize issues of concern to users; draft a five-year science plan for ASF; and advocate new mission support, as addressed by the white paper referenced above.

Jim Conner (ASF User Services) and Greta Reynolds (ASF Mission Planner) talked about the SAR data that have been acquired at foreign ground stations by user request through ASF, and gave a behind-the-scenes look at the procedures and flow of information, starting from the data acquisition request (DAR) and continuing through scheduling and acquisition to final cataloging. Because of the complications arising from the interactions with foreign stations and agencies, there is no automated order-tracking system in place by which users can keep track of the status of their orders. This is an area of concern that is being addressed.

The day concluded with a general discussion period. Members outlined the white paper mentioned above and made writing assignments.

Meeting Review /May 19

Verne Kaupp and others reviewed the different projects and categories of SAR data users.

- RAMP (Radarsat Antarctic Mapping Program) mapped the entire ice-covered continent at a resolution 30 times finer than previously available.
- RGPS (Radarsat Geophysical Processor System) seeks to process complete weekly coverage of the Arctic Ocean into fields of sea-ice motion and thickness.
- GRFM (Global Rain Forest Mapping) is mapping the tropical forests of Africa, Southeast Asia, and South America. ASF is doing the South American component.
- GBFM (Global Boreal Forest Mapping) is mapping the forests of northern Asia and North America. ASF is doing the North American component.
- ADRO (Application Development and Research Opportunity). These are the 61 projects chosen through NASA Research Announcements.
- Other Projects. There are 91 other independent investigations that use data from ASF.
- Operational Users. NOAA and the National Ice Center (NIC) use near real-time SAR imagery for sea- and lake-ice monitoring, iceberg detection, river-ice-jam monitoring, fishing enforcement, oil-spill detection, wind and storm information, and flood mapping.

A new satellite receiving station on Svalbard is planned for the reception of EOS AM-1 data. This station could be made compatible for SAR data as well, which would improve Arctic coverage. The ASFUWG will recommend that NASA work out an agreement with the Canadian Space Agency (CSA) for the reception of SAR data at the Svalbard station.

Jason Williams (ASF calibration engineer) talked about the calibration and validation of SAR data. The many beam modes of Radarsat-1 make this a challenging task. The standard beams have been calibrated and the ScanSAR Wide Beam (SWB) mode will be done soon.

There were two "allocation" discussions. One involved the allocation of processing resources among the different projects listed above. The ASFUWG needs to assist ASF in assigning priorities and assessing the need for increased processing capacity. The second discussion focused on the 1519 minutes per 24-day cycle of Radarsat-1 that are allocated to U.S. users. When the total user requests exceed 1519 minutes, ASF must decide how to trim the requests to bring them within the allocation. Also, submitted requests are sometimes rejected by CSA due to scheduling conflicts, but there is usually not enough time to re-submit a modified request. This results in unused allocation time.

Rick Guritz (ASF Science Division) informed the group about software "tools" development at ASF. This includes programs for reading, mosaicing, and geocoding images, as well as more-advanced functions such as terrain correction. The ASFUWG was asked to recommend or prioritize the development of further software tools.

Tom Bicknell and Dave Cuddy (ASF Development at JPL) talked about the upcoming migration of all the SAR signal

data to a Level-0 archive. This will preserve the data in a more-usable format and facilitate tape handling and maintenance. It also presents the opportunity to extract certain information from the signal tapes as they are scanned. For example, a browse archive could be created. The ASFUWG should consider the benefits and costs of such opportunities.

Science Plan

The last ASF Science Plan was written in 1989 in anticipation of the launches of ERS-1, JERS-1, and Radarsat-1. Now is the time to draft a new five-year science plan to guide SAR research through the next generation of advanced SARs onboard ENVISAT-1, Radarsat-2, LightSAR, and ALOS. Input is needed from a wide range of researchers and operational users regarding their anticipated or potential applications, and their required (or desired) SAR coverage in space and time. Groups or individuals interested in contributing to the science plan should contact Harry Stern (harry@apl.washington.edu) or Leslie Morrissey (lmorriss@nature.snr.uvm.edu), co-chairpersons of the ASFUWG. We plan to have a rough draft by the time of the next meeting, tentatively scheduled for the end of September in Seattle.

For more information on ASF, visit their web site at http://www.asf.alaska.edu. For more information on the ASFUWG, including minutes of the meeting, recommendations, the white paper, and e-mail addresses of members, visit the web site at http://psc.apl.washington.edu/ASFUWG.

