



# THE EARTH OBSERVER

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## EDITOR'S CORNER

**Michael King**  
EOS Senior Project Scientist

The year 2000 marked a major milestone in the development of the Earth Observing System, with unprecedented new global measurement capabilities and science results from the EOS satellite Terra, complemented by those from Landsat 7, QuikScat, ACRIMSAT and EO-1. As exciting as this year has been, it is merely the beginning of an aggressive and comprehensive spaceborne global monitoring campaign, and will greatly increase the frequency and significance of new Earth science discoveries.

Many of these new science discoveries were presented at the Fall American Geophysical Union conference held in San Francisco in December. Several important Earth science findings were published in a variety of disciplines, including hydrology, atmospheric chemistry, oceanography, and glaciology. Many of these findings were presented during two dedicated Terra sessions. A Terra-biosphere-results session was chaired by Terra Project Scientist Jon Ranson, and an atmospheric results session was chaired by John Gille and Yoram Kaufman. This diverse suite of new research applications demonstrates the comprehensive global monitoring capabilities of the EOS program, and is indicative of its certain contributions in the near future.


Also during the AGU meeting, a special NASA Town Hall meeting was held to discuss NASA's New Strategic Plan for Earth Science Research, and to solicit feedback from the diverse audience. Associate Administrator for Earth Science, Ghassem Asrar, and Director of the Research Division, Jack Kaye, presented the new Research Strategy that will be used to prioritize and structure solicitations for new measurement capabilities. The Research Strategy is a living document and will continue to be refined with the input of the broader Earth science community.

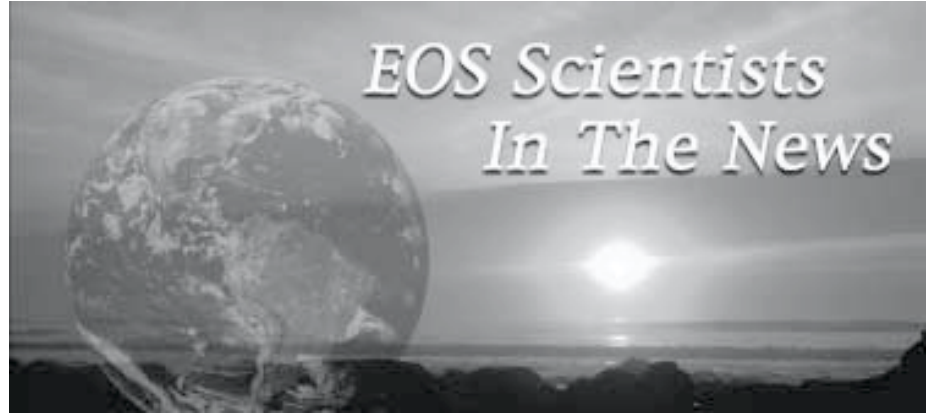
I'm pleased to announce the availability of a new Terra Data Sampler, produced by the EOS Data and Information System. It contains a variety of data from Terra instruments obtained for the Western U.S. wildfires that occurred in the fall of 2000. All data on the CD-ROM are in HDF-EOS format, and include comprehensive documentation and viewing tools. It is

*(Continued on page 2)*

compatible with all computer systems capable of reading an ISO 9600 CD-ROM, and its imbedded HTML links will provide real-time access to external data and reference materials. This package will aid in familiarizing data users with new data applications, formats, and analysis tools. To obtain a copy of the Terra Data Sampler CD-ROM, contact the EOSDIS Science Operations Office by e-mail at outreach@eos.nasa.gov.

The EOS Project Science Office has also produced the 2001 volume of the EOS Global Change Media Directory. This valuable reference provides journalists and other media professionals with a ready source of international expertise on global change science and policy. The 343 scientists included in this directory represent over 30 scientific disciplines at the center of NASA's EOS program, from ozone chemistry and natural hazards to global warming and ecosystems. The scientists listed in the Directory have expressed an interest and willingness to work with the media, and many have offered to respond to inquiries within 24 hours. The Global Change Media Directory is available online from the Newsroom of the Earth Observatory Web site at earthobservatory.nasa.gov/Newsroom/.

Finally, I want to express my congratulations to all of those who have contributed to an extremely successful year for NASA's Earth Science Enterprise. Now we are eagerly anticipating the launches of METEOR 3M/SAGE III, Jason-1, QuikTOMS, Aqua, ESSP/GRACE, ADEOS II, and ICESat. May 2001 be just as successful as 2000. 



**“Rain Maps Show Air Pollution Hinders Rainfall,” (December 19)  
CNN.com, CNN cable, United Press International**

Daniel Rosenfeld (Hebrew University of Jerusalem), Robert Adler (NASA Goddard) and Edward Zipser (University of Utah) discussed new rain maps from the TRMM satellite that show how smoke can reduce rainfall from a storm by as much as half compared to the same kind of storm over the ocean.

**“Ozone Layer Over Arctic is Not Healing Quickly,” (December 18)  
CNN.com, CNN cable, Associated Press**

NASA Goddard's Paul Newman and Dale Hurst (NOAA) discussed that bromine may be preventing the Arctic ozone loss from recovering, even though chlorine levels are dropping.

**“Satellite Images Show Africa's River of Smoke,” (November 30) CNNfn, AllAfrica Inc.**

Robert Swap (University of Virginia) and Peter Hobbs (University of Washington) were interviewed about their involvement in the SAFARI 2000 field campaign, which monitored pollution from biomass

burning over southern Africa this summer.

**“Robots in the Sky,” (November 2000)  
Scientific American**

Judy Curry (University of Colorado) is using unmanned aircraft in Alaska to gather weather data and fill in data-poor areas in the Arctic. Curry hopes to use them to enhance global weather forecasts and monitor the movement of Arctic sea ice.

**“Satellite Eyes Coral Reefs,” (October 31) Discovery.com**

Frank Muller-Karger (University of South Florida) and Darrel Williams (NASA Goddard) discuss how NASA's Landsat 7 imagery is providing a quicker and more cost-effective way of monitoring coral reefs around the world.

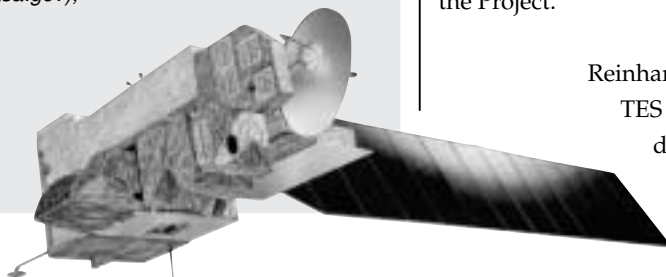
**(Now the Ebola Forecast,” (October 19)  
New Scientist**

Compton Tucker (NASA/Goddard) and Jim Wilson (World Health Organization) used satellite data to monitor wet and dry conditions and believe a rare climate pattern precedes outbreaks of the deadly Ebola disease.

***(Continued on page 27)***

## Aura Fall Annual Meeting

— Anne Douglass ([douglass@persephone.gsfc.nasa.gov](mailto:douglass@persephone.gsfc.nasa.gov)),  
NASA Goddard Space Flight Center



The Aura Fall Annual Meeting (AFAM) for the Aura project was held Tuesday and Wednesday, October 17-18, 2000, in Easton Maryland. The AFAM replaced the Chemistry Annual Project Steering Meeting (CHAPS) for Fall 2000. After the delta critical design review (CDR) for the spacecraft on September 11, meetings of the Mission Operations Working Group and the Integration and Test Working Group occurred. Thus the Project decided not to schedule CHAPS as such and to have a reduced meeting that allowed more time for discussions of Aura validation. The focus of the AFAM was limited to the remaining working groups (Algorithms, Education and Outreach, Data Systems, Aerosols, and Validation).

Mark Schoeberl (Project Scientist) introduced formation flying to the science team and discussed the benefits of acquiring MODIS cloud and aerosol products very close in time to an Aura fly over. In general, each of the instrument PIs saw value in acquiring nearly simultaneous MODIS data with formation flying but also saw some complications and felt more analysis was needed. A second formation flying group meeting was held at Goddard on November 28 with the PIs of CloudSat, PICASSO-CENA, PARASOL, and Aqua making presentations.

Peg Luce, Aura Project Manager, gave an update on project activities and the latest activities on the spacecraft buildup at TRW. Although Aqua will pave the way for Aura, Aqua difficulties and schedule delays could have an impact on Aura's schedule.

John Liacono (Aura Deputy Project Manager) gave a report on the instrument and spacecraft status. His presentation focussed on delivery of subsystems; there has been rapid tangible progress during the last year, which is expected for a project that is in this part of its life cycle relative to the expected launch date of summer 2003.

John Gille gave a status report on HIRDLS development and discussed the algorithm for dealing with variability in temperature and constituent mixing ratio along the line of site.

Joe Waters provided an update on MLS development and discussed retrievals for CH<sub>3</sub>CN (methyl cyanide) and posed the problem on how these data would be validated.

Bert Van de Oord gave an update on the status of the OMI instrument. The demonstration model, with only UV channels, is undergoing tests at the contractor facility, which will demon-

strate its spectral imaging capability. OMI Level 1 requirements and the primary data deliverables were officially presented to the instrument teams and the Project.

Reinhard Beer reviewed TES development and discussed TES's ability to detect tropospheric ozone. Cal-

culations utilize ozone sonde profiles to simulate TES observations. These simulated observations are utilized in the TES retrievals, and results are compared with the original profiles. Results of this study indicate that ozone will be detectable at several levels in the troposphere.

Dolly Perkins, the ESDIS Project Manager, discussed the EOSDIS funding status. EOSDIS was under a lot of stress because of budget constraints set by NASA HQ. Aura is expected to get funding and is not likely to suffer as a result of Terra or Aqua pressures for more funding.

### Aerosol Working Group

Representatives from the HIRDLS, OMI, and TES science teams attended a working group meeting (Steve Massie, chair). The OMI representative stated that the AERONET network would be a primary source of correlative data. Information on characteristics of aerosols (size distributions, composition) in the upper troposphere is needed by all three teams. It was also clear that the group needs to obtain (or modify) existing codes so that the influence of multiple scattering can be examined.

## Algorithm Working Group

A brief meeting was held on Tuesday evening (Nathaniel Livesey, chair). There are plans to utilize constituent output from the MOZART model to test algorithms and compare results among the instrument teams. Although only one day will be considered in detail, it is important that atmospheric variability be realistic. The integration can be completed using input winds from the Terra system of the NASA GSFC Data Assimilation Office.

## Education and Public Outreach

Aura's outreach program includes the American Chemical Society which will reach 30,000 high school chemistry teachers on atmospheric chemistry and measurements from space. The Smithsonian's National Museum of Natural History will develop a display on atmospheric chemistry in conjunction with its Global Links program. Drexel University is developing a low cost instrument and protocol to measure UVA and UVB, along with aerosols, for the GLOBE program (public schools, K-12), which has international participation. Aura's new Website was presented to the attendees for their comments. Scheduled launch of the Website is January 2001.

The main subject of the Fall Annual Meeting concerned validation of the Aura data products. Prior to this meeting, Lucien Froidevaux (Chair, Validation Working Group) had assembled a comprehensive version of a validation document. At this meeting, a subgroup attempted to set priorities for validation. Criteria used for the stratosphere were data continuity and importance of the constituent measurement to understanding changes in the ozone layer. For the troposphere, the

criteria were key species that are fundamental to ozone production.

Discussion on Wednesday morning concerned lessons learned from the correlative measurement campaign for the Upper Atmosphere Research Satellite (UARS). Mike Kurylo (NASA HQ) commented that, in the case of UARS, correlative measurements were made in the first years after launch. Later, science applications contributed to the overall validation effort. Phil DeCola (NASA HQ Aura Program Scientist) and Vicki Connors (NASA HQ Acting Head of the Tropospheric Chemistry Program) also participated in the meeting discussion.

Lynn Sparling (NASA GSFC) showed an analysis of aircraft observations of ozone to highlight the differences between geophysical variability and instrument errors. Such analyses are of importance to the Aura platform because of the emphasis on the lower stratosphere and upper troposphere, where synoptic variability plays a significant role. It is not obvious how to compare *in situ* observations made along an aircraft flight track with remote measurements when there is significant geophysical variability along the flight path that defines the footprint for a single remote observation.


The remainder of the meeting centered on reports from the Snowmass working groups. These groups were formed to define aircraft missions that could fulfill the following roles: (a) test realistic scientific hypotheses; (b) be part of the satellite validation; and (c) utilize both satellite and *in situ* measurements to address science goals and questions related to hypotheses in (a).

Darryn Waugh (Johns Hopkins) presented arguments for investigations of

the tropical upper troposphere/lower stratosphere. The physical and chemical processes in this region have a strong influence on both ozone and water vapor and represent key couplings between atmospheric composition and climate. Ross Salawitch (JPL) argued for measurements of a variety of constituents at the tropical tropopause. Jim Holton (University of Washington) argued for tropical measurements to clarify the mechanisms for entry of dry air into the lower tropical stratosphere.

Daniel Jacob (Harvard) presented a broad agenda for aircraft observations in the troposphere. The missions said to have the most support from the aircraft community are the Intercontinental Chemical Transport Experiment (INTEX) and LARS TRACE B. Both of these are considered excellent missions; LARS TRACE B takes advantage of the LBA Project in the Amazon basin and must take place while the ground-based observations that are part of the Large Biosphere-Atmosphere Experiment in Amazonia (LBA) Project are in progress (through 2004).

Mark Schoeberl charged Steve Massie (Aerosol Working Group) with the task of developing a validation plan for aerosols. Each of the four instruments on Aura has some products that are related to aerosols.

Writing assignments were made with deliveries due in November. Most of these have been received. The Validation Working group will now be finishing up version 1.0 of the document. For further information on the Aura project, instruments, and working groups, visit the EOS Aura Project Home Page, (<http://eos-aura.gsfc.nasa.gov>). 

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

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

The 22nd Clouds and the Earth's Radiant Energy System (CERES) Science Team meeting was hosted by Ron Welch at the Bevell Conference Center, University of Alabama in Huntsville (UAH), on September 20-22, 2000. The Science Team approved release of validated Terra CERES Level 1 radiance data products as well as the global Earth Radiation Budget Experiment (ERBE)-like top-of-atmosphere (TOA) fluxes. Early "Beta" products were already available at the Langley Atmospheric Sciences Data Center (ASDC), and the new CERES data will be the first validated Level 1-3 Terra Data Products available to the science community for research and publication. Data Quality Summaries will be completed this Fall and the Edition 1 data products will appear at the ASDC by December. The merged Tropical Rainfall Measuring Mission (TRMM) cloud property/radiation data product (Single Scanner Footprint, SSF) was also approved. The next Science Team meeting is scheduled for January 23-25, 2001 at the NASA Langley Research Center (LaRC).

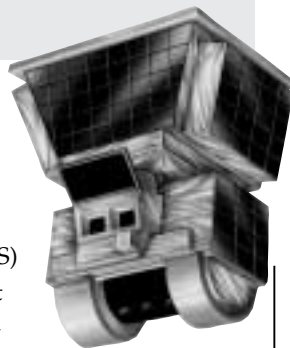
The next meeting will focus on science team results, geostationary diurnal corrections, early Angular Distribution Model (ADM) results from SSF data products, Surface and Atmospheric Radiation Budget (SARB), Chesapeake

Lighthouse and Aircraft Measurements for Satellites (CLAMS) plans, instrument deep space determined offsets, and improved spectral corrections.

Bruce Wielicki (LaRC), CERES Co-Principal Investigator, opened the meeting with an Earth Observing System (EOS) program status report. The Aqua launch date has slipped to July 2001. Wielicki is continuing to work with the science community, including modelers, to evolve the EOS science strategy. Bruce Barkstrom (LaRC), CERES Co-Principal Investigator, discussed the science impact of the present bounds on Earth Observing System Data and Information System (EOSDIS) hardware capacities.

### CERES Instrument Status

Kory Priestley (LaRC) presented the instrument status report. The Aqua instruments were delivered on schedule and have completed mechanical and electrical integration on the spacecraft. While no instrument problems have been encountered, there are outstanding spacecraft interface issues, including suspect traceability of spacecraft supplied bolts to mount the instruments



as well as spacecraft supplied deployment drives that continue to leak penzane oil. Priestley gave a 'post mortem' report on the CERES instrument on TRMM. The likely culprit for the demise of this instrument is the failure of an interpoint voltage converter. The Terra instruments have continued to function flawlessly since their launch in December 1999. These two instruments are currently in an opposing three-month operational cycle of rotating azimuthal plane and fixed azimuthal plane scanning. We expect that in early 2001 the Terra spacecraft will perform a Deep Space Calibration maneuver such that final measurements of the scan angle dependent offsets can be made.

### Terra Radiometric Validation

Kory Priestley (LaRC) led the session that reported results of 11 studies which quantify the radiometric performance of the CERES/Terra Flight Model 1 (FM1) and Flight Model 2 (FM2) instruments as well as their relative relationship with the CERES/TRMM and ERBE scanner instruments. These studies utilize data products ranging from instantaneous raw counts to temporally and spatially averaged TOA fluxes and are statistically robust at the sub 1% confidence level. The ground-to-flight traceability of the radiometric calibration is better than 0.3% for the total (TOT) and shortwave (SW) channels. The window channel calibrations both shifted by about 0.5%, but in opposite directions. Pointing accuracy has been established via coastline detection techniques to be better than 1.8 and 2.4 km at nadir for the FM1 and FM2 instruments, respectively. Tropical Deep Convective Cloud (DCC) investigations were used to establish both a three-channel intercomparison and SW albedo metric.

The three-channel intercomparison suggests an inconsistency between the FM1 SW channel and SW portion of the TOT channel at the 1.1% level while the FM2 instrument had no significant inconsistencies in the SW region. The DCC albedo metric demonstrates that the SW channels on all three CERES instruments agree to within 0.5%, suggesting the inconsistency in FM1 resides in the SW portion of the TOT channel. Results of a direct comparison of the FM1 and FM2 instruments on Terra conducted by Richard Green (LaRC) were in general agreement with the other studies. A direct comparison between the CERES instruments on TRMM and Terra performed by Martial Haeffelin (Virginia Tech) showed that Terra radiances are within 0.5% of the CERES/TRMM values.

### Terra ERBE-Like TOA Fluxes

Norman Loeb (Hampton University [HU]) conducted theoretical tests that showed that unfiltering algorithms are more robust for Terra SW compared to TRMM. Unfiltered SW and long wave (LW) radiance differences between FM1 and FM2 are small (less than 0.5%) and show no evidence for any systematic dependence on scene type or solar angle.

David Young (LaRC) updated the status of ERBE-like product validation for TRMM and Terra. He compared tropical means from 1998 CERES data with Earth Radiation Budget Satellite (ERBS) scanner five-year (1985-89) averages. Comparison of Terra results with the ERBE climatology was consistent with a similar comparison using TRMM data. A comparison of results from the crosstrack and rotating azimuth plane scan modes showed zonal mean differences less than  $2 \text{ Wm}^{-2}$  except at the Poles.

### Data Production

Erika Geier (LaRC) updated the team on CERES data product status, major SSF changes, subsetting data products (Langley ASDC can subset SSF, CRS, and ERBE-like instantaneous products), and CERES data distributed from the Langley ASDC. There have been some problems in receiving Terra data. Most data sources are available for March-May 2000, but June-August data are only available sporadically. Terra count conversion offsets previously set to zero have been updated to the ground-determined values. Reprocessing will be completed this fall.

### TRMM SSF Edition 1 Status and Early MODIS/TRMM comparisons

Patrick Minnis (LaRC) summarized recent improvements to the cloud algorithm. The  $1.6\text{-}\mu\text{m}$  calibration was revised, sub-pixel cloud contamination was minimized with a spatial variability test for aerosol optical depth (AOD) retrievals, a  $10'$  land/water mask was incorporated, three new parameters were added to SSF (fraction of pixels, and the mean  $0.6\text{-}$  and  $1.6\text{-}\mu\text{m}$  reflectances used for AOD retrievals), and three different  $3.7\text{-}\mu\text{m}$  reflectance models were compared to help explain differences in particle size. Preliminary cloud retrievals from the Moderate-Resolution Imaging Spectroradiometer (MODIS) were completed and compared to Visible Infrared Scanner (VIRS) results.

