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Michael King
EOS Senior Project Scientist

The Office of Earth Science has now finalized the selection of proposals arising from the NASA Research Announcement (NRA) for validation studies for data products from the EOS Aqua platform and EOS-related spectroscopic studies. NASA received 84 proposals in response to this announcement, 27 of which have been selected. The final selection results can be summarized as follows:


| | |
|----------------------------|----|
| AMSR-E Validation | 12 |
| Rainfall | 4 |
| Soil moisture | 4 |
| Snow water equivalent | 1 |
| Surface winds | 1 |
| Sea ice | 2 |
| AIRS Validation | 10 |
| Forward model | 4 |
| Upper troposphere humidity | 3 |
| Water vapor column amount | 1 |
| Ozone column and profiles | 1 |
| NMP impact assessment | 1 |
| Aura/ AIRS Spectroscopy | 5 |
| AIRS/ TES/ HIRDLS | 4 |
| MLS | 1 |

The recent EOS Investigators Working Group (IWG) meeting proved to be an extremely stimulating exchange of new science initiatives and discoveries. The IWG meeting is the primary and most comprehensive forum for sharing EOS program activities and scientific studies, and the primary focus of this meeting was to learn of exciting new science from recently launched missions, and to assess plans for the EOS program over the next few years. These topics were complemented by several very interesting presentations from numerous EOS Interdisciplinary Science (IDS) investigations. Several presenters commented on the excitement of new remote sensing capabilities, and how they might complement their own research. The interest in presenting the latest EOS mission status and science results forced an extension of the meeting

beyond its originally scheduled conclusion. See the full report on the Fort Lauderdale meeting on page 3 of this publication. The IWG meeting is held nominally every nine months, and the location usually alternates between eastern and western U.S. venues. The next IWG meeting will be held in early November with the Lake Tahoe area being a candidate location.

On a related topic, several Terra science symposiums are being planned around upcoming science meetings, including those sponsored by the American Society of Photogrammetry and Remote Sensing (ASPRS), the American Geophysical Union (AGU), the International Geoscience and Remote Sensing Symposium (IGARSS), and the International Association of Meteorology & Atmospheric Sciences (IAMAS). The participation in respected professional organizations is indicative of the tremendous

contributions to Earth system science being made by the EOS program. A dedicated Terra science workshop is also being discussed to explore in depth the unique science capabilities and data usage from Terra. Dates and locations have not yet been determined, but information on this important event will be provided in upcoming issues of *The Earth Observer*.

The Ozone Monitoring Instrument (OMI) slated for the Aura atmospheric chemistry mission will begin producing Algorithm Theoretical Basis Documents (ATBDs), and will participate in a peer review process similar to all other EOS instruments. The concept of the ATBD and its review process was presented at the recent OMI Science Team meeting in the Netherlands. There will likely be four documents produced this summer, with a one-day ATBD review planned in the Netherlands this fall. 

Dr. Jim Hansen

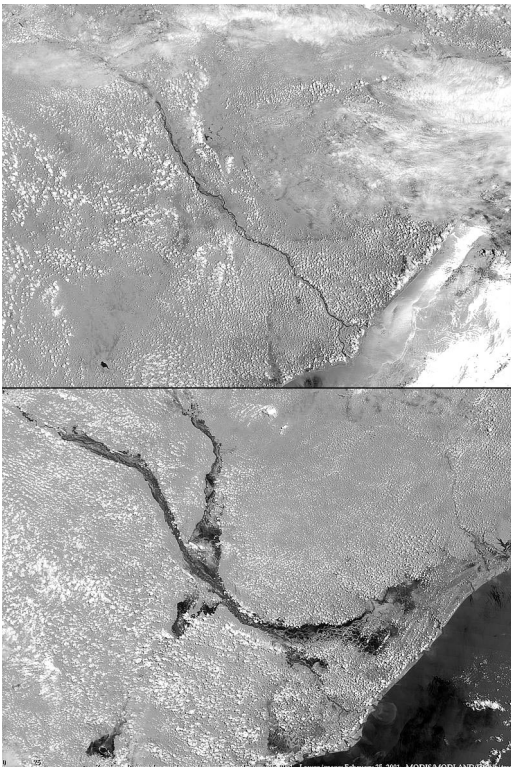
Wins

Heinz Award

Dr. Jim Hansen, an environmental researcher at Goddard Institute for Space Studies, was one of the recipients of this year's Heinz Award. Hansen won this award for helping to raise the awareness of the potential importance of human-made climate change.