NASA's Earth Science Enterprise/Earth Observing System Supports an Odyssey of the Mind Problem

— Doug Bennett, EOS Project Science Office, doug.bennett.1@gsfc.nasa.gov
— Steve Graham, EOS Project Science Office, steven.m.graham.2@gsfc.nasa.gov

As part of its ever-expanding outreach and education efforts, the National Aeronautics and Space Administration (NASA), has funded a grant to support an Odyssey of the Mind (OM) problem for the 1998-99 school year. OM is a world-wide school program that promotes creative team-based problem solving for kids from kindergarten through college. Students solve problems in a variety of areas — from building mechanical devices such as spring-driven vehicles to giving their own interpretation of literary classics. It features an annual competition component at local through international levels. The program fosters divergent thinking and problem-solving skills while participating in a series of challenging and motivating activities, both inside and outside their regular classroom curriculum.

During July 1997, OM representatives visited Goddard Space Flight Center (GSFC) and presented the philosophy of the OM program to a diverse group from GSFC and NASA Headquarters. After their presentation, it was readily apparent that OM could provide a unique forum for students to learn more about NASA's comprehensive program to study the Earth as an environmental system, the Earth Science Enterprise. A unanimous decision to support an Earth Science problem prompted the return of the OM staff to GSFC in November 1997. After a day of intense discussions with NASA scientists, educators, and other members of the EOS staff, a prototype of the problem was formulated; the final version of the problem follows:

The Problem – EnvirOMental Challenge

"The team will present a performance about an Earth species that requires atmosphere, water and land for survival, whose present habitat suffered disruption and is now uninhabitable. Four potential new habitats are available but whether the species can live in any of them is unknown. During the performance, the team will collect samples representing atmosphere, water and land from the habitats and analyze them with a discriminating device to determine if each habitat is suitable for the species. The result of these evaluations must be communicated to each site by a non-verbal method. Time Limit is 8 minutes. Cost Limit is $100."

Just as scientists use satellites and other tools to study the Earth, NASA hopes that by supporting an OM problem it will inspire students to gain a better understanding of the global environment by

(Continued on page 34)

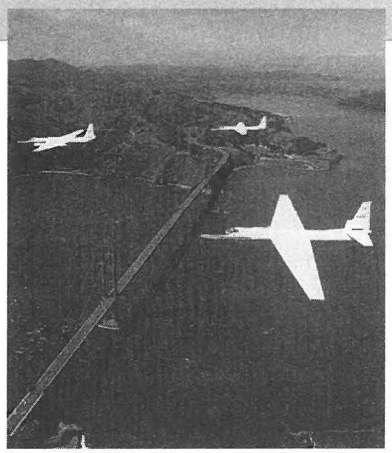
NASA Demonstrates New Technology for Monitoring Fires from Space

— David D. Herring (dherring@climate.gsfc.nasa.gov), Science System & Applications, Inc. (SSAI), EOS AM-1 Outreach Coordinator

Earth scientists at NASA's Goddard Space Flight Center recently demonstrated that the MODIS instrument, scheduled to launch in mid-1999 on NASA's Earth Observing System AM-1 satellite, will have unprecedented abilities to detect forest fires anywhere on the surface of our planet. In two scientific papers forthcoming, the scientists announce that MODIS will measure the intensities of fires and will therefore enable them to detect active fires and accurately estimate rates of combustion, as well as derive the amounts of emission products—such as smoke, greenhouse gases, and aerosol particles—they produce.

According to the papers' principal authors, Yoram Kaufman (GSFC) and Chris Justice (U. of Virginia), the new fire monitoring capability MODIS provides could greatly enhance our abilities to more-efficiently manage natural resources and more-effectively combat wild fires. Moreover, in concert with other space-based sensors including the MODIS scheduled to fly on EOS PM-1 in the year 2000, MODIS will enable scientists to assess the impacts fires may have on air quality near local communities, or even metropolitan areas.

Kaufman, EOS AM-1 project scientist, explains that due to MODIS' moderate (1 km) resolution, most fires will appear relatively small from its perspective in orbit. Consequently, it will only detect



During the SCAR campaigns, the MODIS Airborne Simulator was flown aboard NASA's ER-2 aircraft (pictured above).

about 25 percent of the fires burning worldwide. Yet, because those are the larger, more-intense fires, they are responsible for 80-to-100 percent of the biomass burned.