### Angular Modeling

Norman Loeb discussed ADM-related activities. LW ADMs were developed for clear and overcast scenes stratified by cloud properties. Progress was made on validating cloud property averaging over CERES footprints. A new method was developed for reducing angle-

dependent biases in satellite cloud optical depth retrievals. The approach will be used to develop CERES ADM optical depth classes, but will require more than the eight months of VIRS data.

### CERES Validation Experiments

Ken Rutledge (Analytical Services & Materials, Inc. [AS&M]) briefed the team on the status of the CERES Ocean Validation Experiment (COVE) site. Chesapeake Lighthouse is an ocean platform located 25 km from Virginia Beach, VA. COVE measures insolation, albedo, net LW flux, and AOD. The basic radiometric instrumentation has been installed using the recommendations of the Baseline Surface Radiation Network (BSRN).

Tom Charlock discussed plans and objectives for the summer 2001 CLAMS mission. The CLAMS validation mission includes clear-sky measurements of aerosols, SW broadband fluxes, and spectral radiances at the sea surface and within the atmosphere. CLAMS will include COVE measurements of radiation, meteorology, and ocean waves, a low-level aircraft to measure radiation at the sea surface, a mid-level aircraft to profile aerosol properties *in situ*, and a high-level aircraft to measure radiation and sense aerosols remotely with lidar.

### Advances in Temporal Interpolation

David Young reviewed the status of data sets and algorithms for incorporating three-hourly visible and infrared data from four geostationary satellites into the CERES temporal interpolation process. Preliminary results show a significant improvement in daily and monthly mean fluxes. Using geostationary data to

interpolate cloud properties further reduced the instantaneous SW flux interpolation errors.

### **CERES/ERBE Decadal Variability**

Bruce Wielicki showed an update on the decadal variability of tropical broadband LW radiation budget using both observations and general circulation model results. Observational analysis using data from five independent broadband radiation instruments between 1985 and 2000 shows good agreement among measurements and significant variability in the tropical broadband radiation budget. This decadal variability in the tropical broadband radiation budget, however, is not captured by the current general circulation models (GCMs). These models tend to under-predict the tropical mean interannual variability in both radiation and precipitation.

### **Cloud Working Group**

Patrick Minnis led discussions of cloud retrieval, archival, and validation issues. Minnis, Jim Coakley (Oregon State University [OSU]), and David Young will continue conducting comparisons of particle size and optical depth over the ocean to isolate the differences in retrieval techniques. Other action items included fixing a problem in the optical depth interpolation routine and adding the mean viewing zenith angle of imager AOD retrieval pixels. SSF Edition 1 has cloud properties, aerosols, and clear-sky fluxes, but cloudy sky fluxes will not be available until new ADMs are generated.

Larry Stowe (NOAA/National Environmental Satellite, Data, and Information Service [NESDIS]) discussed the effect of recent changes in VIRS calibration on retrieved AOD. The 1.6  $\mu\text{m}$  channel calibration is still unsettled. Alexander

Ignatov (NESDIS) discussed the dependence of AOD retrievals on scattering, solar zenith, and viewing zenith angles. Xuepeng Zhao (NESDIS) reported on efforts to validate VIRS-derived AOD using surface data collected at Aerosol Robotic Network (AERONET) sites.

Bryan Baum (LaRC) reported that the MODIS channels from 1.23 to 4.55  $\mu\text{m}$  were having serious problems due to electronic cross talk. He compared MODIS Airborne Simulator-derived ice crystal habits and size distributions with model calculations. Xiquan Dong (University of Utah) compared VIRS- and MODIS-derived cloud properties with surface-derived cloud properties from ARM and other surface sites. Ron Welch (UAH) demonstrated a new version of their MODIS cloud classifier and presented results from an improved polar cloud classifier.

### **SARB Working Group**

The meeting was jointly chaired by Thomas Charlock and David Kratz (LaRC). Action items included: continue CLAMS field experiment planning, determine the status of meteorological products from the Data Assimilation Office and the European Center for Medium-range Weather Forecasts (ECMWF), and conduct early CRS (Clouds and Radiative Swath) data product testing with new SSF data products.

David Rutan (AS&M) presented an update on the CERES ARM Validation Experiment (CAVE) database that was developed to facilitate the validation of CERES-derived surface fluxes. CAVE consists of flux measurements from ARM, BSRN, SURFRAD, and other surface sites from around the world that are matched in space and time with CERES retrievals.

Ellsworth Dutton (NOAA/Climate Monitoring & Diagnostics Laboratory [CMDL]) presented the status of surface radiometric observations at CMDL and the 23 BSRN sites. Spectral AOD measurements are now being made at several CMDL sites. Martial Haefelin presented a procedure to eliminate large errors in measured irradiance caused by temperature differences between the body and the dome of pyranometers. Bernardo Carnicero-Dominguez (Virginia Tech) showed that there is a linear relationship between the net LW flux measured by a pyrgeometer and the thermal offset of a pyranometer.

David Kratz presented validation results for CERES/TRMM surface-only SW and LW fluxes. CERES fluxes were compared with measurements from ARM, BSRN, and CMDL ground sites. CERES SW results showed excellent agreement with ARM data, but large positive biases relative to CMDL and BSRN measurements.

Anand Inamdar (Scripps Institution of Oceanography, SIO) found good agreement between model outgoing LW results and CERES monthly average values. He also showed the seasonal variation of ocean surface temperature and the normalized atmospheric greenhouse parameter.

Fred Rose (AS&M) presented a study of the effects of using sea surface temperature (SST) and column precipitable water vapor (PW) retrieved from TRMM Microwave Imager (TMI) measurements on SARB results. Use of TMI PW in SARB computations provided better agreement with CERES.

Qingyuan Han (UAH) suggested two different approaches for monitoring indirect aerosol radiative forcing from

satellites. The snapshot method uses cloud properties from a region and correlates them with aerosol properties from adjacent regions. His one-month regression method correlates cloud and aerosol properties acquired from the same region.

### TOA Fluxes/ADM Working Group

Norman Loeb led the working group meeting with a general overview of critical ADM/Inversion research issues. The group concluded that we should avoid screening out “no cloud property retrieval cases” or flux biases will occur. In addition, optical depth frequency distribution normalization should help minimize flux retrieval biases.

Nitchie Manalo-Smith (AS&M) presented LW and window limb darkening functions obtained from CERES measurements under overcast conditions. She examined how stratifications of the measurements based on scene parameters, such as precipitable water, cloud-surface temperature difference, and cloud emissivity, influence the anisotropy of the scene.

Richard Green compared SW reflectances and albedos for ERBS and CERES/TRMM. His results demonstrate how the difference in footprint size between these two instruments causes large differences in scene type frequency-of-occurrence. If the same ADMs are used to estimate albedo from both instruments, the differences in scene type frequency-of-occurrence lead to large biases in the all-sky mean albedo despite the fact that the mean reflectivities are consistent. Separate ADMs are needed for ERBS and CERES/TRMM to account for the differences in footprint size.

Lin Chambers (LaRC) demonstrated the

diurnal variability in cloud optical depth retrievals from three months of ground-based radar over the SGP and Tropical Western Pacific ARM sites. She found a much smaller diurnal trend than is suggested by satellite retrievals (e.g., VIRS). Her theoretical simulations showed that 1D cloud optical depth retrievals showed considerable bias for solar zenith angles beyond 45°.

### Invited Presentations

Pete Robertson (Marshall Space Flight Center [MSFC]) presented a comparison of decadal variability of tropical-mean outgoing LW in the ERBE/CERES data set, and in the TIROS (Television and Infrared Observation Satellite) Operational Vertical Sounder (TOVS) Path-A data set derived from the High Resolution Infrared Radiation Sounder (HIRS-2)/Microwave Sounding Unit (MSU) measurements. ERBE/CERES data showed a much stronger variability than Path-A, though the differences for corresponding clear-sky fluxes were smaller.

Roy Spencer (MSFC) made a presentation on the retrieval of cloud liquid water path (LWP) and rain rates from passive microwave satellite measurements. Areas of high LWP are often indistinguishable from those of light rain. The advantages of microwave techniques are that ice clouds are transparent to microwaves and the absorption is insensitive to drop size distribution. Notable disadvantages are the large footprint of microwave instruments, and that the absorption is temperature-dependent.

John Christy (UAH) presented a 20-year time-series of atmospheric temperatures derived from the MSU. This record agrees well with balloon measurements

from 30 highly reliable stations in the U.S. Christy also presented the work done for the IPCC 2000 where long time-series of atmospheric variables (e.g., temperature, precipitation) were examined to detect long-term trends. He found no evidence of global warming and related effects in the data sets.

### Investigator Presentation Highlights

Baijun Tian (SIO) presented a study examining the role of tropical cloud radiative forcing (CRF) in maintaining Hadley and Walker circulations. While GCM studies show that Hadley and Walker circulations are maintained by tropical CRF, the observational basis of this hypothesis is still missing. From an observational perspective under clear skies, radiative and latent heat processes do not provide the necessary energy gradients. He showed that LW CRF of the atmosphere establishes the necessary energy gradients for maintaining these circulations.

Leo Donner (NOAA, Geophysical Fluid Dynamics Laboratory) presented results of a GCM study examining the effects of the treatment of convective shields and cumulus-scale vertical velocities on general circulation. When convective shields are included and vertical velocities are allowed to vary in cumulus parameterizations, the convective systems are much larger and model results match better with observations.

David Randall (Colorado State University) presented a comparative study of convective and stratiform precipitation with particular emphasis on the Tropics. He presented TRMM data that show that precipitation types are not limited to convective and stratiform. He stressed the need to develop and use similar



parameterizations for convective and stratiform precipitation.

Shi-Keng Yang (NOAA/National Centers for Environmental Prediction [NCEP]) analyzed the downward trend in LW CRF in the new NCEP/NCAR 50-year reanalysis data set and concluded that the trend is caused by changes in mid-tropospheric relative humidity.

Helene Chepfer (Laboratoire de Meteorologie Dynamique [LMD], France) presented results of a study of ice-particle shapes in cirrus clouds when the same cloud is observed from two different directions. Her results can be used to validate the phase functions for CERES and MODIS processing and to improve estimates of ice water content.

Michel Viollier (LMD) presented results of a new temporal interpolation procedure for SW fluxes. He applied monthly, regional climatological diurnal albedo curves derived from five years of ERBS data to fill all local hours for March 2000 CERES/Terra data. Comparisons with ERBE-like data showed regional differences up to  $10 \text{ Wm}^{-2}$ , but no significant differences for tropical and global means.

Nicolas Clerbaux (Royal Meteorological Institute of Belgium) compared the Geostationary Earth Radiation Budget (GERB) Spinning Enhanced Visible and Infrared Imager (SEVIRI) scene identification algorithm with the corresponding CERES algorithm. GERB processing will use ADMs developed by CERES.

Bryan Baum (LaRC) compared MODIS cloud fraction, optical depth, height, and phase retrievals with data from other satellite instruments/algorithms and field experiments.

Larry Stowe and Alexander Ignatov

(NESDIS) presented results of SSF Edition 1 data testing. Stowe showed that Edition 1 data were much improved over earlier SSF versions. Ignatov outlined the steps underway for developing a third generation aerosol retrieval algorithm.

Thomas P. Charlock (LaRC) discussed the aerosol effect in the residual clear-sky insolation discrepancy. This discrepancy surfaced a few years ago when several well-regarded theoretical simulations produced values for clear-sky SW insolation that exceeded measurements by 20 to  $30 \text{ Wm}^{-2}$ . By both carefully screening the radiometer observations and adjusting them with sound physical principles, Charlock found that the theory exceeded observations by only 5 to  $10 \text{ Wm}^{-2}$ . Also, for moderate values of AOD, the aerosol forcing to surface insolation is considerably greater than the (now reduced) discrepancy of theory and observations.

Seiji Kato (HU) presented a radiative transfer algorithm that can treat horizontal inhomogeneities of cloud optical thickness in a CERES footprint. The algorithm assumes a gamma distribution for optical thickness and uses the discrete ordinate method to compute the footprint-averaged irradiance.

James Coakley (OSU) presented estimates of direct aerosol radiative forcing over cloud-free ocean regions derived using CERES/TRMM SW reflectances with models of AOD. Analyses of Indian Ocean Experiment (INDOEX) data suggested that model AOD values provided reasonable results.


Robert Cess (State University of New York at Stony Brook) presented algorithm development strategies for retrieving downward LW flux (DLF) at

the surface. Model results showed that even for clear skies, the relationship between DLF and outgoing LW was not good. Cess suggested that averaging cloud-base height over a grid box is inappropriate, and that cloud LWP could be used in the regression as a surrogate for cloud-base height.

Lou Smith (Virginia Tech) presented the methodology and results for limb-darkening functions derived using CERES/TRMM along-track radiances from the window channel.

Bing Lin (LaRC) presented a comparison study of cloud LWP derived from *in situ* and microwave radiometer data taken during the Surface Heat Budget of the Arctic (SHEBA) experiment. Mean cloud LWP derived using the standard ARM retrieval technique is nearly twice as large as coincident *in situ* aircraft data. Lin's new microwave radiative transfer model accounts for atmospheric gas and cloud water absorption. This method results in a 25 to 45% reduction in LWP values relative to the ARM estimates. If possible precipitation cases are excluded, the difference is reduced to only 3%.

### Educational Outreach

Lin Chambers (LaRC) reported that over 600 schools from all 50 states and over 44 nations are now participating in the Students' Cloud Observations On-Line (S'COOL) program. 

## The Availability and Status of MODIS Land Data Products

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 — *Robert Wolfe (rwolfe@kratmos.gsfc.nasa.gov), Raytheon*  
 — *Nazmi El-Saleous (SSA)*  
 — *Jacques Descloitres (SSA)*  
 — *Eric Vermote, David Roy (droy@kratmos.gsfc.nasa.gov), University of Maryland*  
 — *John Owens (jowens@virginia.edu), University of Maryland*  
 — *Ed Masuoka (emasuoka@ltpmail.gsfc.nasa.gov), NASA Goddard Space Flight Center,*  
 — *MODIS Land Science Team (MODLAND)*

Over the past few months there have been a number of enquiries as to the status and availability of MODIS land data products. This article provides a summary of the status as of the time of publishing.

### Background on MODIS Production and Option A+

The Terra spacecraft was launched on December 18, 1999. After a period of instrument checkout the first images from MODIS were obtained on February 24, 2000. Since that time MODIS has been acquiring data with short breaks for orbital maneuvers, and a period from August 5-18 when the instrument went into safe-hold and no Earth-view data were collected, due to a formatter reset problem.

In 1998, a NASA management decision was made based on the 1997 biennial review to hold the MODIS Level 2/3 data production to 50% of full capacity during the first year of MODIS production, followed by a ramp up in subsequent years to 0.75 and 1.0X. In 1998, as NASA Headquarters approved the so-called Option A+ budget for EOSDIS, the hardware budget allocations were

determined using the 1996 baseline of estimated processing loads and data volumes and applying the ramp-up rules (0.5, 0.75, 1.0).” Budget constraints dictated this limitation in capacity. The plan was to increase capacity in the second year after launch to 0.75X production capacity with an additional 0.75X capacity for data reprocessing. In addition, the distribution capacity was capped at 1X of the same baseline. Concerns of the instrument team in terms of the serious impact of this decision on production were raised at that time, but were not addressed. The baseline estimates were developed prior to most of the algorithms being run in test mode providing a best-guess of likely volumes and loads. As expected, since that time the needed volumes and loads have increased. A summary and explanation of this growth is provided in the recent SWAMP Working Group on Data Report ([ftp://typhoon.larc.nasa.gov/pub/brb/SWGD\\_Final\\_Final.doc](ftp://typhoon.larc.nasa.gov/pub/brb/SWGD_Final_Final.doc)).

The 1X (L1) and 0.5X (L2/3) production capacity has been a significant constraining factor in our ability to establish steady data production during this first year since launch.

In 1998, a decision was made to move the production of the MODIS L2/3 out of the ECS system, and generate these products on a PI Processing system called MODAPS (MODis DATA Processing System). MODAPS operations are overseen by the MODIS Science Team and are managed and run by the MODIS Science Data Support Team (SDST). This approach was seen as a cost-effective means to generate the MODIS higher-level data sets, and this, indeed, has been the case. However MODAPS was scoped only to meet the Option A+ levels of production because of the budget constraints previously described.

Recognizing the need to generate full-resolution data sets for assessing instrument performance, quality assessment, validation, land science, and applications, the MODIS land group (MODLAND) of the MODIS Science Team approached the 0.5X production cap with a plan to develop a mix of sample global data and continuous regional data sets. High priority regions were selected based on regional emphasis in the NASA Research and Analysis Program and Applications Programs. At a meeting of the EOS Interdisciplinary Working Group in June 1999, the science community requested that MODIS land products be made available for the entire globe at 500 m and 1 km. Recognizing the budget constraints associated with the 1996 baseline and in response to the IWG request, the MODLAND group developed a work-around solution, supported by Martha Maiden (ESIPS Manager) at NASA HQ, for a rapid development of a PI-based processing and distribution system for the high volume MODIS 250-m products. This approach was developed outside of the EOS Core System to maintain the MODIS allocated volumes and loads, whilst enabling global production of 500-

and 1-km land products during the first year. The land 250-m production system has evolved as part of the MODIS PI processing system (MODAPS) and is currently scoped to generate and distribute 10% of the global 250-m daily products (surface reflectance and vegetation indices). As a result, the 250-m Vegetative Cover Conversion product (MOD44A) developed by John Townshend, University of Maryland (UMD), is currently being generated at the UMD Earth Science Information Partnership (ESIP) – the Global Land Cover Facility. The current system capacity of 10% was a function of funds available for hardware purchase.

There are several links in the MODIS land data production chain, that are supported by the ESDIS project. The Level 0 data are sent from EDOS to the GSFC Distributed Active Archive Center (DAAC). The GSFC DAAC produces and archives the Level 1A (MOD01), Level 1B (MOD02), Geolocation (MOD03), and

Cloud Mask (MOD35) products. These data are sent to MODAPS where the land products are generated and sent to the EROS Data Center DAAC. The MODAPS-generated snow and ice products are sent to the National Snow and Ice Data Center DAAC. These two DAACs provide archiving and distribution for MODIS land products. The steps in the MODIS land production are shown in Figure 1.

Experience has shown that, with 1X and 0.5X capacity and several links in the land production chain, if one link goes down for an extended period, then it is very difficult for the production system to maintain current production and catch up on missed data. As a result, during the first six months of production there were large gaps in the data production including a series of problems associated with EDOS tape production and “bit flips.” During the high-speed playback of the Terra on-board solid-state recorder, electronic cross-talk causes random and sporadic changes to individual bits in the real-time instrument data being downloaded to the

White Sands Receiving Station. It is worth noting that the MODIS land L2/3 processing and archiving for year two is scoped at 0.75 of the '96 baseline. The current global 500-m and 1-km products alone add up to 40% more than this allocation. At this level, the system will be unable to generate and archive all the peer-reviewed L2/3 products currently provided by the Science Team.

In addition to the ESDIS supported activities, NOAA has a feed of the Level 0 data from the

GSFC DAAC and is preparing to generate selected products, including snow and ice products to support operational weather forecasting. There are also a number of Direct Broadcast stations that are receiving MODIS data and producing some of the lower-level products.

### Data Release

The MODIS Level 1A and Level 1B data at 1-km, 500-m and 250-m resolutions and the MODIS Geolocation product were made available through the GSFC DAAC starting on April 19, 2000. For the first six months there were a large number of gaps in the global products generated by GSFC and MODAPS, due to incomplete processing from EDOS and inadequate catch-up capacity. We plan to fill these gaps at the first major data reprocessing.

The land products are being released as originally planned before launch, in a phased approach making them available as soon as possible following initial evaluation changes in instrument calibration, initial product quality assessment, and the integration of necessary patches to the code, and prior to validation, i.e., as a Beta release. As a result, several of the products have known problems that are described in the product specific web sites and the user guides, which have been developed for each product. Due to several product interdependencies, it is important to understand the quality of upstream products that are used in product generation.