The \$250,000 award, bestowed annually by the Heinz Family Foundation since 1993, honors the memory of Sen. John Heinz, R-Pa., who died in a plane crash in 1991. He was heir to the Heinz food fortune. The award is given in recognition of people who enhance the lives of others. The winners received their \$250,000 awards at a March 5 ceremony in Washington, D.C.

The founder of Apple Computer Inc., a psychiatrist, an arms control advocate and two dance instructors are among the other Heinz Award recipients.



According to Reuters news reports, on February 28, 2001, rescue teams went into action again in Mozambique to evacuate hundreds of thousands of people endangered by the flooded Zambeze River (also spelled "Zambezi" by some sources). In a repeat of last year's operations in Mozambique, South African search and rescue helicopters were called in to pluck people stranded by the rising river waters. Unfortunately, 52 people have died in this event and more than 85,000 are now homeless.

This pair of Moderate-resolution Imaging Spectroradiometer (MODIS) images shows the Zambeze River before the flood (January 15, 2001) and more recently after the river overran its banks (February 25, 2001). Dark pixels are water and white pixels are clouds. Notice the plumes of sediment, which appear light grey in the latter scene, outflowing into the Mozambique Channel at various places along the coastline.

Images courtesy Jacques Desclotres, MODIS Land Team, NASA Goddard Space Flight Center

Minutes of the Seventeenth Earth Observing System (EOS) Investigators Working Group (IWG) Meeting

— Robin Williams (william@pop900.gsfc.nasa.gov), SSAI

The 17th meeting of the EOS Investigators Working Group (IWG) took place at the Wyndham Resort and Spa, Fort Lauderdale, Florida, January 30 - February 1, 2001.

Tuesday, January 30

Morning Plenary Session (Earth Science Enterprise/EOS Status)

Michael King (NASA Goddard), EOS Senior Project Scientist, Chair

Ghassem Asrar, NASA's Associate Administrator for Earth Sciences, opened the meeting and presented an overview of NASA's Earth Science Enterprise (ESE). He congratulated all concerned for contributing to a most successful year, independently assessed to be the best in the history of the program. He also thanked the international partners. A plan for the next decade was submitted to the new administration in mid February 2001 that forms the basis of the budget for FY 2002 and beyond. EOSDIS is now archiving a terabyte of data per day and this will increase dramatically with new launches slated for the next three years. A major concern is that the system's capacity and throughput may not keep up with increasing demand so improvements to its efficiency and capacity may be necessary. To this end, ESE will continue to switch from an infrastructure that focuses on

hardware to one that focuses on scientific objectives, data analysis and utilization. By 2005, scientific data analysis and modeling will constitute 25% of ESE's budget. Another major priority is to expand the use of NASA data beyond the traditional Earth science community by reaching out to state and local governments and international organizations. To help achieve this goal, a Broad Agency Announcement (BAA) is being issued to fund new applications. Asrar concluded by stressing that we must demonstrate more effectively the usefulness of ESE to the broader community. He stated that delivering on our past commitments to the Nation and our partners will assure continued support for the Enterprise in the future.

Jack Kaye (NASA HQ) presented an overview of ESE strategic planning. ESE has recently published a report that presents a strategic plan entitled "Exploring Our Home Planet" (www.earth.nasa.gov/visions/stratplan/index.html). In order to predict the future more accurately we must better understand the past. To achieve this goal, more detail in the science program is required and, to this end, a list of 23 key questions has been compiled. The plan proposes an end-to-end approach from basic research to assessment. There will be fewer NRAs, and these will be more focused than in the

past. More funding for university-based outreach is envisaged. Kaye concluded by defining a new mantra: characterize, understand, and predict (CUP).