"This is an important point, because until recently, scientists didn't fully understand the relationships between the radiative energy a fire emits, its rate of combustion, and the resulting emission products," Kaufman states. Based upon the results from the 1995 NASA-sponsored "Smoke, Clouds and Radiation" (SCAR) campaign in Brazil, the authors conclude that "a fire's radiative energy output is highly correlated (97 percent) with the generation of the burn scar and therefore with the consumption of biomass."

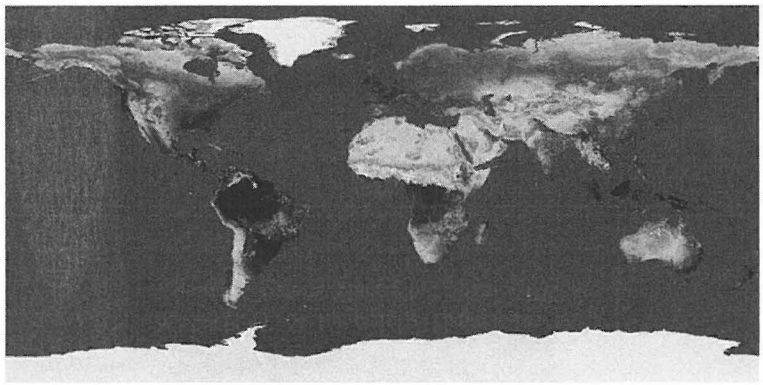
Fires generally burn at temperatures anywhere from 500 K to 1400 K (440°F to 2060°F). Fires toward the higher end of this range become so hot they actually burn down into the soil—in addition to consuming plants, leaching the soil of its essential nutrients for sustaining life. Because MODIS is more sensitive to fires' temperatures than previous satellite remote sensors, scientists can better assess the damage they cause, as well as help firefighters prioritize which fires are in most urgent need of fighting.

"For individual wild fires," Kaufman continues, "the rate of combustion is an indicator of the strength and danger of a fire, and can be useful to firefighters in decisions on whether or not to fight the fire, as well as in developing a strategy for fire containment and suppression."

Scientists will try to use the MODIS data to determine the phase of a given fire—whether it is flaming or smoldering (flaming combustion is the least polluting). Although the rate of combustion is higher during the flaming phase, more smoke, aerosol particles, and greenhouse gases are emitted during the smoldering phase due to the lower combustion efficiency. Therefore smoldering fires have the greatest influence on regional pollution and, potentially, on global climate change. "From late May to early July, there were more than 1,900 fires in Florida that burned more than 425 square miles of land in and around urban communities. Most of the fires are believed to have been caused by lightning strikes. An estimated 40,000 residents were evacuated from their homes, while citizens in neighboring counties with respiratory problems were urged to remain indoors due to health risks presented by the heavy smoke emissions."

In recent months, the public media have focused on a number of unusually large fires burning in various parts of the world. In October 1997, smoke from the

widespread burning in Indonesia covered a large portion of the Asia-Pacific region and was linked to a high number of health problems and some deaths in that country. Since early May of this year, more than 1,000 fires have burned in Southern Mexico and Central America, producing a cloud of smoke so dense and widespread that visibility in parts of southern Texas was reduced to 2 km. Some flights in that region were cancelled due to poor visibility and 53 counties were placed on a health advisory.



This Earth image shows a combination of fire data taken globally by two different remote sensing satellites during two different time periods. Those regions with brighter pixels (Central America, Venezuala and Brazil, Central and Southern Africa, Madagascar, Southeast Asia, Indonesia, and Northern Australia) are a composite picture of where fires occurred during the time periods from April 1992 to May 1993, and from October 1994 to March 1995. Data from the Defense Meteorological Satellite Program's (DMSP) Operational Linescan System (OLS) and the National Oceanic and Atmospheric Administration's (NOAA) Advanced Very High Resolution Radiometer (AVHRR) were used to produce this experimental fire imagery. The AVHRR data were processed by the International Geosphere-Biosphere Program Data and Information System (IGBP-DIS). (Credit: Rob Simmon, EOS AM-1 Visualization Team)

"Most people are unaware how extensive fire is on our planet," observes Justice, lead scientist for the MODIS Land Discipline Group. "With increasing variability in weather events and climate, we're likely to see changes in fire frequency and extent and the associated disturbance to natural and managed ecosystems. For example, we have seen considerable interannual variability in fire occurrence in Brazil, Africa, and Florida, United States, over the last few years. The occurrence of large fires near populated areas in California in recent years has caused considerable concern for state and local authorities and highlighted the need for improved fire management and monitoring."