The first land products were released by the EDC DAAC on August 4, 2000, for the period starting June 9. These were the 8-day 500-m Surface Reflectance, the 16-day 500-m and 1-km Vegetation Indices, and 8-day 1-km Leaf Area Index.

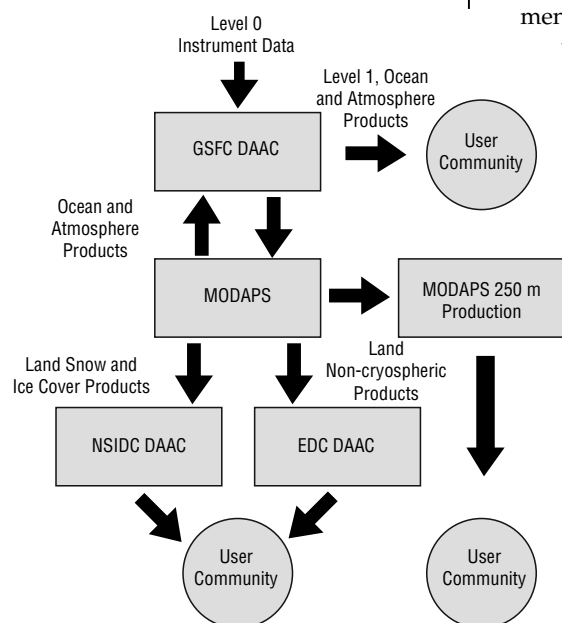


Figure 1. MODIS Land Data Flow

The 1-km Land Surface Temperature products (L2, daily L3, and 8-day L3) are available for the period starting June 25. The 16-day 1-km BRDF/Albedo product is available for the period starting July 11. The 8-day 1-km Fire product is available for the period starting August 20. The 500-m Snow products (L2, daily L3, and 8-day L3) are available for the period starting September 13. Problems encountered with obtaining a steady data flow have delayed preliminary assessment of the monthly products and those relying on time-series data, e.g., land-cover, and vegetative-cover conversion. Planned release dates are summarized in Table 1.

**MODIS 250 m Production (Jacques Descloitres, John Owens)**

The first 250-m 8-day Surface Reflectance product was made available on August 4 for the acquisition period starting June 9. The complete North America data set (from 20°N to 60°N) was released shortly thereafter, followed by the next 8-day period starting June 17. In the first phase of this rapid prototyping, production was limited to generation of the Surface Reflectance product for North America. Difficulties in stabilizing the input data flow led to a suspension in production until the 8-day period starting September 13. Data for this compositing period are available for North America and Southern Africa for SAFARI 2000. In early November, the production of 250-

m daily L2G Surface Reflectance was transitioned to the MODAPS production system with the 8-day period starting September 21. A steady flow of 10% of the global production was reached starting October 15. Generating the corresponding MODIS 250-m 16-day Vegetation Indices product is a work in progress. A 250-m NDVI product is, however, being generated and distributed by the UMD ESIP. Current understanding is that in the second year of production and as part of the MODIS reprocessing plan, the 250-m products will be reprocessed and shipped to EDC for archive and distribution. The speed at which this is done will depend on the available reprocessing and archiving resources.

Table 1.

Product ID	Product Name	Level (Frequency *)	Release Date	Start Date of data Series	Archive & Dist. Center
MOD09	Surface Reflectance	2G	11/10/00	6/9/00	EDC
		3(8d)	8/4/00	6/9/00	EDC
MOD10	Snow Cover	2, 3 (1d, 8d)	10/13/00	9/13/00	NSIDC
MOD11	Land Surface Temperature & Emissivity	2, 3 (1d)	9/1/00	6/25/00	EDC
		3 (8d)	10/13/00	8/28/00	EDC
MOD12	Land Cover/Land Cover Change	3 (96d)	3/30/01	6/1/00	EDC
MOD13	Gridded Vegetation Indices (Max NDVI & Integrated MVI)	3 (16d)	8/4/00	6/9/00	EDC
MOD14	Thermal Anomalies, Fires & Biomass Burning	2, 2G	1/19/01	1/1/00	EDC
		3 (1d)	2/2/01	11/1/00	EDC
		3 (8d)	10/13/00	8/20/00	EDC
MOD15	Leaf Area Index & FPAR	4 (8d)	8/4/00	6/9/00	EDC
MOD17	Net Photosynthesis, Net Primary Productivity	4 (8d)	2/2/01	10/31/00	EDC
MOD29	Sea Ice Extent	2, 3 (1d), 3(8d)	2/16/01	12/7/00	NSIDC
MOD43	Albedo	3 (16d)	9/29/00	7/11/00	EDC
	Nadir BRDF-Adjusted Reflectance	3 (16d)	9/29/00	7/11/00	EDC
	BRDF Ross-Li Model	3 (16d)	2/2/01	10/31/00	EDC
MOD44	Vegetation Cover Conversion and Continuous Fields	4 (32d)	3/30/01	2/28/01	EDC

\* Frequency is 5 min. for Level 2 and daily for Level 3 unless otherwise noted. EDC=EROS Data Center, NSIDC=National Snow and Ice Data Center.

## Status of the MODIS Land Products

### *Geolocation (R. Wolfe, M. Nishama)*

The MODIS geolocation algorithm has been working well since launch. The geolocation accuracy specification is 300 m (2 sigma) and the goal is 100 m (2 sigma) at nadir. This goal is primarily driven by land 250-m change product requirements. A global distribution of Ground Control Points from 110 Landsat TM scenes are correlated with MODIS data to measure about 100 control point residuals per day. The basic geolocation algorithm corrects off-nadir pixel locations for terrain parallax effects by using the GTOPO30 1-km terrain model. The at-launch geolocation error of 1.7 km RMS was larger than expected when the first Earth-view data was received in late February 2000. We quickly computed the first bias correction primarily in the roll and pitch axes. By applying this correction, the error was reduced to 500-m RMS starting in late March 2000. A second correction was performed in June 2000 and included a correction to the yaw and the mirror wedge and tilt angles. This reduced the measured error to 100 m RMS (200 m 2 sigma). We expect to make a correction of the small remaining biases expected in December 2000. We are also currently evaluating effects of the change to Side B mirror encoders.

In 2001, we will continue further analysis to characterize along-scan mirror motion and any remaining biases. A longer-term analysis will look at trends and cyclical variations: dependence on temperature, time on orbit, etc. We will be examining periods near orbit and attitude maneuvers and other events to determine when the instrument is outside of accuracy specifications/goals and developing

processes to identify the events. To do this we will make the island control-point matching algorithm operational, which will allow almost continuous measurements of the geolocation error. Later in 2001 we will work toward improving the accuracy in areas of significant terrain variation by analyzing the accuracy of the terrain model and terrain correction algorithm. We will also examine cross-instrument geolocation issues by comparing results with MISR and ASTER instrument teams.

### *Surface Reflectance (E. Vermote, N. El Saleous)*

The first released data set of surface reflectance (starting June 6, 2000) was a preliminary version that did not include the correction for aerosol effects, i.e., comparable to the AVHRR Pathfinder II and SeaWiFS Land Surface Reflectance products. However, due to the better set of bands for MODIS, the effect of water vapor found in AVHRR data are greatly reduced in MODIS data and the "composited" data set should be very useful to the scientific community. Starting at the end of September (Julian day 273), after an evaluation of the aerosol product and evaluation of a correction prototype, a conservative aerosol correction was applied to the data, which greatly improves the product. The correction is still under evaluation and an extension of the current aerosol correction to brighter targets is being developed and should eventually give near-global correction. Once a substantial data set of good quality LAI and BRDF products has been produced and evaluated, the BRDF/atmosphere coupling correction will be assessed and applied. The correction for adjacency effect is currently being given lower priority as the effect on MODIS is likely to be small, especially at 500-m

resolution, but the correction will be included prior to the first major reprocessing. The impact of the second order effects (BRDF and adjacency) on the derivation of the aerosol and the associated feedback will be part of further development. In parallel, validation activities are on-going which will enable us to refine/and confirm the error bars advertised in the ATBD and possibly lead to subsequent algorithm refinements.

### *Land Surface Temperature (Z. Wan)*

The MODIS Land-Surface Temperature (LST) algorithm is being refined and the PGE16/31 code has undergone a number of updates and patches. We have made several refinements to the LST algorithm, reducing identified problems, such as striping due to the cloudmask associated with the fourth noisy detector element in band 22. The absolute radiometric accuracy of MODIS TIR channel data was evaluated with in situ data collected in a vicarious calibration field campaign conducted in Lake Titicaca, Bolivia, during May 26 and June 17, 2000. The specified absolute radiometric accuracy is reached or nearly reached in MODIS bands 29-32. It is difficult to obtain a definitive estimate in other bands because of the polarization effects and larger effects of the uncertainties in atmospheric temperature and water vapor profiles. An error in the difference of brightness temperatures in bands 31 and 32 is estimated as 0.3 K, causing an error of 0.7-0.9 K in the MODIS LST product. A correction for this effect was made in the generalized split-window LST algorithm in late September and implemented in the operational PGE16 code in early October. The accuracy of daily MODIS LST product at 1-km resolution was validated through in situ measurement data collected in field

campaigns. The MODIS LST accuracy was better than 0.7 K over Mono Lake, California, in two daytime cases and one nighttime case, over a grassland in Bridgeport, California, in two nighttime cases, and over a rice field in Chico, California, in two nighttime cases. It is difficult to validate the daytime LST product over land sites rather than lakes, because of the high spatial variation in the in situ LST data. Errors in the 1-km LST product are expected to be larger in semi-arid and arid regions where surface emissivities in bands 31 and 32 are highly variable. The MODIS LST product at 5-km resolution generated by the day/night algorithm is currently being evaluated. The quality of this LST product is sensitive to the calibration errors in seven MODIS TIR bands and to the quality of the MODIS product of atmospheric temperature and water vapor profiles. The 5-km LST product will be released in early 2001.

### ***Vegetation Indices (A. Huete, Kamel Didan)***

The MODIS Vegetation Index (VI) Algorithm has undergone four updates as a result of improved understanding of the instrument data quality and the performance of upstream products. The MODIS VI products have benefited greatly from improvements in performance of both the surface reflectance and the cloud detection algorithms. Moreover, the effort by LDOPE to identify quality and performance issues with each of the MODLAND products has helped with further adjustments of the VI algorithm, leading to more complete spatial coverage with better handling of non-ideal data (e.g., cloudy viewing angles). The Enhanced Vegetation Index (EVI) is performing well, improving the detection of vegetation changes where the normalized difference vegetation

index (NDVI) has little sensitivity. We are continuing analysis of possible problems with NDVI saturation, which does not appear in the EVI product. Although some problems were found with the EVI over snow and cloud, the newest algorithm update (end of 2000) should correct this anomalous behavior and further improve the quality of the MODIS VI products. Comparisons with the AVHRR NDVI show a stronger sensitivity of MODIS to vegetation, with the MODIS NDVI signal being 1.3 times that from the AVHRR. A preliminary global quality analysis of the MODIS VI product indicates that the compositing algorithm has greatly minimized view-angle-related problems (encountered with MVC) resulting in a more consistent, potentially long-term data set. Our current analysis of the 250-m MODIS VI's shows significantly higher spatial variations in vegetation amount and structure. All indications lead us to believe that the MODIS VI product will be robust and reliable, with resulting major improvements to all VI-based applications and products.

### ***BRDF/Albedo (A. Strahler, C. Schaaf, J.P. Muller)***

Albedos and Nadir BRDF-Adjusted Reflectances (NBAR) produced by the MODIS BRDF/Albedo Product Algorithm (MOD43B) from July 2000 onward have now been released to the public. BRDF parameters will be released in early 2001. The algorithm makes use of a kernel-based BRDF model and multi-date, cloud-cleared, atmospherically-corrected MODIS surface reflectances to provide gridded global spectral and broadband products every 16 days at 1 km, based on two 250-m and five 500-m bands covering the whole shortwave region. While the initial products were derived from surface reflectances that

had not been accurately corrected for aerosols and thus could not be evaluated quantitatively, qualitative examination of the spatial patterns and temporal trends indicate that the algorithm is behaving very well and producing consistent and reliable albedo and NBAR quantities. Although some contamination by clouds also affected the products, the algorithm was able to consistently flag these areas as poor quality results. Now that the aerosol correction has been implemented operationally and the cloud mask has been updated, quantitative assessments are possible. Improvements were also made to QA flags. Validation field data were collected during the 2000 growing season at agricultural sites in Beltsville, MD; Luancheng, China; and Barton Bendish, UK. Data were also collected at the SAFARI-2000 site at Mongu, Zambia. Although most of the extensive comparisons between field data and MODIS results will have to await the reprocessing of the initial products, some validation is currently underway with field data that were acquired in October from Beltsville, MD, and Mongu. Validation activities include use of AirMISR, IKONOS stereo, POLDER, and AVHRR data.

### ***LAI/FPAR (R. Myneni, J. Knjazihhin, Y. Zhang)***

The MODIS green Leaf Area Index (LAI) and Fraction of Photosynthetically Active Radiation absorbed by vegetation (FPAR) are 8-day composite values of daily retrievals at 1-km resolution. The product, technically called MOD15A2, has been released to the public since early August 2000 from the EDC DAAC. Tile and global level quality assurance (QA) on both the daily and 8-day products has revealed some occasional radiometric artifact (striping) inherited from the upstream reflectance inputs.

Recent temporal analysis of some daily and 8-day FPAR, LAI images also reveals some moderate radiometric discontinuities across period boundaries; these do not yet appear to reflect systematic biases, and are now being investigated at the SCF. In general, the FPAR, LAI product appears to be producing very reasonable biophysical signals, when stratified across biome types and examined across a number of successive periods. Users are strongly encouraged to consult the associated Quality Assessment (QA) files in view of the evolving maturity of the product. Validation of MOD15A2 with data from grasslands and savannas (southern Africa), broad leaf forests (Massachusetts), and needle-leaf forest (Finland) are encouraging. Further details on MOD15A2 algorithm physics, prototyping, data access, user guides, and validation activities can be found on the LAI Web site provided below.

***Snow and Ice (D. Hall, G. Riggs, V. Salomonson)***

The MODIS snow algorithms have undergone several refinements and the code has been revised several times in response to quality assessment of the products. Changing of MODIS calibration settings affecting the responses of detectors has caused problems in the algorithm, but those problems were fixed with changes in the algorithm and in the MODIS radiance data product. The recent move to the B-side electronics appears to have improved the MODIS data. Preliminary analysis of MODIS Level 2 snow products (MOD10\_L2) generated with B-side data has revealed an improvement in a qualitative sense. Confusion of snow and cloud persists in the algorithm and limits the accuracy of snow maps in some situations. Investigation of ways to alleviate the snow and

cloud confusion continues. The global snow climate modeling grid product, MOD10C1, and algorithm have been revised in response to validation studies. A daily global view of snow cover extent is shown with the MOD10C1 product. Release of the MOD10C1 product is expected in early 2001. Preliminary comparisons of the MODIS snow product with operational snow products from NOAA have shown good correspondence. However, some differences among the maps have been observed. It is not known which of the maps is the most accurate. A field and aircraft campaign was conducted last March in New Hampshire. Results, which are under analysis, show good correspondence with two NOAA operational snow maps for that period, except in the Catskill Mountains in New York. An upcoming experiment in January 2001 will focus on the area where the snow maps disagree. A fractional snow cover enhancement to the snow maps, and a daily snow albedo map should be available in the spring and summer, respectively.

***Sea Ice Products (D. Hall and G. Riggs, V. Salomonson)***

Sea ice products contain two arrays of data. One is the extent of sea ice as determined by reflectance characteristics. The other is sea ice surface temperature (IST) determined by a split-window technique. Dr. Jeff Key, University of Wisconsin, has provided the coefficients based on geographic location and temperature for the IST algorithm. A major revision of the MOD29 algorithm and code is underway to incorporate those IST coefficients and to incorporate many changes similar to those made in the snow algorithm for processing MODIS radiance data. Uncertain knowledge of detector responses in

thermal bands 31 and 32 was used in the IST calculation, and optical crosstalk factor in the calculation of IST. Recent changes to B-side electronics and improved understanding and handling of those effects in the L1B processing have reportedly diminished those effects in the data. An investigation is underway. The revised code will be delivered early in 2001 and release of the data will follow shortly thereafter. Preliminary validation work by Shusun Li, from March 2000 in the Southern Ocean, shows good qualitative correspondence between the MODIS sea-ice maps and ship observations. This data set is currently under analysis by Li. Future efforts will focus on comparison of the MODIS sea-ice maps with NOAA NESDIS passive microwave sea-ice maps. A daily sea ice albedo map should be available by the summer of 2001.

***Fire / Thermal Anomalies (C. Justice, L. Giglio, D. Roy, Y. Kaufman)***

The MODIS Fire Algorithm is being refined and the MOD09/14 code has undergone a number of patches. We have made several refinements to the fire algorithm over the last four months removing or reducing identified problems associated with sunglint and false detections from hot and highly reflective surfaces. A new version of the fire code can be expected in early 2001. We have encountered several problems associated with dead and noisy detectors in band 22 and 21, related to electronic crosstalk and incomplete sensor calibration. The recent move to the MODIS B-side electronics has improved the quality of the 1B data reducing the number of out-of-family detectors and we are evaluating the impact on the fire product. Initial evaluation shows an overall improvement in product quality, particularly

with respect to the detection of smaller fires. Initial comparisons between MODIS, TRMM, and AVHRR fire products are very favorable, however there are clear differences in fire detection as a result of overpass time. In some of the cases the earlier MODIS overpass time has shown reduced cloud cover and clearer viewing conditions. Product validation is underway and emphasis is being placed on comparison with ground and airborne data collected for fires in the Western U.S. and the SAFARI-2000 campaign. The latter will include the use of ASTER, Landsat, MAS, and field data. An experimental MODIS burned-area algorithm is being tested and evaluated associated with this latter intensive campaign.

#### ***PSN, NPP Level 4 Algorithm Status (S. Running, J. Glassy)***

The PSN, NPP Level 4 land algorithm is a model-oriented, rather than a primarily instrument-driven algorithm. As such, it is currently the only Level 4 algorithm in the MODIS land product suite per se, and one of the few requiring time-continuous ancillary climatology data (from the Goddard DAO). Since it is driven from the FPAR/LAI product (requiring 1-km aggregated MODIS surface reflectances), it is the final step of the entire vegetation processing string. In short, any and all upstream gaps in the production system end up disproportionately affecting the PSN, NPP products. An implication of this is that the PSN, NPP production rules are more complicated, since we must track each pixel's history throughout the model year. In particular, the time-continuity on a tile basis is especially important, due to the way we must continually accumulate the GPP and respiration terms over the course of a model year to compute annual NPP for each tile. For this first

data-year, the EOSDIS production chain as a whole has been quite challenged to provide the level of tile-level time continuity required to make reasonably accurate 8-day PSN products. Thus far, the MOD17A1, A2 string (PGE36, PGE37) chain has only been run successfully (globally) at the University of Montana SCF. Our most recent global runs using MODIS 8-day FPAR, LAI, and DAO inputs represents the period June 29 to July 6 and September 7-14 2000 and may be seen from our Web page (below). Several recent changes have dominated the current MOD17 activities. These are: a) changes in the MOD15A1 (daily FPAR) and MOD15A2 (8-day FPAR) pixel level QA organization and interpretation to better track non-vegetation pixels in the final product, b) the recent discovery and correction of a units-label error (by the DAO) in the specific humidity variable (was labeled as g/kg, should have been labeled kg/kg) that caused seriously depressed GPP values, and c) the addition of the 5-km coarse logic to match the daily and 8-day FPAR, LAI products.

#### ***MODIS Land Cover (A. Strahler, M. Friedl)***

The MODIS land-cover algorithm is currently generating early results from the available MODIS data. These results are currently being evaluated at the Science Computing Facility in Boston. The algorithm employs a supervised classification methodology, and a global database ( $n > 900$ ) of site data compiled from Landsat Thematic Mapper, which are used in the final stages of quality assurance. Initial global runs are being generated using three dates of nadir and BRDF adjusted reflectances for seven MODIS bands. The results from these runs are very encouraging and attest to the spectral and radiometric quality of

MODIS data for land-cover applications. As more dates are added to the classification runs, we expect that the quality of the land-cover maps will improve accordingly. The land-cover product is targeted for release in April 2001.