Five short talks followed on the status of EOS missions, starting with **Chris Scolese** (NASA Goddard). EO-1 and SAC-C were successfully launched in December 2000. Both Terra and Landsat 7 have demonstrated short-term operational capability so Terra has been transferred to the Earth Science Mission Operations (ESMO) Project and Landsat 7 to USGS. The launch date for Aqua has slipped from its previous date of July 12, 2001, and the Aura project has slipped six months. The ICESat Project LRD has changed to December 15, 2001 because of GLAS problems. The AM constellation of Landsat 7, Terra, EO-1, and SAC-C is operating successfully. The SORCE Project implementation phase is proceeding to a July 2002 launch date. NOAA-16 was launched but is having APT problems. GOES-11 was launched and the constellation is operational. The next GOES launch will be in summer 2001. The first ESSP launch will be GRACE in 2002 followed by PICASSO/CENA and CloudSat. ESMO is operating ERBS, UARS, TRMM, TOMS-EP, and Terra, and is also supporting USGS/Landsat 7. Lastly, an overview of formulation activities was presented.

Phil Sabelhaus (NASA Goddard) reported on the status of Aqua, which will carry AIRS, AMSU-A, CERES, HSB, AMSR-E, and MODIS. These were all delivered by December 1999 and have been integrated into the spacecraft. The Observatory is fully integrated except for the FMU. The EOC Training and Simulation Facility was delivered in August 2000. Science data algorithms have been delivered, and flight software development is complete. Collaboration with the Japanese is planned for AMSR-E. The Aqua Science Working Group coordinates collaboration between instruments.

Mark Schoeberl (NASA Goddard) reported on the status of Aura whose

launch is scheduled for June 2003. Lessons have been learned from the Aqua experience. There will be fewer instruments on Aura and processing will be done using a SIPS approach. HIRDLS (a joint venture with the U.K.) has power system problems. The status of the MLS limb sounder is very good. The TES has problems with its flight detector assemblies. The OMI is a joint Dutch/Finnish venture and can be thought of as TOMS+. Aura will be part of a constellation called the "A-train" that will include PARASOL, CloudSat, PICASSO-CENA, and Aqua. GOES and Triana will provide the global view.

Chip Trepte (NASA Langley) gave a status report on SAGE III, the follow-on mission to SAGE II. It will measure aerosols, ozone, and water vapor in the stratosphere and upper troposphere, and will fly on the Russian Meteor 3M satellite that has already been delayed three years. Testing is complete and launch is scheduled for May or June 2001. The engineering team is in Russia waiting for the integration test to begin before the instrument is mounted in the spacecraft. An external review of SAGE III was conducted for NASA HQ. A mock readiness review will take place in March and a science meeting in May 2001. A sister instrument was planned for the Space Station but delays have necessitated alternatives to be explored.

Lee-Lueng Fu (Jet Propulsion Laboratory) reported on the status of Jason-1, the follow-on altimeter to TOPEX/Poseidon (T/P). T/P was successful in identifying the surface features in the Pacific due to ENSO and determining the rising trend in mean sea level. Jason-1 is one fifth the weight of T/P, employs solid-state electronics, and has a dual frequency capability. All specifications have been met. T/P and Jason-1 will fly in tandem with a one-minute separation enabling inter-calibration to be performed. The tandem mission will fly in an interleaved orbit after the verification phase and result in better spatial resolution, velocity vector estimates, enhanced coastal tide models, and improved global change detection.

Marc Imhoff (NASA Goddard) described the ESSP Pathfinder. ESSP missions are part of the Earth Explorer program that is targeted to fill gaps in our knowledge. ESSP missions are rapid-response, low-cost missions that must answer a problem succinctly, fulfill an objective, or be a proof-of-concept for an operational mission. Between the first and second AOs, four missions were funded: the Vegetation Canopy Lidar (VCL), GRACE, CloudSat and PICASSO-CENA. NASA will soon release the third AO, which is on the Web. Key areas to consider are climate forcings, responses, feedbacks, and prediction. The third AO will possibly fund four missions. NASA will provide launch services leaving the PI to concentrate on the instrument(s).