Co-author Darold Ward, of the U.S. Forestry Service, states that an estimated 6 petagrams (about 6.3 billion tons) of biomass are burned worldwide each year. He notes that about 80 percent of all biomass burning takes place in tropical countries. About 3-to-5 percent of the worldwide total—or 7 million acres—is burned annually here in the United States.

"Approximately 2-to-5 million acres are burned by wild fires in the U.S. each year," Ward states, "while 5 million acres are burned as 'prescribed' fires, or fires that are beneficial in managing the ecosystems. Prescribed fires are deliberately planned and set by fire management officers for a variety of reasons."

Forest managers often set prescribed fires to prepare a particular site for tree planting, as well as to kill undergrowth to reduce the competition from unwanted vegetation. Prescribed fires are used extensively for wildlife habitat improvements. Prescribed fires are also set and managed to reduce the potential hazard of larger, uncontrolled wild fire outbreaks. These fires reduce dead vegetation, or consume "fuel," that has accumulated on the forest floor.

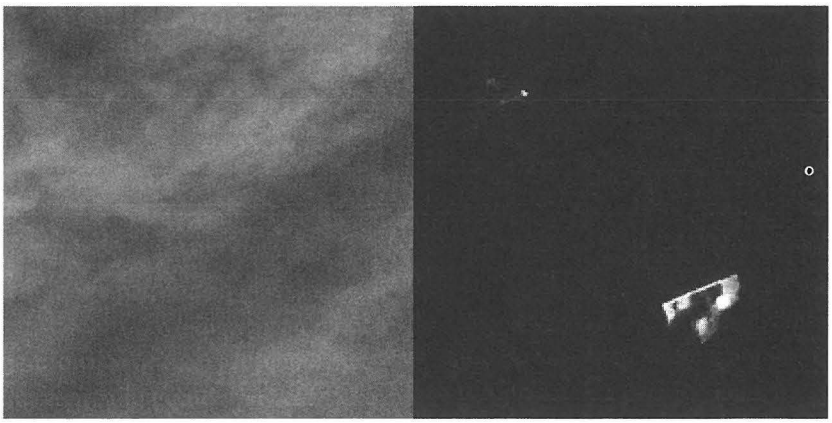
"In the western United States, forests have been well-protected from fire for the last 60-70 years," Ward explains. "These ecosystems that evolved in the presence of occasional 'natural' wild fires are now developing 'unnaturally' in competition with off-site species. Consequently, the forests have become unhealthy because of the large amount of dead and dying vegetation. This may lead to the spread of insects, disease, and to disastrous wildfires.

"So, we recognize that fires are an important part of the ecosystem and we're trying to bring them back into the ecosystem in a responsible way," Ward concludes. "This requires fairly aggressive prescribed burning by land managers. We think MODIS data will be useful in helping us monitor their smoke output in light of air quality regulations. Additionally, through remote sensing, we can do a better job of assessing the impacts of fires in restoring the fire-dependent ecosystems."

MODIS' advanced fire monitoring capabilities were first tested during the

Tropical biomass burning and smoke plume, Central Brazil, near the Xingu River, August 23, 1995. This image was created from multispectral MAS data with 50-meter nadir pixel resolution.

SCAR campaign held in Brazil in 1995. Jointly sponsored by NASA and the Brazilian government, SCAR was conducted by a team of government and university scientists from both nations. During the campaign, a MODIS Airborne Simulator was flown aboard NASA's ER-2 aircraft (a U-2 airplane modified for science use) at altitudes of up to 40,000 feet. The purpose of this simulator is to enable scientists to gather "MODIS-like" data so that they may refine their data processing techniques in anticipation of the launch of the real MODIS.



Coincident images of the Brazilian rain forest, at 0.657 μm and 4.05 μm, respectively. The visible light image shows only smoke, while the thermal infrared image show details of the fire beneath it. They were acquired by the MODIS Airborne Simulator on August 23, 1995.

According to Elaine Prins, co-author and research scientist with the NOAA/NESDIS Office of Research and Applications, MODIS is an improvement upon previous satellite sensors due to its higher "saturation thresholds" as well as its larger number of spectral channels to better characterize the atmosphere and fires. By analogy, the sun is so bright that it quickly "saturates" a human eye when looked at directly. Similarly, remote sensors can become saturated when viewing hot, bright fires, rendering it impossible for them to distinguish important characteristics about that fire, such as its rate of combustion.