#### ***Vegetative Cover Conversion Product (J. Townshend, X. Zhan, R. Sohlberg)***

The MODIS 250-m Vegetative Cover Conversion (VCC) (MOD44A) product is currently in the initial data collection and processing stage. Generation of the product requires composited Surface Reflectance data for the two 250-m bands for two 32-day periods which are at least three months apart. For the reasons stated above, the 250-m Surface Reflectance data processed to Level 2G have been available only for the conterminous United States for limited 16-day periods. The first 32-day composite will be available during December. At present we are running the VCC code with limited inputs to generate some early results. We are expecting that the Look-Up Tables (LUTs) derived originally with AVHRR data and used by the current VCC code, will need to be updated using MODIS retrievals. The procedure for updating the LUTs is being conducted with the available June and September MODIS data. Validation of the VCC product will be carried out with Landsat ETM+ images, IKONOS 1-m and 4-m data, and ground observations where available. An automated change-detection procedure is being prepared for using the ETM+ data to validate the land cover changes indicated by the VCC product. The planned date of public release for the first MODIS VCC product is March, 2001.



***Vegetation Continuous Fields Product (J. Townshend, R. DeFries, M. Hansen)***

The MODIS Vegetation Continuous Fields (VCF) product is a post-launch product. The generation of the product requires monthly composites of 500-m surface reflectance data for a full year. The VCF product generation code has been prepared with algorithms used for the prototype VCF product generated with AVHRR data. The procedure is being updated with MODIS data currently being collected. A validation data set for Kalahari woodlands was collected as part of SAFARI 2000 activities. This will be complemented by a Miombo data set to be collected during 2001. The validation data combines IKONOS fine resolution data with ground observations collected using a laser canopy closure instrumentation. In a separate validation activity, canopy density data are being collected for a transect across the Appalachian Mountains from Washington, DC, to Columbus, Ohio. This activity utilizes a four-band airborne radiometer with a spatial resolution of 1 m. Leaf-on data were collected during July 2000. The leaf-off flight is scheduled for late March 2001. The planned date for releasing the first MODIS VCF product is July 2001.

***Overall Goals for MODLAND***

The overarching goals for MODLAND include: developing the next generation of new and improved global land data products of known accuracy (i.e., validated products); establishing the relationship and continuity with existing land data sets; providing the proof-of-concept for land products to be used by the next generation of operational sensors, i.e., the NPOESS Visible Infrared Imaging Radiometer Suite (VIIRS); and, most importantly, developing a consis-

tent science-quality climate data record of high-priority land products for the science community. This latter task will necessitate reprocessing of the MODIS data record. The first major reprocessing, to be undertaken in 2001 will provide the time-series of 'science-quality products.' The reprocessing will fill in the large gaps that occurred in the global data during the first six months and will apply revised versions of the code, modified to account for instrument performance and initial validation results. There are major concerns that reprocessing at 0.75X of the 96 baseline level (i.e., less than one day in a day) will be inadequate to respond to the science community immediate need for a timely delivery of one year of science quality time-series products. Clearly, rapid development of new and innovative approaches to large-volume data processing, reprocessing, and archiving needs to be given a high priority if we are to realize the potentially enormous science pay-off from the MODIS data. A MODIS reprocessing 'pathfinding' activity will be started in January to establish procedures and logistics for large-volume reprocessing with the currently available hardware. Issues of data retrieval and staging will need careful attention. Candidate periods for the reprocessing trial include July, to provide data sets for SAFARI 2000 validation, and April, coincident with an oceans validation initiative.

***WWW Sites Associated with MODIS Land Products***

***(To Obtain MODIS Land Data)***

***EOSDIS Data Gateway***

[http://eosdatainfo.gsfc.nasa.gov/eosdata/terra/data\\_access.html](http://eosdatainfo.gsfc.nasa.gov/eosdata/terra/data_access.html)

***Level 2/3 Land Data / EDC DAAC***

<http://edcdaac.usgs.gov/>

***MODIS L2/3 Snow and Ice Products/ NSIDC DAAC***

<http://nsidc.org/NASA/MODIS/>

***Level 1b, Geolocation, Cloud Mask/ GSFC DAAC***

[http://daac.gsfc.nasa.gov/CAMPAIGN\\_DOCS/MODIS/index.shtml](http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/MODIS/index.shtml)

***MODIS 250-m Data***

<http://modis-250.m.nascom.nasa.gov/>

***250 m V.I.***

<http://glcf.umiacs.umd.edu/MODIS2/main.html>

***MODIS Sample Imagery***

<http://modland.nascom.nasa.gov/gallery/>

***(MODIS Overview Information)***

***MODLAND Site***

<http://modis-land.gsfc.nasa.gov/>

***MODIS Science***

<http://tpwww.gsfc.nasa.gov/MODIS/MODIS.html>

***Land Quality Assurance***

[http://modland.nascom.nasa.gov/QA\\_WWW/qahome.html](http://modland.nascom.nasa.gov/QA_WWW/qahome.html)

***MODIS Land Validation***

<http://modis.gsfc.nasa.gov/MODIS/LAND/VAL/MCST>

***MODIS Instrument Performance***

<http://mcstweb.gsfc.nasa.gov/>

***MODIS Science Support Team***

<http://ltpwww.gsfc.nasa.gov/MODIS/SDST/>

***Direct Broadcast Site***

<http://ltpwww.gsfc.nasa.gov/MODIS/MODIS.html>

*(MODIS Land Product Web Sites)***Surface Reflectance/Atmospheric Correction Algorithm Products**

<http://modis-land.gsfc.nasa.gov/mod09>

**Land Surface Temperature (LST) and Emissivity**

<http://www.ices.ucsb.edu/modis/modis-lst.html>

**Leaf Area Index (LAI) and Fractional Photosynthetically Active Radiation (FPAR)**

<http://cybele.bu.edu/>

**Vegetation Indices**

<http://gaea.fcr.arizona.edu/projects/modis/index.html>

**BRDF and Albedo**

<http://geography.bu.edu/brdf/index.html>

**Snow and Ice Cover**

[http://snowmelt.gsfc.nasa.gov/MODIS\\_Snow/modis.html](http://snowmelt.gsfc.nasa.gov/MODIS_Snow/modis.html)

**Fire and Thermal Anomalies**

<http://modis-fire.gsfc.nasa.gov/>

**Vegetation Production, Net Primary Productivity (NPP)**

<http://www.forestry.umt.edu/ntsg/RemoteSensing/modis>

**At-Launch Land Cover**

<http://www.geog.umd.edu/landcover/modis.html>

**Land Cover**

<http://geography.bu.edu/landcover/index.html>

**Vegetation Continuous Fields and Vegetative Cover Conversion**

<http://www.geog.umd.edu/landcover/modis.html>



## Formation of the Science Working Group on Data (SWG-D)

— Bruce R. Barkstrom ([b.r.barkstrom@larc.nasa.gov](mailto:b.r.barkstrom@larc.nasa.gov)), Atmospheric Sciences, NASA Langley Research Center  
— Chris Justice ([justice@virginia.edu](mailto:justice@virginia.edu)), University of Virginia

It is generally recognized that developing a data system to support processing, archiving, and distribution of NASA's Earth Science data is an extraordinarily difficult endeavor. Part of the difficulty lies in the technical problems associated with the very high throughput required of the system, as well as the high processing power, the large storage volume, and the complexity of making the data accessible to a wide variety of data users. Another part of the difficulty lies in the fact that this system must engage a large number of different communities that are unaccustomed to exchanging data with each other. The development process has been difficult, and the initial operations have been a learning experience for all parties involved. It is a tribute to the hard work of many members of these communities that the Earth Observing System Data and Information System (EOSDIS) is beginning to produce and distribute data. The data volumes currently being generated are unprecedented for the Earth Science Community.

A few weeks before the end of 1999, the EOS Terra satellite was launched and EOSDIS began to work with the data from its instruments. These instruments began observing the Earth near the end of February and have continued their

observations since. At the March 16-17 meeting of the Science Working Group for the AM Platform (SWAMP), SWAMP members noted that there needs to be on-going evaluation of how well the current EOSDIS can support the Terra, Aqua, and Aura missions for which it has been designed. While there has been considerable discussion concerning the type of Data and Information System (DIS) required beyond the current EOSDIS implementation, there has not been a systematic evaluation of how well the current system is working. Chris Justice (of the MODIS Land Team) accepted a motion that he should convene a workshop of data representatives from the Terra instrument teams to carry out this evaluation and report to the SWAMP regarding both their concerns and possible solutions.

On June 1-2, the workshop was held at NASA Goddard Space Flight Center (GSFC). It constituted the inaugural meeting of a Science Working Group on Data (SWG-D). Participants included (1) Terra instrument team representatives from CERES, MISR, MODIS, MOPITT, (2) EOS Project and Earth Science Data and Information System (ESDIS) Project representatives, (3) EOS Project Science Office representatives, including the Terra, Aqua, and ESDIS Project Scien-

tists, and (4) Distributed Active Archive Center (DAAC) and Science Investigator-led Processing System (SIPS) representatives. Prior to the workshop, the participants set the following specific objectives:

- 1) Assess the current status of the data system for Terra, and, if possible, assess the planned capacity for Aqua;
- 2) determine how requirements have changed with respect to the current design and system capacity;
- 3) identify mismatches between current plans and needed capabilities; and
- 4) recommend solutions to meet evolving needs.

While there were production problems during the middle of the summer, the immediate EOSDIS situation appears to have improved as early EOS Data and Operations System (EDOS) problems are being solved. However, EDOS remains backlogged\*. Beyond these immediate problems, the EOS data system remains unstable and appears to be systematically undersized. There is concern that the lack of hardware will delay the scientific validation effort by 2-3 years. The preliminary SWGD hardware appraisal needed to deal with validation and reprocessing shows a need of about \$15 million in computer hardware in each of FY01 and FY02 to solve the problems, with small additions in later years (~\$2M). The problem goes back to unrealistic downsizing of hardware when budget problems hit a few years ago.

\*The EDOS backlog at the time of the meeting (June 2000) was more than 1000 hours and growing. At the end of December 2000, it was 700 hours, being worked off at the rate of 70-100 hours/week.

During the workshop, the participants discussed the current operating status of EOSDIS, and, in particular, the lower-than-expected throughput and how it should be addressed. They noted that the February 1996 baseline sizing used to implement EOSDIS is not adequate to support the science data needs. Because that baseline was established before the algorithms were developed and could be run in the production environment, it did not have a clear empirical basis. In addition, the 1996 baseline\*\* does not appear to have been based on previous NASA experience in validating and producing Earth science data. Terra instrument team representatives presented revised system sizing estimates based on current experience and improved understanding of the EOS production environment. The group noted that the current performance of the system has yet to meet an operational level of production equivalent to the Option A+ first year capacity of 1x of Level 1 products and 0.5X of Level 2 and higher products as volumes specified in the 1996 baseline.

The primary finding from the working group was the need for a marked and rapid increase in the system capacity to generate data products. The current budget situation is difficult on all sides. It is clear that there will need to be frank and open discussions between all of the parties involved in EOSDIS regarding possible options. One area of concern is the impact of the rapid evolution of information technology on the obsolescence of the current system. This impact suggests that we may need to move rapidly from the current system to the

\*\*At the end of December 2000, the production was exceeding the Option A+ baseline requirements in both processing rates and volumes of data archived.

more distributed system being envisioned for NASA's New Data and Information Systems and Services (NewDISS).

In addition to this finding, the workshop covered a greater range of challenges and opportunities for improvements to the service EOSDIS can provide to its user community. Some specific challenges for the coming months and years that were identified at the workshop include:

- reprocessing;
- perturbations to operations, particularly those involving the Aqua turn-on and the associated increase in volumes and loads;
- data distribution;
- dealing with the diversity of the producer and user communities;
- obsolescence; and
- transition to a non-ECS environment.

This workshop provided a useful forum for sharing views and experiences among the DAAC's, ESDIS, and the instrument teams. It succeeded in identifying more accurate and meaningful system-capacity requirements than are currently implied by the existing baseline, which dates from February 1996. The SWGD expects to help maintain these estimates in the future in conjunction with ESDIS, the DAAC's, and the SIPS. There is a need to extend the SWGD-type of activities to include the Aqua and Aura teams. Neither of these teams were able to participate in the workshop.



## Terra Science Working Group (SWAMP) Meeting

— Jon Ranson ([jon@taiga.gsfc.nasa.gov](mailto:jon@taiga.gsfc.nasa.gov)), Terra Project Scientist, NASA Goddard Space Flight Center

The semi-annual science working group meeting for Terra was hosted by the MOPITT Instrument Team at the University of Toronto, September 7-8, 2000. Many thanks to PI Jim Drummond and the MOPITT team for selecting a beautiful time and venue for this successful meeting.

Yoram Kaufman started off the meeting with the reminder that he was stepping down as Project Scientist and that Jon Ranson, his Deputy for the past four years, would succeed him. He also announced that Si-Chee Tsay has been selected as the new Deputy Project Scientist. Yoram will continue his activities as a MODIS team member and plans to stay involved in Terra education and outreach activities.

Kaufman reiterated the need for a spacecraft maneuver to provide a view of deep space for calibration of MODIS and CERES. He mentioned that Terra Level 1 data were mostly released (ASTER forthcoming) and Level 2 and 3 data products were being made available. Kaufman also stated his concern that the EOS Data Information System (EOSDIS) was underscoped with respect to data processing margin and reprocessing capacity, especially with the Aqua launch and the expected increase in data processing next year.

### *Science Working Group on Data*

In response to Kaufman's request at the last SWAMP meeting, Chris Justice was asked to hold a workshop to examine current capabilities and expected needs of Terra data processing. Subsequently, a Science Working Group on Data (SWGd) was formed among representatives of the Instrument Teams, DAAC's, and ESDIS. A report was prepared by B. Barkstrom (CERES), F. Bordi (EOS Project), G. Bothwell (MISR), C. Justice (MODIS), E. Masuoka (MODIS), R. Wolfe (MODIS), and D. Ziskin (MOPITT) and presented to the SWAMP. A summary of the report is offered on page 18 of in this issue.

It has since been decided to give the SWGD a prominent role dealing with EOS data issues. Jon Ranson and Skip Reber, EOSDIS Project Scientist, took the action to include Aqua Project Scientist, Claire Parkinson, and develop a charter for this group. The charter is now in the final stages of approval.

### **ASTER**

Yasushi Yamaguchi from Nagoya University presented the status of ASTER on behalf of Japanese PI, Hiroji Tsu. As of September 1, ASTER had acquired over 50,000 scenes. These data

are expected to be released in the United States through the EROS Data Center during November. Issues discussed at the SWAMP included changes in calibration lamps resulting from the lamps starting brighter than expected, some delay in implementing the Version 1.0 of the processing software and the desire by the ASTER team to acquire 16 minutes of data over two orbits rather than the 15 minutes that are currently allotted. Yamaguchi showed some high quality examples of ASTER data from presentations made earlier at IGARSS '00. Anne Kahle followed with more ASTER images including a very interesting composite of Shuttle Radar Topographic Mapper data and ASTER of the Miyake-Jima, Japan, volcano.

### **CERES**

Bruce Barkstrom of NASA Langley discussed the status and issues regarding the CERES instruments on Terra. All planned activation events have been accomplished except the deep-space calibration maneuver. The Terra CERES instruments are performing very well. Barkstrom mentioned that problems with the EOS Data Operation System resulted in missing data for CERES over the summer. For the most part the missing data can be recovered or compensated for. He suggested that success criteria be established for monthly data ingest to gauge the effectiveness of the data system for science activities. Given the scope of the current data processing and reprocessing capabilities, Barkstrom suggested the following science impacts: greater uncertainty in products, 2-4 year delay in producing validated data, reduced user community, limited commercial activities and limited school involvement.

## MISR

David Diner, MISR PI, agreed that reprocessing of data was an issue that needs to be addressed. He mentioned there has been public release of MISR Level 1 data since June; Level 2 will be available for preview in the near future and routinely available later in the fall. He presented some interesting images showing MISR derived cloud heights and wind vectors. He also showed examples of bidirectional reflectance properties of smoke. Diner stated that current MISR data reprocessing capability is inadequate.

## MODIS

Vince Salomonson, MODIS PI, stated that MODIS is working very well and that there are data products available for atmosphere and land disciplines. Ocean products are in progress but more time is required before they can be released to the public. Instrument issues concerning the A/D converter, striping, and bidirectional properties of the mirror are being resolved. Salomonson stated that MODIS direct broadcast is working and cited the recent use of data by the forest service to help locate wildfires in Montana. At least 20 requests for direct broadcast software have been filled. Recent examples of MODIS images for arctic ice, Montana fires, atmospheric moisture, subvisible cirrus cloud detection, and African dust were presented.

## MOPITT

Jim Drummond described the status of MOPITT as good with a few issues being worked regarding possible minor leakage of length modulation cell and decreasing current in a Pressure modulation cell. John Gille stated that MOPITT

level 1 data were to be released in October and Level-2 scheduled for release April 15, 2001. Level 3 beta data are expected by October 2001.

## Terra Spacecraft

Paul Ondrus reported on the status of the Terra Spacecraft and indicated that Terra is in working order. Main issues confronting the operations team are an upcoming deep space calibration maneuver, and the need to develop a plan for Terra's equatorial crossing time. Regarding the first issue, a study is being conducted to examine possible deep space calibration maneuver scenarios that could result in loss of control of the spacecraft and assumption of a sun-pointing safe hold. These events could be detrimental to ASTER since the sun could track across the instrument apertures. Currently, likely scenarios have been simulated and found not to present danger to ASTER. Further scenarios were simulated to understand the effects of loss of one of the reaction wheels on the control of the spacecraft during the maneuver and the possible recovery strategies. A final report and recommendation to proceed was to be made in November with the actual maneuver to be performed in February 2001. (Currently, the review process is on-going and approval of the maneuver is still pending). The crossing time is an issue since currently Terra is at a crossing time around 10:45 am and is on a trajectory to get to a 10:30 am crossing time in about two and one-half years. A decision must be made as to when to initiate the series of burns to keep the crossing time from becoming progressively earlier. This issue will be worked over the next few months after the project has provided the SWAMP a report on various options.

## ESDIS response to the SWGD

Dolly Perkins presented a summary of the ESDIS situation and position regarding the recommendations of the SWGD. She reviewed the process that led to the current set of ESDIS requirements, the now famous A+ Option, that were developed from a February 1996 baseline. She then outlined the ESDIS activities directed at the problems highlighted by the SWGD report, and indicated future solutions will require efficiencies both within EOSDIS and the instrument teams. She stated that without a budget augmentation the recommendations of the SWGD could not be accommodated in the near term.

## Data Production Status

Vanessa Griffin updated the SWAMP on the EOSDIS status and plans. The data system is capturing over 350 Gb/day including nearly 200 Gb/day for Terra. After the Aqua launch next year this data rate will increase to 480 Gb/day. Archived data for Terra has reached 850 Gb/day. She summarized the problems experienced by the EOSDIS Data Operations System that impacted Terra data production. These included a series of problems with tape drives, ftp, backup and operations that conspired to create a large data processing backlog during May through July. Efforts by ESDIS to resolve these problems were also discussed. The data system has improved greatly with smoother operations since late August. The backlog of data continues to be worked off.

## Terra Beta Data Products

Terra Beta Data Products are being released by the instrument teams. Beta

*(Continued on page 38)*

## 2nd Science Team Meeting for the Solar Radiation and Climate Experiment — SORCE

— Gary Rottman ([gary.rottman@lasp.colorado.edu](mailto:gary.rottman@lasp.colorado.edu)), University of Colorado.  
— Robert Cahalan ([robert.cahalan@gssc.nasa.gov](mailto:robert.cahalan@gssc.nasa.gov)), NASA Goddard Space Flight Center.