Vanessa Griffin (NASA Goddard) gave an update on EOSDIS data processing and data system status. EOSDIS performance is significantly improved since the last IWG meeting. EDOS problems have been resolved and the reprocessing backlog has been reduced dramatically. The ECS SDPS capability for Terra reprocessing and Aqua processing is in place and will be operational by April 2001. Preparations for Aqua are proceeding steadily and are further along than at the corresponding time for Terra. The distribution capability is currently of concern, and creative ideas are sought.

George Seielstad (University of North Dakota) gave a presentation on ESIPs (the Federation of Earth Science Information Partners). The Federation meets twice a year to facilitate an exchange of ideas. The NewDISS cluster concept, advanced by the Federation, is a flexible information exchange system that draws on the creativity of its members. A case study was presented involving the evolution of the snow pack that exemplifies the advantages of the NewDISS approach. A global village model was used to point out the alarming rate at which resources are consumed and the inequities in their distribution. The Federation aims to play an important role in meeting the resulting challenges.

First Afternoon Plenary Session (International Partners and New Mission Overviews and Science Results)

Mark Schoeberl (NASA Goddard),
Aura Project Scientist, Chair

Chris Readings (European Space Agency) spoke on ESA Earth-observation missions, highlighting aspects of current ESA plans. He noted that MSG includes GERB (to measure the Earth's radiation budget) as well as an enhanced imager. ERS-2 is the current operational ERS satellite and differs from ERS-1 in that it carries an enhanced ATSR and GOME for global ozone monitoring. ENVISAT (due for launch in June 2001) will carry seven ESA-developed instruments and three AO instruments including DORIS. METOP will carry the joint NOAA/EUMETSAT Meteo-package, three ESA instruments (including GOME and a wind scatterometer), and one AO instrument (IASI). He outlined the new "Earth Explorer Missions" (EEMs) concept which addresses ESA research objectives in a more efficient way (ESA document SP-1227). Detailed descriptions followed of approved EEMs (Cryosat, GOCE, SMOS and ADM/Aeolus), back-up, and current candidate missions. The next call for smaller EEMs will be in mid-2001 (fuller details will be found at www.estec.esa.nl/explorer/).

Toshihiro Ogawa (NASDA) spoke about ADEOS-II, AMSR-E, and other NASDA activities. The JERS-1/SAR global forest-mapping project was described. The tropical forest has now been mapped and the emphasis is now on boreal forest mapping. Data from the upcoming ALOS/PALSAR mission will be used for this project. Data showing the capabilities of the ADEOS/IMG to measure methane and water vapor were presented. AMSR on ADEOS-II and AMSR-E on Aqua will fly in AM and PM orbits, respectively, and thus complement each other. GLI on ADEOS II is very similar to MODIS. BIBLE-C aircraft validation for MODIS was conducted over sites in Japan, SE Asia, and

Australia. The GCOM series of satellites to be launched later this decade will be used for global change observations.

Second Afternoon Plenary Session (Instrument Overview and Performance, and New Science Results from ACRIMSAT and Landsat 7)

Mark Schoeberl, Chair

A joint presentation was given by **Richard Willson** (Columbia University) and **Roger Helizon** (JPL) on the ACRIMSAT instrument/ground system overview and performance. The instrument is performing extremely well. The data have been analyzed since June and archived since late Fall 2000 and are collected by JPL's Table Mountain Observatory in California. The data agree to within 0.1% with those from ACRIM II on UARS. The goal of the mission is to extend the time series of solar irradiance that began with Nimbus-7 in 1978.

Three talks on Landsat 7 followed, the first of which was a joint presentation by **Darrel Williams** (NASA Goddard) and **Phil Teillet** (Canada Centre for Remote Sensing) on instrument overview and performance. Landsat 7 is performing extremely well and the ETM+ instrument is the best so far in the Landsat series. 450 (250 for the U.S.) scenes are acquired per day and a total of 131,000 scenes are now in the archive. The long-term acquisition plan (LTAP) was described, including the LTAP scheduling software. Because Landsat imagery is now less expensive, orders have increased dramatically. Calibration activities were described including the Landsat 5/Landsat 7 underfly experiment. Cross-calibration with MODIS and SeaWiFS is also performed.