"The primary fire detection channel on the AVHRR (Advanced Very High Resolution Radiometer) has a saturation threshold of approximately 320 K," Prins states. "MODIS has four channels that are sensitive to fires. Two are located in the infrared portion of the electromagnetic spectrum at 4 and 11 micrometers with thresholds at 500 K and 400 K, respectively, and can be used to monitor fires day and night. The other two are located at 1.6 and 2.1 micrometers for nighttime fire detection."

Once certain of its viewing pixels pass the "brightness temperature" test that identifies them as potential fires, the data are then computer processed to differentiate them from background pixels that are obviously not fire. Then, the 4-micrometer channel data are compared with data from MODIS' 11-micrometer channel to provide an additional perspective. The 4- and 11-micrometer channels were chosen because they are "window" channels that enable remote sensors to "see" more clearly through the atmosphere than most other channels. At night, MODIS can use its 1.6- and 2.1-micrometer channels for detecting fires, when data in these channels are acquired. NASA is planning two field campaigns in 1999 to test the accuracy of the MODIS fire product for Brazil and Southern Africa, two major fire regions of the World.

According to the authors, MODIS data will also be applied in other useful and relevant ways. For instance, a fire-potential product is being developed to indicate what regions are susceptible to wild fire outbreaks. Another co-author plans to use MODIS data to monitor volcanoes and, based upon sudden temperature increases, help forecast when a given volcano is about to erupt.

In cooperation with MODIS science team members, as well as other agencies such as NOAA, the EOS AM-1 outreach team created a Global Fire Monitoring Web site. The URL is http://modarch.gsfc.nasa.gov/fire_atlas.

The purposes of this site are to provide an up-to-date view of fires around the globe on a "near-real-time" basis, and to provide an evolving view of the state of the science with respect to emissions of greenhouse gases, smoke, and particles from fires.

NASA Satellite Sheds New Light on The La Niña Phenomenon

— David E. Steitz, Headquarters, Washington, DC (202) 358-1730
— Allen Kenitzer, Goddard Space Flight Center, Greenbelt, MD (301) 286-2806

Research scientists using data from the recently launched Tropical Rainfall Measuring Mission (TRMM) satellite, a joint U.S/Japanese mission, are shedding new light on the phenomenon known as La Niña. TRMM research team members have successfully retrieved sea-surface temperature data from the TRMM Microwave Imager (TMI) instrument onboard the spacecraft.

These data are giving scientists new insight into the complex evolution of the La Niña event—the TMI is the only spaceborne microwave instrument observing sea-surface temperature in the tropics at the optimal 10.7 Ghz frequency. The images show changes in sea-surface temperature, and ocean current movement and the dissipation of El Niño. While it is too early to draw definite conclusions, the results to date appear to confirm the onset of La Niña type conditions.

"TMI is an all-weather measuring instrument that can see through clouds," said Dr. David Adamec, oceanographer at the Goddard Space Flight Center, Greenbelt, MD. "The standard instrument (infrared radiometer), used to measure sea-surface temperature, must contend with clouds and atmospheric aerosols. Clouds block the flow of data, yet an uninterrupted consistent data stream is crucial for long-term climate study."

La Niña is essentially the opposite of the El Niño phenomenon and is characterized by unusually cold ocean temperatures in the equatorial Pacific, as compared to El Niño, where ocean temperatures are warmer than normal. Historically, an oscillation of pressure and temperature, measured at several sites in the South Pacific, and El Niño have been discussed together and termed the El Niño Southern Oscillation or "ENSO." La Niña sometimes is referred to as the cold phase of the ENSO.

At the Earth's surface, La Niña effects on the world's climate tend to be opposite those of El Niño. At higher latitudes, El Niño and La Niña are just two of several factors that influence climate. However, the impacts of El Niño and La Niña at higher latitudes are most clearly seen in winter. During a typical La Niña year, winter temperatures are warmer than normal in the Southeast and cooler in the Northwest.

Knowledge of La Niña is not as mature as that for El Niño. For example, every strong El Niño is not necessarily followed by a La Niña. Scientists at Goddard are performing advanced studies of El Niño and La Niña through information obtained from satellites in space and instruments in the oceans.