SORCE Science Meeting 2000, September 13, 14, 15, 2000 Snowmass, Colorado Attendees

Gail Anderson, NOAA, Boulder, CO; Jim Brault, LASP, Univ. of Colo.; Rock Bush, Stanford Solar Observatory, Stanford Univ. Stanford, CA; Robert Cahalan, NASA Goddard Space Flight Center, Greenbelt, MD; Gary Chapman, CSUN, San Fernando Observatory, Northridge, CA; Dominique Crommelynck, Royal Meteorological Institute, retired, Brussels, Belgium; Matt Deland, Raytheon Technical Services Co., Lanham, MD; Giuliana DeToma, LASP, Univ. of Colo., Boulder, CO; Ginger Drake, LASP, Univ. of Colo., Boulder, CO; Peter Fox, HAO, NCAR, Boulder, CO; Claus Frohlich, PMOD, World Radiation Center, Davos Dorf, Switzerland; Jerry Harder, LASP, SORCE SIM Instrument Scientist, Univ. of Colo., Boulder CO; Greg Kopp, LASP, Univ. of Colo., Boulder, CO; Robert Kurucz, SAO CfA, Harvard, Cambridge, Mass; George Lawrence, LASP, SORCE TIM Instrument Scientist, Univ. of Colo., Boulder, CO; Judith Lean, Naval Research Lab, Washington, D.C.; John Leibacher, National Solar Observatory, Tuscon, Arizona; Sasha Madronich, Mesa Lab, UCAR, Boulder, CO; Bill McClintock, LASP, SORCE SOLSTICE Instrument Scientist, Univ. of Colo., Boulder, CO; Jim McGuire, NASA Goddard Space Flight Center, Greenbelt, MD; Bill Ochs, NASA Goddard Space Flight Center, Greenbelt, MD, SORCE Mission Manager; Chris Pankratz, LASP, Univ. of Colo., Boulder, CO; Peter Pilewskie, NASA Ames Research Center, Moffett Field, CA; George Reid, NOAA, Boulder, CO; David Rind, NASA Goddard Space Flight Center, Greenbelt, MD; Ray Roble, HAO, NCAR, Boulder CO; Gary Rottman, LASP, SORCE Principal Investigator, Univ. of Colo.; Rodney Viereck, NOAA, Space Environment Center, Boulder, CO; Dick White, HAO, NCAR, Boulder, CO; Dick Willson, Center for Climate Systems Research, Columbia Univ., Coronado, CA; Martin Woodard, Big Bear Solar Observatory, New Jersey Institute of Research, Big Bear, CA; Tom Woods, LASP, SORCE XPS Instrument Scientist, Univ. of Colo., Boulder, CO.

### Introduction

The SORCE Science Team Meeting was held September 13-15, 2000, in Snowmass, CO. This is now a critical time with the four instruments (TIM, SIM, SOLSTICE, XPS – see the 1999 EOS Reference Handbook) designed and being built, but still awaiting full characterization, calibration, and testing. The meeting provided a forum to acquaint the solar and climate communi-

ties with the instruments' capabilities and measurement program. It is also a critical time in the development of instrument observing sequences and observation plans, and the meeting provided an ideal opportunity to review measurement requirements. These discussions insured that the individuals responsible for the instruments were fully aware of the recent developments in solar physics as well as the present needs of the atmospheric and climate

communities. A unique aspect of this SORCE Science Team was, therefore, the participation of specialists in the variety of solar and terrestrial physical processes that influence Earth's climate. In fact, a significant aspect of the first two SORCE team meetings in Taos and Snowmass has been the communication across these two disciplines. Consequently, terrestrial scientists on the team have learned much about the Sun, and likewise solar scientists have learned about the Earth. Collaboration over a wide spectrum of disciplines is essential to achieving the goals of SORCE.

### Instrument Status and Overview

The presentations at the Science Team Meeting provided an overview of the four instruments' capabilities, since more detailed information has been reviewed and critiqued in a number of project reviews. See the SORCE Web site (<http://lasp.colorado.edu/sorce/>) for more detail.

George Lawrence and Greg Kopp described the Total Irradiance Monitor (TIM). This is a four-channel active cavity radiometer adhering to the basic principles of electrical substitution radiometry (ESR) — that is, a balanced radiometer that substitutes a precise amount of electrical power or Joule heating to replace solar radiation that has been intermittently removed by a shutter. This is the same observing technique used by the ACRIM instrument series, the VIRGO instruments on SOHO, and other devices measuring Total Solar Irradiance (TSI). TIM introduces several improvements through the use of modern materials and enhanced electronics. However, its major advance will be the use of phase lock detection at the shutter frequency resulting in a decrease in the measurement uncertainty

of at least a factor of 10 — determination of the aperture area will remain the largest uncertainty factor ( $\approx 70$  ppm).

Jerry Harder provided an overview of the Spectral Irradiance Monitor (SIM). This spectrometer covers the spectral range 200 nm to 2 nm, and is intended to provide the first, reliable measurement of the visible and near infrared irradiance of the Sun. The challenge is to achieve precision and accuracy suitable for establishing solar variations that are likely smaller than 0.1%. The new instrument design is a small prism spectrometer using only a single optical element and a miniaturized version of the ESR's developed for TIM. The SIM is fully redundant and self-calibrating.

Bill McClintock reviewed the Solar Stellar Irradiance Comparison Experiment (SOLSTICE). This is a second generation version of the highly successful UARS SOLSTICE which has been in continuous operation since September 1991. This spectrometer will cover the spectral range 112 to 320 nm, but in addition to measuring solar irradiance it has the unique capability of observing bright, blue stars with the very same optics and detectors. These stars become the "standard candles" against which the Sun is compared, and they serve as a method of establishing changes in the sensitivity of SOLSTICE throughout the SORCE mission. However, the solar/stellar comparison technique serves an additional purpose and allows a direct comparison of the SORCE solar observations to those made by UARS, or by any other future SOLSTICE-type observation.

Tom Woods provided information on the XUV Photometer System (XPS). This instrument has 12 photodiodes with nine different filters to isolate spectral bands in the XUV from 1 to 35 nm, and at

Lyman- $\alpha$ . It has heritage from other LASP programs including SNOE and TIMED SEE.

All data processing for SORCE will occur at the Science Operations Center (SOC) at LASP. Chris Pankratz reported that all SORCE data will be processed within 24 hours of reception. Provisional products will then be distributed via the SORCE Web site within 48 hours, and fully-calibrated science products will be available approximately three months after reception. These standard data products, as well as the raw data and associated metadata, will be archived at the GSFC DAAC.

### Present TSI Observations

There are presently five different instruments returning TSI data: two ACRIM instruments, one on UARS and one on ACRIMSAT, two instruments on the ESA/NASA SOHO spacecraft, and the ERBE on ERBS. It is not inconceivable that several, if not all, of these instruments will still be returning data at the time of the SORCE mission. Such data overlap will provide a tremendous enhancement to the value and reliability of the SORCE data but, moreover, sharing the experience and findings of these programs provide valuable insight to the present SORCE development. Dick Willson of Columbia University described recent achievements of the ACRIM program which today includes two instruments, one on UARS operating for the past nine years and the other on the recent ACRIMSAT, launched December 20, 1999. The latter ACRIM III has gathered more than 60 minutes of high quality TSI data per orbit since April 5, 2000, and these data have been archived at NASA's Langley Research Center's (LaRC) Distributed Active Archive Center (DAAC) since June 2000.

The initial calibration phase for the ACRIM sensors was completed October 2000, and archiving of fully calibrated results has begun on a regular basis. Willson presented the initial ACRIM III results compared with results from his other on-going TSI monitor, the UARS/ACRIM II experiment. The close agreement is extremely encouraging and demonstrates the value of having at least two TSI devices making simultaneous observations.

Claus Fröhlich of PMOD and Dominique Crommelynck of the Royal Meteorological Institute of Belgium presented the latest results from their respective instruments on SOHO launched late in 1995. Claus is the Principal Investigator for the VIRGO instrument and discussed TSI observations from the PMO6V operational radiometers. The second type of radiometer is the DIARAD provided by Dominique and his colleagues (analyses by S. Dewitte). Both VIRGO instruments provide excellent TSI data that enhances and extends the time series of the ACRIMs and ERBE. Moreover, by operating from the same space platform, the two VIRGO instruments provide simultaneous data records for direct intercomparison. Both instrument teams have completed an initial age-dependent correction to their data, and the subsequent comparison shows differences now to be corrected in a second phase. An initial interpretation indicates that a simple exposure dependent degradation will not suffice, and that unknown and more complicated processes likely play a role.

Dominique has a second instrument, SOLCON, that has flown twice as a Shuttle Hitchhiker, with another flight scheduled within the upcoming year (STS 107). The SORCE program is building two TIM instruments in

addition to the one to be flown on SORCE. One of these extra units will be preserved at LASP as a “witness unit,” and the second, referred to as the *Traveler*, is intended to move outside the laboratory and participate in various intercomparisons. The SORCE program has received NASA Headquarter’s approval to fly this “traveling” unit as a Hitchhiker payload with SOLCON, perhaps as early as the fall of 2002.

### Understanding Solar Variations

Most of one full day was devoted to discussions of our present understanding of the Sun’s radiant output, and to those variations that should be detectable by SORCE. SORCE TSI data, and perhaps to a greater extent the spectral data, will include fluctuations of a solar origin, but intermixed with inherent noise and artifacts of the instrument and/or operations. Experts in solar variability provided important tutorials on solar physics and observations.

Claus Fröhlich provided additional analysis of the SOHO data, considering reconstructions of both the TSI data and the three spectral channels (402, 500, and 862nm). The short-term (~ 27-day) variations seen in the SOHO time series are adequately modeled using limited knowledge of solar surface magnetism (including sunspots and faculae). Rock Bush of the SSSC at Stanford University described the observations of the Michelson-Doppler Imager (MDI) on SOHO. This instrument images the Sun with 4” spatial resolution, through increasingly narrow spectral filters. In general, MDI sends down complete intensity and velocity (Doppler) images every minute

John Leibacher of Kitt Peak then provided an informative overview of the

characteristics of pressure (p-mode) and internal gravity (g-mode) oscillations in the Sun. Present understanding of these phenomena are provided by the temporal and spatial properties of solar observations — observations now being provided by the MDI on SOHO as well as from ground based observations of the Global Oscillations Network Group (GONG). Decomposing the velocity (Doppler) images into spatial spherical harmonics provides power spectra and identifies the oscillation modes. SORCE will not provide data relevant to helioseismology (for example, TIM provides neither spatial nor velocity information), but understanding and accounting for these solar oscillations will insure that our SORCE sampling scheme will not alias these fluctuations.

There were a number of talks describing contributions from today’s ground-based observations. These observations include precision photometry of the full solar disk and image data as well. Gary Chapman described activities at the San Fernando Observatory using two telescopes. Because of large atmospheric corrections, ground-based observations use relative photometry, and then study the magnetic features on the Sun in terms of their contrast against a constant quiet Sun. Chapman et al. construct simple photometric models and compare them to TSI data (e.g., NIMBUS-7 ERB data) finding correlations > 0.95. These ground-based programs allow “gap-filling” in the space record of TSI and the identification of instrumental jumps and offsets in the record (e.g., SFO found two jumps of approximately 250ppm in the NIMBUS-7 data). Martin Woodard described observations made since 1993 by the SolarDisk Photometer at Big Bear Observatory. These high-precision measurements are being analyzed to understand the physical origin of the

Sun’s luminosity variations.

### Observations of Solar Spectral Irradiance

One of the major new contributions of SORCE will be the first accurate measurement of solar spectral irradiance in the visible and near infrared. No previous observations, from the ground or from space, have had adequate precision and accuracy to establish solar variability — a variability that is expected to be no more than 0.1%. At shorter wavelengths in the ultraviolet the variation is larger, and previous programs (e.g., UARS) have reported solar variations over time scales from minutes, to weeks, to the much longer 11-year solar cycle. Several talks summarized our present understanding of and the importance of the new SIM observations.

Jim Brault described the currently existing Kitt Peak high-spectral resolution data. He included other observations as well, and considered how they compared with the Kitt Peak data. The best available models of solar spectral variability, and also models of atmospheric transmission, require high-resolution data. SIM has been designed with attention to its precision and highest possible photometric accuracy, but with its moderate spectral resolution it will not provide information on a line-by-line basis. It will be essential to interpret the SIM spectra in conjunction with the higher resolution ground observations, an analysis that benefits from the continuous and “seamless” nature of the SIM observations.

Little is known about solar variability in the visible and near infrared, due to the large corrections that must be made for atmospheric absorption and due to the



fact that the solar variations are small ( $\approx 0.1\%$ ). From space measurements of the past 30 years we have information that the ultraviolet ( $\lambda < 300$  nm) varies by far more, increasing to 10's of percent below 200 nm and factors of 2 to 10 below 100 nm. Tom Woods provided a review of the ultraviolet observations made from space. In particular, the SOLSTICE and SUSIM instruments on UARS, the SBUV instruments, and the GOME on ERS-II now give a good empirical description of the wavelength variation of the Sun's radiative output over the last two solar cycles. By combining these data sets, we now have a record of UV variability from 1978 to the present.

When full spectral observations are not being made, or when the quality of the observations is in question, a "proxy" may be used to estimate irradiance. The most widely used proxy or index for the UV irradiance is the Mg II index that uses the core-to-wing ratio of the Mg II absorption feature at 280 nm. Instrument response changes should be cancelled out by taking an irradiance ratio using equally spaced wings. Matt DeLand presented long-term data sets produced since November 1978 by SBUV and SBUV/2 instruments onboard Nimbus-7, NOAA-9, NOAA-11, the SUSIM and SOLSTICE instruments on UARS, and the GOME instrument on ERS-2. Three new instruments will be launched during the next two years to continue this valuable data record.

Solar flares are a well known solar phenomenon that might appear in the time records of solar irradiance variability. Such transient and highly energetic events occur in the solar corona, but provide only small disturbance in the photosphere. Consequently, although TSI data records have been closely

examined, flares have not been seen at the level of about 50 ppm. In the ultraviolet and extreme ultraviolet the situation is of course quite different, and Gary Rottman described flares that are obvious in the ultraviolet time series (SME and UARS). Strong flares can more than double the irradiance, but only at wavelengths short of 160 nm and only for short time periods of five to ten minutes.

NOAA presently monitors the solar ultraviolet and X-rays from a family of polar and geostationary platforms, and in 2002 they will add EUV capability. Rod Vereick described these on-going NOAA programs and introduced the future NPOESS spacecraft as well. The instruments planned for NPOESS include a TSI device, and are also expected to continue spectral measurements similar to those of SIM.

### Physics of Solar Variability

#### *Atomic and Molecular Data Bases*

One session of the meeting was devoted to the physics of solar variability — namely, the evolution of the active regions on the Sun and the radiative transfer out of the solar atmosphere. At the heart of this problem is a complex set of atomic and molecular databases. The NSF SunRise program, for example, has developed a physical model of solar variability using these databases together with ground-based solar images to distinguish magnetic features on the solar surface.

Robert Kurucz of CfA reviewed his work spanning the past 35 years computing atomic line lists for all elements (including ions) up through zinc. He described the monumental task of compiling atomic line data on over 100 million

lines. He now computes the solar irradiance spectrum using these data, but, even after removing the effects of atmospheric transmission, he finds deficiencies — perhaps due to missing lines and perhaps due to inaccurate atomic data. Bob continues to refine the line-lists, now including some diatomic molecules. He is also working on an improved analysis of the Kitt Peak Solar Atlas that was obtained using the NSO FTS developed by Jim Brault.

#### *The SunRise Spectral Synthesis Program*

Peter Fox of NCAR described the present approach that he, Dick White, and Juan Fontenla are using to model irradiance variations using seven semi-empirical models— taking into account sunspots, plages, enhanced and quiet network, and the quiet Sun. They compute the intensity as a function of wavelength and position on the solar disk for each of the structure types corresponding to their models. These calculations include three different approximations for the line source function; one suited for the very strong resonance lines where partial redistribution (PRD) is important, another for the most important non-resonance lines, and another approximation for the many narrow lines that are provided in Kurucz's listings. The image analysis and calculations of the irradiance variation as a function of time were described. This work provides an understanding of the sources of variability arising from structures that are applicable to the SORCE/SIM wavelength range.

#### *The Sun's Impact on Climate*

Bob Cahalan provided an overview of the impact of the Sun on the Earth's atmosphere and climate system, and

chaired a session which focused on heating of Earth's atmosphere and oceans. A common theme emphasized in this session was the importance of the spectral measurements of SIM and SOLSTICE—we must know how solar variations are distributed over ultraviolet, visible, and infrared wavelengths, since these have distinct influences on Earth's ozone layer, clouds, and upper layers of the oceans. Emphasis was also given to understanding both direct and indirect influences of the Sun on the Earth, which involve feedbacks between Earth's stratosphere, troposphere, and oceans. Cahalan emphasized the role of all three phases of water on Earth—water vapor being the primary greenhouse gas in the atmosphere, the importance of trace gases such as CO<sub>2</sub> arising from their absorption in the “water vapor window” at 800 - 1250 cm<sup>-1</sup> (12.5 to 8 micrometers). Melting of polar ice is one major response to the post-industrial global warming, enhanced due to “ice-albedo” feedback. Finally, water in liquid form has a major influence due to cloud albedo and ocean absorption, particularly at visible wavelengths. A large fraction of solar energy absorbed by the ocean goes into the latent heat of vaporization. Thus the solar heating of the atmosphere-ocean system is strongly coupled through the water cycle of evaporation, cloud formation, precipitation, surface runoff and ice formation. Each different climate component responds to variations in different solar spectral bands— at ultraviolet, visible and infrared wavelengths.

Gail Anderson of the Air Force Philips Laboratory reported on recent status of the Moderate Resolution Transmittance (MODTRAN) Code that calculates atmospheric transmittance and radiance for frequencies from 0 to 50,000 cm<sup>-1</sup> (200

nm through the infrared). Except for its molecular band model parameterization, MODTRAN adopts all the LOWTRAN 7 capabilities, including spherical refractive geometry, solar and lunar source functions, and scattering (Rayleigh, Mie, single, and multiple), and default profiles (gases, aerosols, clouds, fogs, and rain). MODTRAN's newest 2cm<sup>-1</sup> band model employs the spectral line parameters of the HITRAN96 database for each of 13 molecular species, plus cross sections for the heavy molecules (e.g., CFCs). A major upgrade of the current version is the capability of users to easily define cloud and rain descriptions. A second major upgrade is the inclusion of molecular band model parameters based on the HITRAN96 spectroscopic database.

The impact and importance of atmospheric forcing were discussed, beginning at high altitudes with stratospheric processes. David Rind of Goddard Institute for Space Studies (GISS) reported on recent calculations using the GISS Global Climate Middle Atmosphere Model (GCMAM). This research has studied the impact of UV variations on the stratosphere and resulting affects on the troposphere via wave-mean flow interactions. On long-time scales, variations in solar activity in combination with altered stratospheric ozone may provide for decadal and multidecadal changes in planetary wave patterns, and hence regional climates. Placing the potential solar influence mechanism in the broader context of wave/mean flow interactions may help explain some of the empirically derived solar-climate relationships.

Moving to lower levels of our atmosphere, we considered the solar influence on the troposphere. Peter Pilewski of NASA/Ames discussed recent measure-

ments of the downwelling solar irradiance at the ground. Spectra obtained under cloud-free conditions were compared with calculations using a coarse-resolution radiative transfer model to examine the bias between model and measurement due to water vapor. Indeed there is a bias strongly correlated with the amount of water vapor, and the source of the discrepancy remains unknown. In light of these differences and the inherent uncertainties in spectral solar source functions used by current radiative transfer models, SIM will provide a significant improvement. The inherent accuracy of both TIM and SIM may potentially prove to be valuable reference standards for surface and airborne sensors. During the calibration, validation, and comparison phases of the SORCE program (e.g., at the JPL Table Mountain Solar Laboratory) we will conduct instrument comparison between TIM and other TSIM sensors (ACRIM). Similar comparisons between SIM and, for example, the NASA Solar Spectral Flux Radiometer (SSFR) and other airborne and surface radiometers will also be pursued.