Sam Goward (University of Maryland) gave an overview of Landsat 7 science. The original intent of the Landsat mission was to determine the effects of humans on land cover. The spatial resolution was chosen to be at a scale that would enable us to understand the driving mechanisms behind such phenom-

ena as urbanization and changing agricultural patterns. Several examples were shown of land-use changes and patterns from all over the world.

Jim Irons (NASA Goddard) gave a presentation on the Landsat Data Continuity Mission (LDCM). The government prefers a private sector, buy-back approach to this mission to reduce the cost to the government. A request for information (RFI) was released jointly by NASA and USGS in June 1999. The Stennis Space Center and NASA Goddard will manage the mission. A first draft of the specifications is on the Web (ldcm.usgs.gov) and comments are sought. The launch of LDCM is planned for 2005-2006.

Wednesday, January 31

Morning Plenary Session (Terra Instrument Overview and Performance, and New Science Results)

John Ranson (NASA Goddard), Terra Project Scientist, Chair

Hiro Fujisada (Science University of Tokyo) gave an overview of the ASTER instrument and its performance. ASTER is programmed to collect data by target acquisition requests of which there are three types: one for users, one for the Science Team, and a third for the Instrument Team. There are now 135,000 scenes in the archive, and scenes are collected at the rate of 600/day. Level-1A products are available through the EDG and Level-1B products are generated by request.

Anne Kahle (JPL) gave the first of two talks on ASTER science discoveries focusing on validation and early science. There have been ten cal/val field campaigns and atmospheric correction problems identified. There is good agreement with the Lake Tahoe buoy data and with data from MODIS and Landsat, especially in the thermal bands. Temperature emissivity validation against data from the Mauna Loa volcano, where there is a strong spectral signature due to basaltic

rocks, shows differences of up to four degrees. This is being investigated. The DEM product is very good.

Tsuneo Matsunaga (Tokyo Institute of Technology) also presented ASTER science discoveries. He described the successful calibration and validation experiments at the Salton Sea, Railroad Valley, and the Hawaii sites, which show that the instrument is performing within specifications. Several case studies showing the impressive capabilities of ASTER were highlighted: two Japanese volcanoes (Miyakejima Island and Usu), the Northwest Pacific monitoring program, the Great Barrier Reef, and Mount Fitton near Adelaide. Most high-level products are still in the validation stage.

Bruce Barkstrom (NASA Langley Research Center) presented an overview of the CERES instrument and performance. Calibration and validation have been performed, and, as a result, a provisional data set, called "Edition-1 Products," is now available from the Langley DAAC. Data from the two CERES instruments have been compared and show excellent agreement, typically within a few tenths of a percent for each type of flux or albedo. Monthly means also agree very well.

Bruce Weilicki (NASA Langley) reported on CERES science discoveries. The CERES data continue the record of Earth radiation flux measurements that began in 1985 with ERBE so that we can now identify decadal tropical variability. Model versus data comparisons show that models (except GFDL's) do not replicate clouds well in the tropics. The issue of how cloud albedo is affected by rain was also discussed. Comparisons with INDOEX data illustrate the importance of absorption by atmospheric aerosols. Upcoming products include the TRMM SSF Edition 2 to be released in September 2001 and TRMM SRBAVG Edition 1 to be released in November 2001. CERES data reduce by factors of 3-4 major angular and time sampling errors, greatly improve

our ability to study cause and effect in radiation fields, and enable us to place much more rigorous constraints on climate models.

David Diner (JPL) reported on MISR instrument performance and aerosols/surface results. Validation experiments have been conducted over desert sites in North Africa, over Lunar Lake, and during SAFARI 2000. Initial problems caused by camera angles have now been solved. The Level-1 product is now geolocated and registered correctly. With MISR different colors can be assigned to data from different angles allowing us to differentiate surface physical structures. This color coding was applied to the "first MISR James Bay image" with startling results: smooth ice appears blue and rough ice appears red. MISR can also be used to measure parameters associated with haze such as aerosol optical depth (AOD) because the higher-angle-degree view paths are affected more by haze. MISR data and tools will soon be available from the Langley DAAC.