Acquiring quality sea-surface temperature data via a microwave scanner has been a long-term aspiration among oceanographers for more than a decade. None of the previously existing microwave scanners had the capability of the TRMM Microwave Imager. Ideally, this information will be used for the improvement of weather forecasting, anomalous weather study, and a better understanding of ocean current alteration.

Several NASA missions study the effects of El Niño and La Niña with orbiting satellites. The joint U.S.-French TOPEX/Poseidon satellite measures sea surface height; the Sea- Viewing Wide Field-of-View Sensor (SeaWiFS) measures ocean color; and TRMM measures precipitation and sea-surface temperature. The Tropical Atmosphere-Ocean Array consists of nearly 70 moored buoys in the tropical Pacific designed by the National Oceanic and Atmospheric Administration (NOAA). The devices take real-time measurements of air temperature, relative humidity, surface winds, sea surface temperatures, and subsurface temperatures down to a depth of 500 meters. Data from these moored buoys are processed by NOAA and then made available to scientists.

The TRMM Microwave Imager instrument was provided by NASA. TRMM was developed jointly by NASA and Japan's National Space Development Agency (NASDA) and launched last November from NASDA's Tanegashima Space Center, Japan.

This La Niña research is part of NASA's Earth Science Enterprise, a long-term research program designed to study the Earth's land, oceans, air, ice, and life as a total system.

Images on this research are available at URL: http://www.eorc.nasda.go.jp/TRMM

NASA Earth Science Enterprise Education Program Update

1999 ESE Workshops Selected for NSTA National Conference

— Nahid Khazenie (nkhazeni@pop900.gsfc.nasa.gov), Earth Science System Program Office, NASA Goddard Space Flight Center

A call for proposals for NASA ESE workshops to be presented at the 1999 National Science Teachers Association (NSTA) conference was distributed in May to over 120 ESE education representatives at NASA HQ, all NASA Centers, and NASA education contracts and grants. The following proposals were selected for workshops to be presented at the 1999 NSTA conference, which will be held March 25-28, 1999, in Boston, Massachusetts.

Using Space Data in the Classroom: Some Examples—Neal Grandgenett and Elliott Ostler, University of Nebraska at Omaha

A Walk Through the PUMAS Web Site—Ralph Kahn, Jet Propulsion Laboratory

Promoting Interdisciplinary Education Within the Earth Sciences—Diane Schweizer and Catherine Gautier, Planet Earth Science

Discover Earth—Colleen Steele, IGES, and Blanche Meeson, Goddard Space Flight Center

Get Global: NASA Langley/NSU Project — S. Raj Chaudhury and Gae Golembiewski, Norfolk State University

Talking to Satellites—Vern Smith, Goddard Space Flight Center

Using NASA Materials to Design a Standards-Based Lesson Plan—Gil Yanow, Jet Propulsion Laboratory, and Bennie Brankhorst, California State-San Bernardino

Using Remote Sensing to Study Weather Patterns—Joan Sanders, Goddard Space Flight Center

EOSDIS Data Sampler CD-ROM Now Available

The Earth Observing System Data and Information System (EOSDIS) User Services Working Group (USWG) has produced a multi-media CD-ROM to provide an introduction to EOSDIS and the data and information products currently available through the EOSDIS Distributed Active Archive Centers (DAACs). To request a complimentary CD, send your name and address to: Anne Racel, USWG Chair, EOSDIS/NASA Langley DAAC, A.M.RACEL@LaRC.NASA.GOV, (757) 864-9587, or Bill North, ESDIS Project/NASA GSFC, Bill.North@gsfc. nasa.gov, (301) 614-5301.

Resources On The Internet

Especially for Kids

http://response.restoration.noaa.gov/kids/kids.html

This National Oceanic and Atmospheric Administration (NOAA) site allows elementary and secondary students to learn about oil spills & hazardous chemical accidents through experiments that can be done at home, in the classroom, or for a science project.

International Year of the Ocean

http://www.yoto.com/

This is official WWW site for the 1998 International Year of the Ocean. This site includes ocean news and information on events, as well as sections on conservation and education; fisheries; recreation; science; technology; arts and entertainment; commerce; and coastal living.

NASA Unveils New Internet Site For Fire Monitoring By Satellite

http://modarch.gsfc.nasa.gov/fire_atlas/fires.html

In an effort to provide up-to-date information about current fire situations around the globe to the public and scientific communities, NASA has developed a WWW site that provides an up-to-date synopsis of current information about fires and their effect on global climate change. This site features animation depicting wildfires across the globe and provides recent imagery and analysis of data from the early and mid-1990s.