There was discussion of atmospheric photochemistry and Sasha Madronich of NCAR considered the influence of solar ultraviolet (UV) radiation on atmospheric chemistry by photo-dissociating relatively stable molecules into highly reactive molecular and atomic fragments. The added reactivity leads to the formation of key atmospheric oxidants such as ozone (O<sub>3</sub>) and hydroxyl radicals (OH), which in turn remove many other species including methane and non-methane hydrocarbons, hydrochlorofluorocarbons (HCFCs), and various oxides of sulfur and nitrogen. Ultimately, these chemicals affect a number of environmental concerns, e.g., formation of urban photochemical smog, acid rain,

and regional gaseous oxidants, the lifetimes of greenhouse gases, and the depletion of stratospheric ozone. Models of atmospheric chemistry require accurate calculations of the rate coefficients for photolysis reactions, which in turn require accurate knowledge of the solar spectral irradiance incident at the top of the atmosphere.

The solar forcing of the ocean system was also discussed and George Reid of NOAA considered global sea-surface temperature (SST) data that are now available for the period beginning about 1856. The decadal-scale variation of SST in all three ocean basins, with a range of about 0.5°C, shows a remarkable correlation with the decadal-scale envelope of the solar-activity cycle. The similarity of the behavior in all of the ocean basins suggests an external forcing, since random stochastic forcing or changes in ocean circulation would be expected to produce different responses in different regions. Studies of the response of globally averaged SSTs to a varying irradiance have been carried out with a one-dimensional ocean thermal model. The analysis uses a reconstruction of irradiance variations based on a low-pass filtered version of the sunspot cycle, and a variation in greenhouse-gas forcing based on the known variation in carbon dioxide and other greenhouse gases during the century. The results indicate that about 30-40% of the cumulative change in global SST since the beginning of the 20th century could have been caused by solar-irradiance variability.

There was discussion of how the SORCE observations will be adopted by the climate modeling activity. Ray Roble of NCAR discussed progress in developing a global atmospheric model extending from the ground to the exosphere.

Planetary wave and gravity wave breaking in the mesosphere has been shown to affect the stratosphere through "downward control." There is an important need for the development of a model of the entire atmosphere that can be used to investigate couplings between atmosphere regions and solar terrestrial interactions. Such a model is now under development coupling the NCAR Community Climate Model (CCM3) and the Thermosphere-Ionosphere-Mesosphere-Electrodynamics General Circulation Model (TIME-GCM).

The final discussions centered on the longer term influence of the Sun on climate. Judith Lean of NRL discussed an array of climate parameters that exhibit "cycles" appearing to match solar activity records. This empirical evidence exists on time scales of decades to centuries. Climate change simulations with the GISS GCM in response to reconstructed total solar irradiance during the past four centuries suggest that global surface temperature variations on the order of 0.4°C occur in response to solar forcing on centennial time scales. Some 65% of the response arises from the feedback of water vapor, clouds and snow/sea-ice cover. The climate change simulations do not, however, reproduce the apparent strength of sun-climate relations on decadal time scales that the empirical evidence suggests. One possibility is that climate models lack processes by which solar cycle irradiance forcing may become phase-locked with decadal oscillations occurring within the climate system. Another possibility is that the model simulations thus far have not accounted for indirect climate forcing by solar UV-induced changes in ozone.



## ***In Memorium***

Dr. Gerald (Jerry) Soffen, former EOS Senior Project Scientist, founder of The Earth Observer newsletter, and leader of the Viking science team that performed the first experiments on the surface of the planet Mars, passed away November 22 at George Washington University Hospital in Washington, DC. He was 74.

Soffen joined NASA's Goddard Space Flight Center in 1983 where he helped establish the Mission to Planet Earth program and served as the EOS Senior Project Scientist from January 1988 until September 1990 at which time he formed the University Programs Office at Goddard. For the past 10 years, he directed activities and programs designed to maintain and broaden the Center's interaction with the university community.

Dr. Soffen will be sorely missed by his colleagues and friends throughout NASA and the educational communities.

***(Continued from page 2)***

## **EOS Scientists In News**

**Attention EOS Researchers:** Please send notices of recent media coverage in which you have been involved to:

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## Distributed Active Archive Center (DAAC) Managers Quarterly Meeting

— Steve Kempler ([kempler@daac.gsfc.nasa.gov](mailto:kempler@daac.gsfc.nasa.gov)), Distributed Active Archive Center, NASA Goddard Space Flight Center

From October 24 to 26, 2000, the managers of the Earth Science Enterprise (ESE) Earth Science Data and Information Systems (ESDIS) Project, and the Distributed Active Archive Centers (DAACs) met at Goddard Space Flight Center (GSFC). The DAAC Managers meet quarterly, alternating between being hosted by the ESDIS/GSFC DAAC and another DAAC (i.e., every other meeting is hosted by a different DAAC). Meeting at GSFC twice a year affords all DAAC Managers the opportunity to interface with a larger number of Enterprise and Project personnel.

The DAAC Managers are faced with many far reaching technical and programmatic issues and recognize, based on individual independent experiences, that many of these issues can be jointly solved. The implicit, yet very real, benefit of the DAAC Manager's discussions is the potential extrapolation of resolved issues being applied to supporting the formulation of future ESE data and information management systems.

The following topics were addressed during the three-day meeting:

### Informational Sessions:

- Computer security and training
- Budgets/Work Plans

- Guest Speaker - Mike Thomas, Code Y0, NASA HQ

### Issues:

- Long Term Archive (LTA)
- Billing and Accounting
- EOSDIS Data Gateway (EDG)
- DAAC Alliance Issues
- EOSDIS Core System (ECS) Issues

### Reports:

- Data Center Benchmarking Study
- Readiness for Aqua Reviews
- User Services Working Group (USWG)
- Federation
- NewDISS

### Informational Sessions:

**Security** — Clayton Sigman, ESDIS Project, presented security guidelines and an interpretation to facilitate the DAACs efforts to be compliant with NASA security requirements. Sigman spoke extensively on various relevant issues, answering questions, and leaving the DAAC Managers with the following:

- DAACs must comply with NPG 2810.1 security requirements. (which would ensure compliance with OMB A-130).

- Security documentation: ESDIS has to concur on all security plans. If a DAAC complies with its NASA local security requirements, it also has to submit the plans to ESDIS for certification. The Authorization to Process form has to be completed by a civil servant related to each DAAC.
- National Agency Checks (NACs) are required for all personnel with root access.

It was pointed out that some of these requirements "go against the grain" of DAACs located at universities. Universities often invite and enroll promising foreign national students to enhance the university's level of research and studies. Security requirements may inhibit these opportunities. Obviously, discussions will continue.

**Budget/Work Plans** - Vanessa Griffin mentioned that the ESDIS-provided DAAC budget will remain as planned. However, the extent of the DAAC system-enhancements budget, which has been a resource for allowing DAACs to develop and implement EOSDIS functionality removed from ECS implementation, is questionable.

**Guest Speaker** — Mike Thomas, Director of the Applications Commercialization and Education (ACE) Division of the Earth Science Enterprise (Code YO), spoke to the DAAC Managers about new and existing ESE Applications Program initiatives. Thomas' ideas were insightful, and he showed much willingness to learn more about the DAAC's collective and individual applications and outreach programs, and how these programs can better contribute to the ESE.

**Issues:**

Long Term Archive (LTA) - Implementation scenarios are still being discussed, as the time to make hard budget decisions draws nearer. Recognizing that the long-term responsibility for the data falls to NOAA, implementation alternatives include: 1) archive the data in place at the DAACs; 2) transfer data to the chosen NOAA data center sites; and 3) outsource the archives to universities, museums, or commercial sites. The science community (through DAAC User Working Groups) needs to make their feelings known on this issue. It is expected that some NASA/NOAA LTA decisions will be made by the next DAAC quarterly meeting.

Billing and Accounting (B&A) - Bill Potter, ESDIS Project, is leading the study to deploy the B&A system at the DAACs. Due to increasing volumes and limited resources for data distribution, this may be necessary. The DAACs will have to charge for data to offset the reduced funding being provided for data distribution. DAACs will be defining requirements and contributing operational concepts to Potter's working group, as well as developing a B&A Business Plan for handling funds. The B&A working group will work on a policy definition for review by the DAAC managers.

It was noted that all components of Earth science will have to recover the costs for disseminating data, including RESACs and ESIPs. NASA-funded researchers (including ESIPS) will not be charged for data. If costs for distribution of data to NASA-funded researchers exceed the budget, Griffin will ask for additional funds.

EOSDIS Data Gateway (EDG) - Robin

Pfister and Richard Ullman of the ESDIS Project, answered several questions regarding the use of EDG. There was discussion that, although EDG is being improved continuously, currently new users have a hard time learning to use EDG. Tutorials at JPL and George Mason University are planned in the future. The new EOS Clearing HOuse (ECHO) system will allow alternative user interfaces to be developed. Ullman presented slides on the new guide system.

DAAC Alliance Issues - The DAAC Alliance, composed of the eight DAACs and the Global Hydrology Resource Center (GHRC), have come together to form an Alliance to address interests and issues of common concern. These include:

- Alliance System Engineering Team (ASET) - in its formulation stage, this team of DAAC engineers can address open source software implementation, B&A implementations, security, etc.
- Alliance Charter - with additional small corrections, the Alliance charter, outlining the joint DAAC effort to be premier data management centers, is ready to be signed by its members.
- Alliance Web Page - discussions continue on how to develop an Alliance Web page economically.

ECS Issues - various ECS issues were recorded. Typical problems at various DAACs include:

- Troubles with production planning — operations generally run smooth with steady data flow; however, small perturbations cause many system problems.

- Gaps in the data sets require a lot of manual cleaning.
- Hardware to accommodate I/O needs to be enhanced.

**Reports:**

Data Center Benchmarking Study - Bud Booth and Ron Holland, from ESDIS, along with others on Vanessa Griffin's staff, have toured many data centers nationally and internationally, benchmarking their best practices and lessons learned. The objective of this study is improve EOSDIS performance and reduce operation costs. A formal report is forthcoming.

Readiness for Aqua Reviews - reports on Science Operations Readiness by John Moses, ESDIS Project and each Aqua DAAC showed that, although we are at least six months before the Aqua launch, the systems at the DAACs are coming together, and issues are being exposed and addressed. The Aqua Operations Readiness Review will be ready two months prior to launch.

Mike Moore, ESDIS Project, provided insight into additional system capabilities needed for operations readiness. These include:

- a system upgrade at LaRC in order to do science software integration for MOPITT; and
- the Simple Scalable Script-based Science Processor (S4P) to provide more efficient processing.

User Services Working Group (USWG) - Diana Starr, NSIDC DAAC, new chair person of the Alliance USWG, raised several topics for discussion:


- the next DAAC yearbook, to be

reviewed by the DAAC Managers, is expected to be ready by December 2000;

- Diana Starr will provide DAAC Managers with proposed guidelines for the activity report contents; and
- the USWG was asked to provide more guidance on kudos and complaints. The group decided to leave it up to each DAAC to provide its own standard.

**Federation** - The next Federation meeting will be January 8-11. It will feature a science showcase showing what the ESIPs have accomplished. Discussion on the DAAC's views regarding increased Federation membership ensued. This will be further discussed by the Federation's Executive Committee.

**NewDISS** - New Data and Information Systems and Services activities are starting to move out, and it is essential that the DAACs be involved. It is perceived that DAAC experience is very valuable. Program personnel discussions to develop prototypes are underway.

Please contact the DAAC Manager of your choice or the ESDIS Science Operations Manager if you would like further information. 

## West Antarctic Ice Sheet May Be a Smaller Source of Current Sea-Level Rise

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The West Antarctic Ice Sheet's contribution to global sea-level rise may be much slower today than it was in the past. New evidence indicates that the size of the ice sheet thousands of years ago has been overestimated and the ice sheet may not have been as big or as steady a source of sea-level rise as scientists thought.

Glaciologist Robert Bindschadler from NASA's Goddard Space Flight Center (Greenbelt, Md.) discussed the latest research results and changing views of the West Antarctic Ice Sheet's history at the American Geophysical Union's annual meeting in San Francisco on December 16.

"Our previous best estimates that the ice sheet is adding 1 millimeter per year to the global sea level are almost certainly too high," says Bindschadler. This revised assessment is based on a synthesis of new data including past sea-level rise estimates presented at a workshop this fall on the West Antarctic Ice Sheet organized by Bindschadler.

Calculations of how much and how fast the ice sheet has thinned and retreated since the peak of the Earth's last major Ice Age 20,000 years ago are based in large part on a recent reconstruction of

how big the ice sheet was during that last glacial maximum. That reconstruction included a West Antarctic Ice Sheet three times as large as it is now. Currently, the ice sheet averages 2000 meters thick, covers an area the size of Mexico, and contains enough water to raise global sea level 5 meters.

But analysis of a 30-by-50-mile rise in the ice sheet near the Ross Ice Shelf called Siple Dome suggests that this feature was not overrun by a massive ice sheet in the past, which is what the reconstruction suggests. A team of glaciologists from the University of Washington led by Charles Raymond used an ice-penetrating radar to study the subsurface layering of Siple Dome.

Another line of evidence that throws the ice sheet's ancient bulk into question is the discovery that the ice sheet was still growing as recently as 8,000 years ago. The reconstruction assumed that the ice sheet reached its maximum growth 20,000 years ago and has only been in retreat since then.

According to a new reconstruction of historic sea-level around the world by W. R. Peltier of the University of Toronto, a major jump in sea level occurred before

**(Continued on page 33)**

# The Emerging Committee on Earth Observation Satellites (CEOS) Working Group on Information Systems and Services (WGISS) Test Facility (WTF) — Global Observation of Forest Cover (GOFC)

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— David Skole (Michigan State University)

## Introduction

The First National Space Development Agency (NASDA) Workshop on Earth Observing Satellites for Earth Resources Monitoring was held in Bangkok on September 11-12 in conjunction with a Committee on Earth Observation Satellites (CEOS) Working Group on Information Systems and Services (WGISS) Subgroup Meeting (Sept. 11-13). The meetings were hosted jointly by the NASDA and the National Research Council of Thailand (NRCT). Over 170 scientists and information technologists attended the workshops. At these back-to-back meetings, the first early results of the partnership that has formed between the WGISS and an international science initiative, the Global Observation of Forest Cover (GOFC), were demonstrated. The partnership was formed because of the importance the international science community placed on exploring new information technologies that can improve data services. The system demonstrations shown at the

workshop were a step towards defining and establishing the role of the WGISS Test Facility (WTF)-GOFC which was formally endorsed at the subgroup meeting.

## Background

CEOS was created as a forum for all nations that operate Earth observing satellites to coordinate their activities. WGISS ([wgiss.ceos.org](http://wgiss.ceos.org)), a working group of CEOS, concentrates on the development of guidelines and approaches that enable the data processing, archival, and distribution systems of the members to interoperate and easily exchange data and information. The WTF will apply infrastructure-related services and tools developed by the Space Agencies to projects of relevance to CEOS. An initial focus for the WTF is to meet the information and data needs of the GOFC project, which is part of the Global Terrestrial Observing System. GOFC ([www.gofc.org](http://www.gofc.org)) is a coordinated international effort with the goal of

developing and implementing a suite of securely funded, on-going observational programs which will provide timely and consistent information about forests worldwide, using an appropriate combination of spaceborne and *in situ* data. GOFC is designed to help provide information needed to address questions of global change research, associated, for example, with the carbon cycle, as well as information for improved natural resource management.

NASA's Terra instruments and Landsat 7 provide important sources of data for GOFC. The data management systems, services, and tools that NASA has developed through the Earth Science Information Partners (ESIPs), EOSDIS, the Science Investigator-led Processing (SIPs), and Distributed Active Archive Centers provide important contributions to the WGISS Test Environment.

## Demonstration Summaries

The September workshop targeted regional applications of Earth observation satellites in Southeast Asia for natural resource monitoring with an emphasis on information technology. One of the main topics of the workshop was GOFC and the development of operational monitoring systems for forests, land-cover change, and fire using satellite data. In addition, the associated information management needs were discussed. Many of the systems demonstrated Open GIS Consortium (OGC)-developed capabilities. Open GIS Consortium is a standards organization for geospatial information systems composed of government agencies and commercial vendors from around the world working together to create standards which are only approved if there will be commercial products implementing them. A number of new

data and information systems capabilities relevant to GOFc were demonstrated at the workshop.

### **Tropical Rain Forest Information Center (TRFIC)**

The Michigan State's Tropical Rain Forest Information Center (NASA/ESIP) provides scientific information on the world's tropical forests using Landsat and other high-resolution satellite data. The TRFIC system uses visualization techniques similar to the OGC Web-based visualization to show deforestation and land-cover changes in the forests of Southeast Asia. The tremendous visualization capabilities shown included the capabilities to overlay multiple data images with maps, to mosaic image tiles, to turn on or off data footprints, and to zoom and pan. The TRFIC system has data servers in multiple distributed locations around the world. Information about deforestation and land-cover changes in areas around the world can be accessed through the TRFIC system, [www.bsrsi.msu.edu/trfic](http://www.bsrsi.msu.edu/trfic).

### **A Distributed Data System for Global and Regional Fire Analysis: MOCHA**

Francis Lindsay demonstrated how the Los Alamos fires could be analyzed, using the MOCHA (Middleware based On a Code sHipping Architecture) system (NASA/ESIP), developed at the University of Maryland Institute for Advanced Computer Studies, and multi-resolution data including the high resolution IKONOS and Landsat TM, high resolution 250-m MODIS, and coarse resolution AVHRR and DMSP data. Data from these diverse and distributed sources were integrated and dynamic image processing tools were utilized for the visualization of burned areas, enabling post-burn assessments.

MOCHA provides an extensible framework to access multiple sites with differing DBMS and data formats, performs basic image processing and data manipulation functions at the site where the data reside, and then brings only the desired data to the user. The Java code to operate these functions is kept in a code repository and automatically shipped to the remote data sites to perform the data manipulation and analysis requested by users. MOCHA's extensible framework enables additional data sources and custom data applications to be added to the system quickly and without extensive code rewriting. MOCHA development and research is being led by Nick Roussopoulos of the University of Maryland, [mocha.umiacs.umd.edu](http://mocha.umiacs.umd.edu).

### **World Fire Web – European Commission Joint Research Center (JRC)**

The European Commission Joint Research Center's World Fire Web consists of AVHRR active fire data collected by a global network of environmental monitoring centers, equipped with receiving and processing facilities. Each receiving station operates a data processing chain for detecting fires in the satellite imagery. Daily, global fire maps are built up from this regional fire information by automatically sharing data over the Internet. OGC Web-based visualization techniques were implemented in the World Fire Web. Clive Best demonstrated JRC's Java client that handled requests to distributed servers that included servers in Bangkok, Australia, Brazil, and Canada and provided interactive mapping and visualization. This system demonstrated a quasi-real-time AVHRR fire map that can be accessed over the internet, providing powerful visualization

capabilities showing fires around the world. By adding new data sources in the next 12 months, JRC expects to have complete global land coverage with the World Fire Web, [opengis.jrc.it](http://opengis.jrc.it)

### **North American and Global Fire Monitoring Program – Canadian Center for Remote Sensing (CCRS)**

Brian McLeod, CCRS, demonstrated two GOFc-focused systems prototyped by using existing WGISS technologies profiled with a specific GOFc theme. The first demonstration presented a GOFc "view" into the CEOS International Directory Network for metadata discovery. After consulting with the science community, pre-defined IDN searches based on IDN keywords were scripted in the CCRS GOFc portal. This allows GOFc users to search and access metadata with a specific GOFc focus without having to learn how to use the system or to know which keywords yield the desired data. The second demonstration combined existing WGISS inventory and browse service with emerging OGC Web-based visualization using Landsat 7 data to support validation of burned areas. Because both prototypes leveraged existing WGISS technologies, the two systems were started and completed in three months, [ceodev.ccrs.nrcan.gc.ca/prototypes/gofc/GofcPortal.html](http://ceodev.ccrs.nrcan.gc.ca/prototypes/gofc/GofcPortal.html).