The Northern Right Whale Monitoring Project

http://www.onr.navy.mil/sci_tech/ocean/Info/NRtWhale/

This Office of Naval Research site lets students listen to dolphin and whale calls and learn about the Navy's effort to save the Northern Right Whale from extinction.

OCEANSP@CE Online Newsletter

OCEANSP@CE is a free online marine

science and ocean technology newsletter targeted for those in ocean-related professions and college-level audiences. Articles have highlighted conferences and meetings, research projects, and Internet resources. To join the e-mail listserv, please send an e-mail to: Oceanspace@dial.pipex.com.

Resources For Involving Scientists In Education
http://www.nas.edu/rise/

Established in 1989 by the National Academy of Sciences/National Research Council, RISE conducts workshops and publishes materials to help scientists and engineers play effective roles in improving science education from kindergarten through high school. In November of 1996, RISE sponsored a working conference for representatives of the nation's most effective local, regional, and national partnerships between scientists and K-12 educators. These participants then generated the substance and form of this Internet resource.

The University Of California Museum Of Paleontology
http://www.ucmp.berkeley.edu/

Features online exhibits and activities that allow you to experience the excitement of discovering and reconstructing a dinosaur, see underwater photos of a great white shark, trace the pattern of events that led to the diversity of life, and more. Sponsored by the National Science Foundation.

U.S. Global Change Data & Information System
http://www.gcdis.usgcrp.gov/

GCDIS maintains global change information from nine federal agencies and offers a question answering service, "Ask Dr. Global Change."

(Continued from page 28)

NASA's Earth Science Enterprise/Earth Observing System Supports an Odyssey of the Mind Problem

exploring the interaction between the Earth's systems of air, land, water, and life. Earth scientists rarely work independently of one another; instead, they bounce ideas around, build on research made by other Earth scientists, and try to solve problems collectively by sharing knowledge and experience. One of OM's overall goals is to help students work similarly by learning skills such as "working with others as a team, evaluating ideas, making decisions, and creating solutions".

The *EnvirOMental Challenge* was designed to encourage students to think critically and cooperatively about a complex problem in the same way that Earth scientists, weather forecasters, farmers, fishermen, politicians, and planners must confront daily the dual challenge of understanding how natural processes affect humanity, and how we affect those same natural processes. NASA is proud to include OM in a long list of partners who are working together to improve our knowledge of the Earth and to use that knowledge for the benefit of all humanity.

Goddard Space Flight Center's EOS Project Science Office participated in this year's 1997/98 World Finals, which were held at Walt Disney World in Orlando, Florida. The objective was to distribute NASA Earth Science Enterprise and EOS materials with the goal of promoting the 1998/99 EnvirOMental Challenge problem. The 1998/99 World Finals will be held at the University of Tennessee at Knoxville, May 26-29.

Additional information on Odyssey of the Mind can be found at www.odyssey.org. NASA's Web site to assist OM teams in solving the problem is located at http://eospso.gsfc. nasa.gov/om.html.

(Continued from page 20)

Moderate Resolution Imaging Spectroradiometer (MODIS) Science Team Meeting Summary

latest round of budget cuts. He stated that over the next few weeks the electronic crosstalk problem will be further analyzed. More definitive information should be available by August, and Team members will be notified about the status of this issue. The AM-1 adaptive processing proposal is another issue in progress, and the Team will be kept apprised of its status. The next Science Team meeting will likely be held in November 1998.

EOS Science Calendar

September 15-17
CERES Science Team Meeting, Suny, Stony Brook, NY. Contact: Theresa Hedgepeth, e-mail: t.c.hedgepeth@larc.nasa.gov.

September 22-24
Land Processes DAAC Science Advisory Panel meeting, USGS EROS Data Center, Sioux Falls, SD. Contact: G. Bryan Bailey, tel. (605) 594-6001.

September 22-24
HDF-EOS Workshop II, Landover, MD. Contact Ben Kobler, e-mail: ben.kobler@gsfc.nasa.gov, URL: http://hdfeos.gsfc.nasa.gov/hdfeos/workshop2.html.

September 29 - October 1
Landsat Science Team, Patuxent Wildlife Visitor's Center and NASA/GSFC, Greenbelt, MD. Contact Jeff Masek, tel. (301) 405-8233, e-mail: jmasek@geog.umd.edu.

October 13-15
Joint TOPEX/Poseidon-Jason-1 Science Working Team Meeting, Keystone, Colorado. Contact Shannon Andrews, e-mail: Shannon_Andrews@qgate.ucar.edu.

October 19-21
EOS Investigators Working Group Meeting, New England Center, Durham, NH. Contact Mary Floyd, tel. (301) 220-1707, e-mail: mfloyd@pop200.gsfc.nasa.gov.

October 20-22
AIRS Team Meeting, Lexington, Mass. Contact: Dr. H. H. Aumann, tel. (818) 354-6865.

November (TBD)
Joint AMSR Science Team Meeting, Tokyo, Japan. Contact: Elena Lobl, e-mail: elena.lobl@msfc.nasa.gov

Global Change Calendar

September 12-17
SPIE's First International Asia-Pacific Symposium on Remote Sensing of the Atmosphere, Environment & Space, Beijing, China. Contact Jinxue Wang, e-mail: Jwang@eos.ucar.edu.

The European Symposium on Remote Sensing, Barcelona, Spain. Contact Steve Neeck, e-mail: steve.neeck@gsfc.nasa.gov; URL: http://www.europto.org/.

September 27-October 2

13th AIP International Congress, Fremantle, Western Australia. Contact Prof. Brian O'Connor, e-mail: promaco@promaco.com.au; URL: http://www.promaco.com.au.

October 5-7

Fifth International Conference on Remote Sensing for the Marine and Coastal Environments, San Diego. Contact Robert Rogers, tel: (313) 994-1200, ext. 3234, fax: (313) 994-5123, e-mail: marine@erim-int.com; URL: http://www.erim-int.com/CONF/conf.html.

October 25-28

Geological Society of America, Toronto. Call (303) 447-2020; fax: (303) 447-0648.

Oct. 29-Nov. 1

First International Conference on GIS Education, Ypsilanti, MI. Contact Jay Morgan, tel. (410) 830-2964, e-mail: jmorgan@towson.edu.

November 16-19

Ocean Community Conference '98, Baltimore, MD. Contact Pete Allen, e-mail: mts-occ98@ieee.org.

December 6-10

American Geophysical Union (AGU), San Francisco, CA. Contact Karol Snyder, tel. (202) 939-3205.

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January 10-15

American Meteorological Society, Dallas, TX. Contact Richard Hallgren, tel. (617) 227-2426, ext. 201, e-mail: hallgrew@ametsoc.com.

January 18-22
International Symposium "Aerosols, clouds and radiation, land surfaces, ocean color: the contribution of POLDER and new generation spaceborne sensors to global change studies, Meribel, France. Contact Gerard Dedieu, email: Gerard.Dedieu@CESBIO.CNES.FR; URL: http://www.cnes.fr/actualities/ALPS99.

January 19-21
NASA, FEMA and GW University are sponsoring the 2nd Conference on "The Applications of Remote Sensing and GIS for Disaster Management," Washington, DC. Abstracts and papers are requested. Contact Greg Shaw, tel. (703) 729-8271, e-mail: glshaw@gwu.edu; URL: http://www.gwu. edu/~cms/gis/

March 1-3
Thirteenth International Conference and Workshops on Applied Geologic Remote Sensing, Vancouver. Contact Marilyn Dehring, tel. (734) 994-1200, ext. 3350, e-mail: dehring@erim-int.com.

March 23-26
Progress in Electromagnetics Research Symposium (PIERS 1999), Taipei International Convention Center, Taipei, Taiwan. Call for papers. Contact: Prof. Kun Shan Chen, PIERS 1999, Center for Space and Remote Sensing Research, National Central University, Chung-Li, Taiwan. tel. (886) 3-425-7232; Fax: (886) 3-425-5535, e-mail: dkschen@csrsr.ncu.edu.tw. or contact Ms. Mei Yuan Lai, tel. (886) 3-425-7232; fax: (886) 3-425-5535, e-mail: maylai@csrsr.ncu.edu.tw; URL: http://piers1999.csrsr.ncu.edu.tw/.

April 27-29
Oceanology International Pacific Rim 99, Singapore. Call for Papers. Contact Versha Carter, tel. +44 (0) 1818 949 9222, e-mail: carter@spearhead.co.uk; URL: http://www.spearhead.co.uk.

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