### **ESA Experimental Web Mapping**

Ivan Petiteville of the European Space Agency demonstrated two prototypes. In the first demonstration, the original ATSR Fire data (available at [ionia.esrin.esa.it](http://ionia.esrin.esa.it)) were ingested into ESA's existing Multi-mission User Interface System (MUIS) Catalog system. EOLI, ESA's newest Java-based user interface to MUIS, was used to visualize the Along Track Scanning Radiometer



(ATSR) Fire metadata and the ATSR products with GIS thematic maps using OGC Web-based visualization. In the second prototype, ATSR fire data were ingested into a vendor product that implements OGC Web-based visualization, which allowed over 288,000 fires to be detected. A user could select a detected fire and access both metadata and data about that fire. In both prototypes, the commercial vendor products were integrated with existing data and systems to achieve new capabilities, URL: [odisseo.esrin.esa.it/eoli/eoli-gis/html](http://odisseo.esrin.esa.it/eoli/eoli-gis/html); [www.ionicssoft.com/esa\\_firei/](http://www.ionicssoft.com/esa_firei/).


### GOFC International Directory Network

Lola Olsen (NASA) demonstrated a GOFC customization of the International Directory Network (IDN), also known as the Global Change Master Directory. The CEOS IDN group has been experimenting with providing the capability for special interest groups to serve their focused sets of metadata. Either IDN partners or interested focused groups can customize interfaces, specifically targeting the nature of the selected subsets of the entire content. Descriptions of only those datasets pertinent to forest coverage, forest characteristics, and forest fires were included in the GOFC customization of the IDN. The IDN team will be working with the GOFC scientists to identify keywords appropriate for GOFC data collections.

Other WTF-GOFC demonstrations at the workshop included:

- Space Time Toolkit - University of Alabama / Huntsville
- Data Information and Access Link (DIAL) OpenGIS Consortium WWW Mapping Demonstration – Raytheon, ITSS
- SPOT Vegetation Data with VEGA 2000 Initiative - SPOT Image, CNES

The systems demonstrated showed a variety of new capabilities that can be used by global change researchers and forestry agencies around the world. Several systems showed excellent data search and access capabilities. A number of the prototypes implemented the OGC WWW mapping technologies that provided capabilities to overlay image data from multiple sources with multiple maps. A variety of other data services such as data subsetting, data mosaicing, data modeling, and data combination were also shown. Such distributed, heterogeneous multi-mission services are similar to those being advocated by the NASA NewDISS Strategy for evolving NASA's Data and Information Systems and Services activities.

With the information technologists from WGISS and scientists associated with GOFC, a WTF-GOFC integrated team will define profiles of WGISS services to support thematic/project views, and will iteratively prototype new services and extend current capabilities. 

- MODIS Active Fire Products – University of Virginia / GSFC
- Earth Explorer - U.S. Geological Survey / EROS Data Center


*(Continued from page 30)*

## West Antarctic Ice Sheet May Be a Smaller Source of Current Sea-Level Rise

the West Antarctic Ice Sheet began its current retreat, but there is no sign of a subsequent rise large enough to account for melting of so much West Antarctic ice.

The question of how fast the ice sheet retreated still challenges scientists. Recent work, however, leads Bindschadler to conclude that the ice sheet experienced a rapid retreat phase some 7,000 years ago that was preceded and followed by a slower retreat that continues today. Bindschadler points to the geologic record of dated stages in the retreat of the ice sheet's continental base as evidence that it has shrunk in fits and starts. Such episodic retreats may be controlled more by the varying depth of the underlying surface and water than by the changing climate.

"The portion of the West Antarctic Ice Sheet we have focused on for the past ten years appears to be in a stage of near-zero retreat now," says Bindschadler, "but what it will do in the future is still uncertain."

"If you extend the new evidence and the new line of reasoning into the future, the behavior of the ice sheet is more difficult to predict. It suggests, however, that if the ice sheet loses its hold on the present shallow bed it is resting on, the final retreat could be very rapid." 

## Global Diagnosis Completed of Ocean Regions Most Sensitive To an Iron-Rich Diet

— Rob Gutro (*rgutro@pop900.gsfc.nasa.gov*), Science Systems & Applications Inc.  
 — Harvey Leifert, AGU Press Room  
 — Lynn Chandler (*lychandler@pop100.gsfc.nasa.gov*), NASA Goddard Space Flight Center, Greenbelt, Md.  
 — Ron Walli, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Adding iron to the diet of marine plant life has been shown in shipboard experiments to boost the amount of carbon-absorbing phytoplankton in certain parts of the world's oceans.

A new study promises to give scientists their first global picture of the extent of these unique "iron-limited" ocean regions, an important step in understanding how the ocean's biology controls the flow of carbon between the atmosphere and the ocean.

The study by researchers at NASA's Goddard Space Flight Center (Greenbelt, Md.) and the Department of Energy's Oak Ridge National Laboratory, was presented at the American Geophysical Union's annual meeting in San Francisco on December 15.

Oceanic phytoplankton remove nearly as much carbon from the atmosphere each year as all land-based plants. Identifying the location and size of nutrient-limited areas in the open ocean has challenged oceanographers for nearly a century.

"We know where the major iron-limited areas are, but we can't draw a line around the precise geographic extent of these areas," says Goddard's Michael J.

Behrenfeld, a co-author of the new study. "This new result may help us do that."

The study pinpointed iron-limited regions by seeing which phytoplankton-rich areas of the world's oceans were also areas that received iron from wind-blown dust. Iron is one of the essential nutrients needed for microscopic marine plant life to flourish, along with nitrogen, phosphorus, and silicate. Where dust from arid regions around the world falls into the ocean depends on the location of the dust source and the rapidly shifting patterns of wind and weather.

The biologically productive ocean regions were identified by images from the SeaWiFS (Sea-viewing Wide Field-of-view Sensor) instrument on the OrbView-2 satellite, which maps global ocean biological activity. Because no similar satellite observations existed for dust-borne iron falling into the ocean, the researchers estimated the location of oceanic dust deposition with a newly improved global dust model. The model calculates where dust travels and falls by identifying the location of the major sources of wind-blown dust around the world and simulating atmospheric circulation patterns.

"The estimates of global dust deposition produced by this model are more accurate than previous ones," says Goddard scientist Paul Ginoux, "because we use a new assessment of dust sources based on TOMS (Total Ozone Mapping Spectrometer) satellite observations. The model also incorporates actual data on global weather patterns, rather than simulated circulation, produced by Goddard's Data Assimilation Office from satellite weather observations."

An annual cycle of average monthly dust deposition maps was produced using three years of simulations up to 1998. These maps were analyzed for a relationship with SeaWiFS 1998 monthly maps of ocean phytoplankton productivity. The areas where the correlation between iron deposition and ocean color were found to be high may indicate iron-limited regions.

To double check their results, the researchers compared their dust maps with ocean color maps from the Japanese ADEOS satellite and found that the regions of high correlation between dust deposition and ocean productivity were essentially the same.

"Global, satellite-based analyses such as this gives us insight into where iron deposition may be limiting ocean biological activity," says lead author David Erickson of Oak Ridge National Laboratory's Computer Science and Mathematics Division. "With this information we will be able to infer how the ocean productivity/iron deposition relationship might shift in response to climate change."

Behrenfeld is leading a series of NASA-supported research cruises to study in

*(Continued on Page 43)*



## HDF-EOS Workshop IV Meeting Summary

— Richard Ullman ([ullman@gsfc.nasa.gov](mailto:ullman@gsfc.nasa.gov)), ESDIS  
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Center

[hdfeos.gsfc.nasa.gov](http://hdfeos.gsfc.nasa.gov)

The fourth annual HDF-EOS Workshop was held September 19 - 21 at Raytheon's ECS facility in Landover, MD. Approximately 130 people attended. They represented data producers, data users, and tools vendors and developers, as well as the HDF-EOS and HDF development teams and ESDIS project members.

The purpose of HDF-EOS is to facilitate scientific data storage, exchange, access, analysis and discovery by making EOS standard data products more easily accessible. It is both the recommended standard format for EOS peer-reviewed science data products, and a library that implements the standard by building on the HDF library. HDF is a self describing, cross-platform portable data format and file access library developed by National Center for Supercomputing Applications (at the University of Illinois) (NCSA). An HDF-EOS product includes storage of EOSDIS metadata within the same HDF file that stores the data. HDF-EOS also explicitly defines types that accommodate the most common organizations of EOS data: point, swath and grid.

The annual HDF-EOS workshop has become, after four years, the single most important event for reviewing progress and setting priorities in the development of HDF-EOS. The comments and

criticisms received from conference participants, both speakers and those in the general audience, inform participants about the continuing work of developing and maintaining HDF-EOS and HDF libraries, as well as documentation and user support activities.

This year's attendance was the largest ever, and conference participation was very active and constructive. This year marked the first workshop after public release of Terra data. All EOS peer-reviewed standard products from Terra use the HDF-EOS format, and several presentations were devoted to lessons learned by Terra instrument teams in HDF-EOS use in product definition. But, the most significant and most actively discussed subject was the transition to HDF5 and especially how the HE5 library (HDF-EOS based on HDF5) will best take advantage of new functionality in HDF5 while accommodating the existing use of the HE4 library (HDF-EOS version 2.x based on HDF4). Many felt that HE5 has potential to add very important functionality, but others felt that HE4 was established as a standard and that it will be difficult to switch or, more likely, to support two different formats.

### Presentations

The HDF-EOS workshop has become an

annual showcase for the status of innovations in HDF-EOS, in particular, and HDF, in general. More than 30 presentations were made, far too many to summarize here; the complete list is at the workshop Web page: [hdfeos.gsfc.nasa.gov](http://hdfeos.gsfc.nasa.gov).

### Transition to HDF5

The most important development reported in the HDF-EOS library was the new HE5 library. Larry Klein and David Wynne presented the implementation timetable and preliminary design. Discussion of the design was dynamic and valuable. An ad-hoc session was convened over lunch and many participants expressed satisfaction that the design was largely responsive to the needs of the community. Larry Klein pledged to shortly make HE5 Beta-2 available for trial and feedback. The official HE5 release will be forthcoming in late January. The design of HE5 was the central discussion over the course of the workshop.

Mike Folk, Elaine Pourmal, and Robert E. McGrath of NCSA each presented aspects of HDF library and tools development over the past year. These centered on the HDF4 to HDF5 transition. Elaine Pourmal presented results of performance studies that show that most implementations using HDF5 could be at least as efficient as their corresponding HDF4 implementation. A major lesson was that developers must understand access patterns to yield the highest efficiency.

Robert McGrath discussed the difficult technical issues that surround the transition from HDF4 to HDF5. The conclusion was that no general-purpose conversion will provide good results. Each data producer must consider the

best use of HDF5 for his/her situation. As a corollary, because EOS standard products typically contain not only HDF-EOS standard objects (point, swath, or grid) but also other HDF objects, each product will require unique analysis before conversion. This finding further set the tone for discussion of HE5. Ray Milburn reported on some tools developed by ECS for working with HDF-EOS files. They include "hdfeos4to5," a command-line conversion utility with capability to convert point, swath, and grid; H5EOSView; an HE5 version of EOSView; and JEB is a Java EOS Browse tool.

### HDF-EOS Application

The large number and wide variety of tools that use or support the EOS data format standard is a measure of the increasing acceptance of the standard. It also speaks to the importance of EOS data that conform to the standard.

Many developers, especially those developing tools for general EOS use, noted that the standard was a useful starting place. However, ambiguities in the standard and enhancements applied by data producers through addition of "extra" HDF objects made the creation of tools more difficult.

Speakers reported substantial progress in tools that use or support the standard. These included: View HDF, the HEW subsetting appliance, HDF Explorer, MATLAB, commercial HDF tools through RSI, the HDF-EOS DataBlade, WebWinds, the DODS server, The Polar HDF-EOS Data Imaging and Subsetting (PHDIS) tool, a Validation Toolkit for Atmospheric Profile Data Stored in the Aura HDF-EOS Swath Format, the MODIS Map Re-Projection tool, the Distributed Interactive Computing

Environment (DICE), Data Processing Error Analysis System (DPEAS), and the Distributed Image SpreadSheet (DISS). Further details are on the workshop Web site.

Also presented were efforts to extend the standard. R. Suresh outlined a proposal for an EOS vector data standard. The format, targeted for the GIS community and requested by some Earth Science Information Partners (ESIPs), would be an independent extension to HDF-EOS. As such, it would be an "add-in" to the HDF and HDF-EOS libraries. The library design uses HDF4. Liping Di reported progress in the use of HDF-EOS in the Open GIS Consortium Web mapping test bed.

### Reports from Data Providers

EOS data providers spoke about their experiences in developing product formats. The experiences related indicated that use of HDF-EOS required careful analysis and engineering of the data product requirements before implementation.

Concerns included how to maintain access to heritage data, data product size, layout of data to facilitate efficient access, access to meaningful metadata, and standardization across data products by a given producer and among EOS data producers. A serious concern continued to be support for the standard in visualization and analysis tools.

The consensus among data producers was that adoption of HDF-EOS was not simple. However, each presenter noted benefits of the standard. Most importantly, each noted the potential for simpler user interfaces and application of more standard tools. Significantly, several presenters indicated that the

standard accelerated data verification and analysis activities.

Michael Reid reported on the use of HDF within the Landsat 7 Processing System (LPS). LPS products are not hybrid: they are either pure HDF or HDF-EOS. The HDF-EOS products contain geolocated swaths and ancillary data and use the Landsat-specific Index Map feature of HDF-EOS. Data are distributed to users in native HDF because more users are familiar with that format.

Mike Bull and Kathleen Crean reported on MISR Project use of HDF and HDF-EOS. HDF-EOS swath and grid formats are the basis of the products, with additional native HDF structures incorporated where needed.

Peter Spence gave a concise presentation on experiences in developing CERES data products. He warned that HDF and HDF-EOS implementation must be linked closely to development of product generation software in order to facilitate the best design. The use of the standard was critical in expediting data verification.

Robert Wolfe's presentation was about experiences the MODIS Land Group has had with HDF-EOS. He asserted that HDF-EOS has made collaborations easier, that the self-documenting nature of the format allows easier exchange of information, and that an essential feature is the standard method for representing geolocation. Subsetting is especially important because of product size. He discussed several shortcomings but he concluded that more standards like HDF-EOS would be helpful.

Richard Hucek told how the MODIS Atmosphere Group also generates products in HDF-EOS format. The Atmosphere software opens and creates

the MODIS product files using the HDF-EOS interface routines in the ESC SDP Toolkit. The HDF-EOS interface allows subsetting of planes within 3-D data arrays, such as height above the Earth's surface.

Cheryl Craig detailed HDF-EOS Aura-File-Format Proposed Guidelines. She noted that, while HDF-EOS constrains HDF with point, swath, and grid implementations, it is still possible to create two HDF-EOS files that are completely different and would require dramatically different readers. To ease cross-platform use of Aura data sets, the Aura teams have agreed to make their files match more closely. Areas of agreement include:

- organization of data fields and attributes;
- dimension names;
- geolocation names and dimension ordering;
- data field names and dimension ordering;
- units for data fields; and
- attribute names, values, and units.

The audience enthusiastically supported the ideas presented. Several participants suggested that the standardization effort for Aura should extend to all new data products. However, after discussion, the consensus was that it is more practical and achievable for this detailed level of standardization to apply to a single mission rather than broadly to all HDF-EOS products.

Doug Moore and Huan Meng discussed their experiences producing operational

real-time products in HDF-EOS in the Microwave Surface and Precipitation Products (MSPPS) from AMSU-A and AMSU-B data. The team had trouble early in implementation, and still has some problems, but the advantage of HDF-EOS was wider portability and the self-describing format. Tools, such as IDL, view\_hdf, and WebWinds that recognize the HDF-EOS standard natively read the products. HDF-EOS to BUFR and GRIB to HDF-EOS conversions are implemented in the MSPSS system.

### Experts' Panel Questions and Answers

The workshop design encourages participation between speakers presenting new progress and the general audience. Time was also set aside to explicitly facilitate exchange in the form of the "Ask the Experts Panel." The format encouraged discussion among the audience and the "experts panel." Some of the notable discussion topics follows:

**Q:** In application, EOS Standard products are "hybrids" in the sense that, while all contain HDF-EOS objects, most (some participants asserted ALL) contain other additional HDF objects. Has the HDF-EOS standard proved to be useful, or given its variation in application, is the more general HDF standard more appropriate?

**A:** *After discussion, it was generally agreed that NASA's use of HDF and HDF-EOS has been advantageous, although not perfect. The response from the experts included that HDF-EOS was developed to standardize geolocation data, not all data. Some non-conformance issues are addressed in HE5, but a certain amount*

*of variation will have to persist due to the wide range of sciences.*

**Q:** Will a single HDF-EOS library be produced that handles both HE4 and HE5?

**A:** *It is feasible but, because such a library will require use of both libraries, design can't be started until after the release of the HE5 library. This was an extremely important discussion, which followed from the previous day's discussion of the design of HE5.*

**Q:** Will Terra data be ported to HE5?

**A:** *There is no EOSDIS policy that requires that data products defined in HDF-EOS be ported to the new HE5 standard. EOSDIS' commitment to the HDF-EOS standard includes continuing support for HE4. Each data producer and science team will need to consider transition to the new standard on a case by case basis. There will need to be a compelling reason, and timing would likely be coincident with scientific reprocessing.*

**Q:** There is a perceived need to include a versioning number in HDF-EOS files that would enable users or applications to identify: (1) the HDF-EOS version used to create the file, and (2) whether the file is "pure HDF-EOS" or a hybrid.

**A:** *HDF-EOS developers will consider adding this functionality.*

**Q:** Some discussion was centered on a hypothetical case of a grad student at a small university. How could such a person sort out all of the different HDF's and figure out how to deal with them?

**A:** *There was no conclusive answer. It was*

agreed that documentation, especially the HDF-EOS primer, needs to be updated. Other ideas given were: concentrate more on HDF-EOS; make a list of all of the standard products that are coming, and list all of the available tools that will help people get started; most don't really need to know about the HDF-EOS/HDF, just look at the data. Ask the DAAC first, then the science team and HDF-EOS support team; provide a user's guide that helps people first determine at what level they need to come in; and provide a tutorial.

Q: Will HDF-EOS be available for Linux?

A: Linux ports are planned. Expect them before spring.

Q: Does HDF5 support parallel I/O?

A: HDF5 supports MPI-IO. It does not support applications running on separate machines and accessing the same file at the same time. But MPI-connect might make this possible.

### Demonstrations and Tutorial

The HDF-EOS Workshop provides an opportunity for vendors and developers to lead hands-on demonstrations and even tutorials on the use of their tools. The third day of the workshop was devoted to this topic and the interest was extremely strong. All of the demonstration sessions were filled to capacity. After the sessions became over-filled on the first day, the schedule was expanded to add new tutoring sessions and those spaces were also filled. Each of the following tutorials and demonstrations was well received.

Barbara Jones, Elena Pourmal, Mike Folk NCSA: HDF5 Hands-on Tutorial: An introductory tutorial to HDF5, covering how to use the HDF5 application

programming interface (API) to read and write simple HDF5 files, and NCSA-supported tools and utilities for working with HDF5 files, was taught. Two sessions were filled.

Robert P. Comer, The MathWorks, Inc.: The MATLAB hands-on demonstration and tutorial covered relevant capabilities in the MATLAB/Image Processing Toolbox used example data from Terra.

Bill Okubo, Research Systems, Inc.: IDL tools hands-on demonstration and tutorial.

Richard Chinman, UCAR-IITA: DODS servers and clients operating in a number of data systems were presented in a real-time network demonstration.

Pedro Vicente, Space Research Software: A hands-on session using HDF Explorer Ver 1.1, a Windows only HDF reader and visualizer, was given. It was the only tool demonstrated to support both HDF5 and HDF-EOS.


Linda Hunt and Kam-Pui Lee, NASA Langley Atmospheric Sciences Data Center: View\_hdf, developed for the CERES project, was shown as generally useful for analysis and plotting of HDF and HDF-EOS formatted data.

R. Suresh, SSAI: The Distributed Interactive Access Link (DIAL), a WWW-based data distribution system demonstration showed how data providers can easily serve their Earth science data directly to their users.

Mark Nestler, SSAI: A short tutorial on the use of the EOS Data Gateway (EDG), the common WWW interface to EOSDIS data located at all DAACs, was given.

### Postscript

The Aura Data Systems Working Group ratified HDF5 and HE5 as the standard for the Aura mission on November 1, 2000.

The HE5 Beta 2 library was released by ECS for public trial and comment on November 30, 2000. 


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### Terra Science Working Group (SWAMP) Meeting

products are early release data products that can be used to gain familiarity with data formats and parameters, and are intended as a test bed to discover and correct errors in the data products. The data product has been minimally validated and may still contain significant errors. The data product will only exist temporarily in the archive, and is not appropriate for scientific publication.

Beta versions of Terra data products are now available for order from the ASTER, CERES, MISR, and MODIS sensors.

MOPITT data will be made available soon. Calibration and validation activities are still underway, but the data quality from all of Terra's sensors appears to be exceptional. Subsequent reprocessing of the data will yield enhanced scientific utility. Beta data should only be used to become familiar with the data products and their formats, and to prepare for the fully-assessed and operational Terra data products. CERES is now releasing Science Validated Data Products. See eosdatainfo.gsfc.nasa.gov/ for current information on Terra data products

The next meeting will be a mini-SWAMP that will be held during the IWG meeting in Ft. Lauderdale, FL, January 29, 2001. 

## NASA, FEMA Partner to Use Science and Space Technology for Disaster Prevention

— David E. Steitz (*dsteitz@mail.hq.nasa.gov*), NASA Headquarters, Washington, DC  
— Michael Widomski, Federal Emergency Management Agency, Washington, DC.  
(Phone: 202/646-4337)

NASA and the Federal Emergency Management Agency (FEMA) has signed a Memorandum of Understanding (MOU) and joined in a partnership on a major natural-disaster initiative.

It is affiliated with Project Impact: Building Disaster Resistant Communities. The cooperative agreement will result in updated and more accurate maps of flood plains, a better understanding of wildfires, and maps to improve disaster recovery and mitigation by state and local communities throughout the United States.

Under the new partnership arrangement signed by NASA Administrator Daniel S. Goldin and FEMA Director James Lee Witt, NASA and FEMA will apply science, technology and remote-sensing research images of the Earth taken by satellites to emergency management issues on the ground, such as mapping of flood plains and earthquake fault lines and observation of wildfires and other natural hazards.

"This new partnership between NASA and FEMA demonstrates the diverse and wide-ranging applications of NASA's Earth science research and technology and its benefit to the American people," said Dr. Ghassem Asrar, Associate

Administrator for Earth Science, NASA Headquarters, Washington, DC. "The Office of Earth Science is eager to form new partnerships with other government agencies, such as FEMA, as well as with industry and public groups to expand America's use of our Earth-science data."

"I am extremely happy to have NASA as a Project Impact partner," said FEMA Director James L. Witt. "Using the technologies by NASA for disaster prevention will help in saving lives and make communities all across America disaster resistant."

The agreement outlines a first cooperative effort to map flood plains in California's Los Angeles basin; around Sacramento, CA; Virginia Beach, VA; the Red River along the North Dakota and Minnesota borders; and San Francisco, CA. Using laser-imaging and radar-mapping data, NASA and FEMA are evaluating technology for creating more accurate maps of these areas that will help state and local officials model and understand drainage and run-off, which are vital to their disaster preparedness. Local communities will benefit from these precise maps by better understanding the physical characteristics of their communities.

At the same time, NASA Earth scientists will gain valuable data for technology development, validation and calibration of satellites, and the understanding of land use, land cover and flood hazards. America's flood-insurance industry also will benefit from the accuracy of these new maps, which will provide more precise views of flood-threatened areas.

As the agreement is implemented, NASA researchers and their FEMA colleagues will use a variety of public and private satellites and aircraft-mounted Earth-observing instruments. These efforts will help in understanding issues such as soil permeability and saturation, which affect how much water during a flood would likely be absorbed, as opposed to remaining above the ground and possibly causing damage to crops, houses and communities.

Satellite imagery also can provide state and local officials with maps of vegetation in areas prone to wildfires. This information can be used by firefighters to determine which types of plants are more likely to fuel wildfires and better predict what paths such fires may take.

Using airplanes and spacecraft that observe characteristics of the Earth invisible to the naked eye, researchers can better see characteristics of the Earth's surface that are changing and can indicate where earthquake fault lines or volcanoes may be expanding, vital data for understanding and preparing for these dangerous phenomena.

The partnership between the space program and FEMA is part of NASA's Earth Science Enterprise, a coordinated research program that studies the Earth's land, oceans, ice, atmosphere and life as

***(Continued on page 43)***

# National Snow and Ice Data Center (NSIDC) User Working Group Meeting September 25-27, 2000

— Ron Weaver ([weaverr@kryos.colorado.edu](mailto:weaverr@kryos.colorado.edu)), NSIDC DAAC Manager  
— David Bromwich ([dbromwic@magnus.acs.ohio-state.edu](mailto:dbromwic@magnus.acs.ohio-state.edu)), PoDAG Chairman

The User Working Group (UWG) for the NSIDC DAAC (PoDAG) met at the National Ice Center in Suitland, Maryland, in late September. This brief report covers the highlights of that meeting. For more information and more detail please consult the PoDAG Web pages at the NSIDC website ([nsidc.org/NASA/PODAG/MEETING17/](http://nsidc.org/NASA/PODAG/MEETING17/))

In addition to the NSIDC DAAC-specific topics reported below, the UWG was treated to an overview of the National Ice Center history, products and operations, a tour of the NIC facility, and overview of the science program and long range plans. NIC staff members also presented information on their current work and plans for sea-ice data assimilation, seasonal sea-ice forecasting, assessment of the Polar Ice Prediction System, and the Environmental Working Group Arctic Atlases for oceanography, meteorology, and sea ice.

## Data Charging

The NSIDC DAAC manager briefed the UWG on the current NASA ESE plans for charging for data and, more precisely, the recovery of costs for distribution of data to the media. Data charging was viewed as uneconomic and undesirable. It was noted that NASA would cover the

costs for NASA projects. Greg Hunolt Also noted that the charges would be less than comparable charges from, for example, the National Climatic Data Center.

## Science Working Group for the AM-1 (now Terra) Platform (SWAMP) Working Group on Data

A key item of discussion was the proposal by the SWAMP Working Group on Data for a huge increase in resources (~\$15M) for EOS science data processing in an environment of very tight funding. The danger is that these costs, if enacted, might starve other existing activities.

## Allocation of EOS versus non-EOS NSIDC DAAC resources

The UWG had asked NSIDC to present a high-level budget assessment, with specific information on the balance of resources expended for the various sub-components of the DAAC (EOS Satellites, Version 0/Heritage Data, Infrastructure etc.) A key concern was that 30-40% of staff effort would now be devoted to EOS data support, potentially jeopardizing essential data sets from other sources such as heritage data. The question was raised as to whether the ECS, which comprises some 60% of the

EOS data support, could be scaled back to allow more resources to be allocated to existing product support.

## Data Set Status Report

NSIDC Operations Manager, Mark Parsons, provided information on recently completed and released data sets, an assessment of upcoming data set releases, and longer term priorities for the DAAC. (See presentation on Web site for details.) PoDAG agreed to review the NSIDC data set calendar and comment on the priorities assigned to the current and planned DAAC data sets

## User Services Status Report

NSIDC User Services Manager, Michelle Holm, presented a summary of user access to NSIDC DAAC data. Points emphasized were: NSIDC focus is on science users; primary mode of distribution is CD-ROM, but the expectation is that FTP and tape will play an increasing role with the advent of EOS-MODIS products; continued strong interest in "Heritage" data is expected; percentage of DAAC requests in relation to NSIDC as a whole has remained relatively constant; and DAAC data support requests represent 67%-75% of all data support requests handled by the NSIDC User Services staff.

## PoDAG in the EOS Era Roundtable Discussion

The UWG and NSIDC invited Michael King and Skip Reber for a discussion on how they thought the UWG should fit into the EOS program. The following summarizes this discussion:

There was general agreement on the need to revise the EOS Science Linkages chart prepared by Vanessa Griffin,



particularly as it does not show the role of the User Working Groups (see Action Items). DAAC UWGs come under the data side of EOS and since King is on the science side of EOS, he is not directly linked to the UWGs or completely aware of their activities and membership. UWGs most appropriately link to HQ Program Scientists, as these managers have purview over both EOS and non-EOS data activities. UWG recommendations and observations should pass through the DAAC manager via the Program Scientist at NASA Headquarters, to ESDIS, and through Skip Reber to the EOS Project Science Office under Michael King.

Heritage data in the DAACs may be targeted if budget cuts are enacted. EOS data activities are mandated, and increases in resources at the DAACs are going into EOS data handling. Skip Reber needs to have articulated the value of ancillary data sets for EOS data analysis.

Current management is not interested in long-term data management, and there are no funds to support it. Long term means launch plus five years, approximately.

The question was raised as to what authority does PoDAG have for rejecting an EOS data set from the NSIDC DAAC. The data set generation has been reviewed (e.g., the ATBDs), but the actual data have not been independently validated. Any problems that the UWG finds with products should be communicated to Skip Reber.

### **PARCA Data Archiving**

The Program in Arctic Regional Climate Assessment (PARCA) is winding down and the disposition of data collected by

the PIs was discussed. Higher level data sets will be available on PI Web sites by March 1, 2001. A data catalog will be available on the NSIDC DAAC Web site. Lower level and higher volume data are more of a problem. Requests for lower level data will determine what actions are taken for archiving of these data. NSIDC will provide an estimate for the archiving of the higher level data sets. This estimate will be completed by the end of 2001. The HQ Program Manager for PARCA will provide guidelines to PIs for depositing data at the NSIDC DAAC.

### **Earth Science Enterprise (ESE) Outreach**

Ming-Ying Wei (NASA HQ Code YO) presented an overview of the ESE education and outreach program. The program is divided into education (formal and informal), outreach, and applications programs. The Outreach Division is proposed to reach a target of about 3% of the total ESE budget within a few years.

### **CryoSat Program**

Keith Raney, Applied Physics Laboratory at Johns Hopkins University, presented an overview of the proposed CryoSat effort. CryoSat is a European near-polar orbiting altimeter mission scheduled for the 2003-06 timeframe. It appears to have great utility for the sea-ice and ice-sheet communities. The European Space Agency is planning three Announcements of Opportunity; calibration/validation, processing, and data utilization in the coming three years.

U.S. scientists may propose under no-exchange-of-funds agreements to these AOs. Such proposals gain access to the data, but financial support must come from U.S. sources.

### **MODIS Snow and Ice Products**

Dorothy Hall, PoDAG member and MODIS snow and ice product lead scientist, presented early results of the MODIS snow and ice data products from Terra. Following are the main points covered, and associated observations of the PoDAG members.

The MODIS cloud-cover algorithm now does a very good job separating cloud from snow/sea ice in many of the areas that have been studied. Initial comparisons of MODIS snow cover with other data sources for New Hampshire during March 2000 shows both agreement and disagreement, with the latter depending, in part, on the spatial resolution contrast of the data sets. Because none of the operational products are fully validated, it is difficult to know which snow map is the most accurate. MODIS snow cover enhancements to come are fractional snow cover and daily snow albedo.

Hall reported that one early user said that there is a steep learning curve required for use of the data. Data request procedures need to be enhanced.

The Sea-ice product is determined by two different methods, one based on reflectance, and the other based on ice surface temperature. Cloud coverage is noted and the land is masked out. An algorithm for snow over sea ice does not exist. This might be feasible to do, but will not be done under the existing MODIS contract at Goddard. MODIS sea ice was compared to ship observations from the Southern Ocean in March 2000 by Shusun Li of the University of Alaska, and good agreement was obtained. The MODIS sea-ice edge coincided with the 1.7C isotherm observed by the ship-based observers.

MODIS does have a surface temperature algorithm specifically for ice sheets, but Zengming Wan of UCSB has produced a surface-temperature product that includes the ice sheets. A climate modelers' snow cover grid will be produced. Snow cover is not detected at night, but sea ice is (from the surface temperature). Snow cover composites have been, and will continue to be, produced to try to limit the cloud obscuration. AMSR and MODIS products will be combined to produce a snow cover extent and depth analysis that is not obscured by persistent cloud cover.

For snow and ice product examples, consult the NSIDC MODIS Web page at [nsidc.org/NASA/MODIS/](http://nsidc.org/NASA/MODIS/) and follow the links to browse images or example products.

### New PoDAG Members

With regret, PoDAG and NSIDC accepted the resignations of three members. Greg Flato, Drew Rothrock, and Mark Drinkwater have stepped down. They were all thanked for their efforts on behalf of the NSIDC DAAC, in particular Rothrock and Flato who are long-time members. PoDAG discussed replacement members, but no decision was made at the meeting.

### Summary of Recommendations and Actions Taken

#### Recommendation:

PoDAG recommends to Skip Reber, ESDIS Project Scientist, that he organize a coordination meeting with DAAC managers and chairs of User Working Groups. The agenda should include data set charging, heritage data in the EOS era, the SWAMP Working Group on Data Funding Proposal, and long-term data archiving.

#### Action Items:


A full list of action items may be found at the PoDAG Web site mentioned above. Listed below are action items of interest to the wider EOS community:

1. Dave Bromwich and Ron Weaver will redraw the EOS Science Linkages chart prepared by Vanessa Griffin, and will circulate the revised chart to Griffin and the other User Working Groups.
2. Dorothy Hall should prepare a more comprehensive overview of MODIS snow and ice products for the next PoDAG meeting. This should include a survey of users. 1-2 users should be invited to the next PoDAG meeting. PoDAG members should use the MODIS data before the next meeting so that they can provide meaningful discussion.
3. Mark Parsons will evaluate the NISE sea-ice product in relation to higher quality sea-ice analyses and report to PoDAG at the next meeting.
4. PoDAG members will review the DAAC data set priority list on the PoDAG website by December 4, 2000 and provide feedback to NSIDC DAAC.
5. Dave Bromwich will write a letter to Skip Reber stressing the value of heritage data to provide a context for EOS data sets.
6. Dave Bromwich and Ron Weaver will explore the need for a coordination meeting between DAAC managers and the chairs of User Working Groups.
7. NSIDC will estimate the resources

required to hold all of the PARCA higher level data that are listed on Web pages maintained by Principal Investigators (after March 1, 2001).

8. The Program Scientist will send instructions to Principal Investigators for depositing data at NSIDC DAAC.
9. Ron Weaver, Roger Barry, and Dave Bromwich will recruit potential new PoDAG members discussed at the meeting.

The next PoDAG meeting will be at NSIDC in Boulder, probably on April 25-27, 2001. Agenda items proposed include:

- MODIS Snow and Ice Products: user survey, input from users, example products to be presented. Dorothy Hall to take the lead here.
- Further discussion of the EOS Science Linkages chart prepared by Vanessa Griffin.
- Cost assessment from NSIDC for holding higher-level data products from PARCA project.
- Data set priorities.
- Report of SWAMP Working Group on Data.
- Data charging.
- New member introductions.
- Selection of a co-chair for PoDAG to eventually succeed D. Bromwich as chair. 

## EOS Science Calendar

### February 8

Aqua Science Working Group Meeting, NASA Goddard Space Flight Center, Greenbelt, MD, building 33, room H114. Contact: Claire Parkinson, tel. (301) 614-5715; e-mail: [claire.parkinson@gsfc.nasa.gov](mailto:claire.parkinson@gsfc.nasa.gov).

### February 14-15

ICESat/GLAS Science Team Meeting, UCSD, La Jolla, CA. Contact Bob Schutz, tel. (512) 471-4267; e-mail: [schutz@csr.utexas.edu](mailto:schutz@csr.utexas.edu).

### February 15-16

SEDAC User Working Group, Arlington, VA. Contact: Bob Chen, tel. (845) 365-8952; e-mail: [bchen@ciesin.columbia.edu](mailto:bchen@ciesin.columbia.edu).

### February 27-March 2

AVIRIS Earth Science and Applications Workshop, Jet Propulsion Laboratory. Contact Robert O. Green, e-mail: [rog@spectra.jpl.nasa.gov](mailto:rog@spectra.jpl.nasa.gov); URL: [makalu.jpl.nasa.gov](http://makalu.jpl.nasa.gov).

### April 25-27

User Working Group (UWG) for the NSIDC DAAC (PoDAG) Meeting, Boulder, CO. Contact Ron Weaver, e-mail: [weaver@kryos.colorado.edu](mailto:weaver@kryos.colorado.edu).

## Global Science Calendar

### April 2-4

International Conference on Information Technology: Coding and Computing (ITCC2001), Las Vegas, Nevada. Call for Papers. Contact Pradip K Srimani, e-mail: [srimani@cs.clemson.edu](mailto:srimani@cs.clemson.edu); URL: [www.cs.clemson.edu/~srimani/itcc2001/cfp.html](http://www.cs.clemson.edu/~srimani/itcc2001/cfp.html).

### April 3-5

Oceanology International 2001, Miami Beach Convention Center, FL. Contact for USA: (703) 312-91214; for Worldwide: +44 20 8949 9822.

### April 8-11

GWXII: The XIIth Global Warming International Conference & Expo, 2001 Annual Conference: KYOTO Compliance Review, Cambridge University, UK. Call for Papers. For abstract submission see URL: [www.GlobalWarming.Net](http://www.GlobalWarming.Net); tel. (630) 910-1551; Fax: (630) 910-1561; e-mail: [gw12@GlobalWarming.Net](mailto:gw12@GlobalWarming.Net).

### April 23-27

ASPRS: The Imaging and Geospatial Information Society, St. Louis. See URL: [www.asprs.org](http://www.asprs.org); e-mail: [wboege@aol.com](mailto:wboege@aol.com); tel. (410) 208-4855; Fax: (410) 641-8341.

### May 14-18

Environmental Risks & the Global Community, Argonne, IL. Contact Joan Brunsvold, tel. (630) 252-5585; e-mail [jbrunsvold@anl.gov](mailto:jbrunsvold@anl.gov).

### July 9-13

International Geoscience and Remote Sensing Symposium, Sydney, Australia. Call for Papers. For abstract submission see URL: [www.IGARSS2001.org](http://www.IGARSS2001.org); tel. 61.2.6257.3299; Fax: 61.2.6257.3256; e-mail: [igarss@ausconvervices.com.au](mailto:igarss@ausconvervices.com.au).

### July 10-13

A Global Change Open Science Conference, "Challenges of a Changing Earth," Amsterdam. Contact Conference secretariat, tel. +31 20 5040200; e-mail: [igbp@congreg.nl](mailto:igbp@congreg.nl); URL: [www.sciconf.igbp.kva.se](http://www.sciconf.igbp.kva.se).

### July 10-18

International Association of Meteorology and Atmospheric Sciences, Innsbruck, Austria. Contact Conference secretariat, IAMAS 2001, tel. +43 512 575600; Fax: +43 512 575607; e-mail: [IAMAS@congress-innsbruck.at](mailto:IAMAS@congress-innsbruck.at); URL: [meteo.uibk.ac.at/IAMAS2001/](http://meteo.uibk.ac.at/IAMAS2001/).

### September 17-20

Fifth International Airborne Remote Sensing Conference & Exhibition, San Francisco. Contact Marilyn Dehring, tel. (734) 994-1200, ext. 3350; e-mail: [dehring@erim-int.com](mailto:dehring@erim-int.com); URL: [www.erim-int.com/CONF/IARSC.html](http://www.erim-int.com/CONF/IARSC.html).


### October 7-10

2001 International Conference on Image Processing, Thessaloniki, Greece. Call for Papers. Contact Diastasi, tel. +30 31 938 203; Fax +30 31 909 269; e-mail [diastasi@spark.net.gr](mailto:diastasi@spark.net.gr).

(Continued from page 34)


## Global Diagnosis Completed of Ocean Regions Most Sensitive To an Iron-Rich Diet

more detail iron-limited areas of the ocean. The first cruise was completed this September in the equatorial Pacific Ocean near Hawaii.

Images to support this release can be found at: <ftp://www.gsfc.nasa.gov/earthpix/agu/>. 

(Continued from page 39)

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