Roger Davies (University of Arizona) gave an overview of MISR top-of-atmosphere/cloud results. MISR calculates cloud-top heights, albedos, and wind vectors using algorithms that include stereo techniques. The various types of clouds and albedo can be differentiated. The example of Hurricane Alberto, which contained a diversity of clouds and albedos, was shown. A case study of a mature extra-tropical cyclone, where MISR-derived parameters were compared to those from GOES, was described. The disagreements were due to differences in albedos used to classify cloud type. Cloud heights differed by +/- 400 m, and winds by +/- 3 m/s. Davies concluded by giving examples of improvements that could be made to present theories and models based on these new types of measurements, including those concerning convection cell schemes and radiative transfer models.

John Gille (National Center for Atmospheric Research) gave an overview of the MOPITT instrument and perfor-

mance. MOPITT is a joint Canadian/US experiment, in which the instrument was developed by the University of Toronto with funds from the Canadian Space Agency, and the data reduction was developed by NCAR under NASA funding. It uses the reflected and emitted signals in the 2.2- and 4.6- μm bands and a technique called correlation radiometry. A movie of the global 5-degree gridded carbon monoxide mixing ratio at the 500 mb level clearly shows the higher levels of carbon monoxide in the Northern hemisphere winter, and the impact of biomass burning in Africa and S. America. Product validation experiments against airborne samples were shown for Poker Flats and during SAFARI 2000. Additional comparisons with ground-based spectrometer data are planned. The delivery of the beta-level carbon monoxide total column, carbon monoxide profile, and methane column is scheduled for April 15th.

First Afternoon Plenary Session (Terra Instrument Overview and Performance, and New Science Results)

Si-Chee Tsay (NASA Goddard), Deputy Terra Project Scientist, Chair

Vince Salomonson (NASA Goddard) reported on the MODIS instrument and its performance. He began with a scientific and technical description of the instrument, including internal and external calibration devices. He described briefly several instrument performance characteristics that are being addressed to improve data products. Sea Surface Temperature (SST) is proving to be one of the most challenging data products. There, for example, is a need to know more precisely the bidirectional properties of the MODIS scan mirror. The relevant effects can be corrected using data provided from a deep space maneuver that is being planned. The development of direct broadcast stations (12 now and growing to 25) is proceeding well. (Note: these numbers have been updated by Jim Dodge since the meeting to 19 and 34 respectively.) The accuracy of MODIS geolocation is

approaching the goal of 50 m rms. Approximately 40 products are being produced. All of these are presently formally designated "beta" products and are available through the related DAACs (Goddard, EDC, and NSIDC). The scientific community was encouraged to examine these products and provide feedback to the validation activities of the MODIS Science Team. Validation activities now ongoing involve field campaigns and checking against comparable products from other spaceborne sensors. Many comparisons so far with other sensors or campaigns have been quite favorable. Data processing became systematic in the Fall of 2000 and continues to improve. Plans include the production of a systematic, consistent data set spanning 12 months by the end of 2001 that will extend from November 2000 through October 2001.

Michael King gave an overview of MODIS Atmospheres products. All products are now available through EDG. A Golden Day was chosen (April 19, 2000) when all granules for Level-2 products were produced and archived for research purposes. Level-3 gridded products with attendant statistical information are released every day, eight days/(equal to half the repeat cycle), and monthly. The Cloud Mask Product, the most important as it underpins most other MODIS products, is performing well. Twelve MODIS bands are used to derive cloud property products. A very important issue in their production is the identification of the different reflectances associated with each ecosystem. To this end field campaigns were conducted in NW Australia and during SAFARI 2000. The MODIS airborne simulator was used during SAFARI 2000. An important new feature of MODIS is the 1.38- μm band that is used to detect high thin clouds. The high spatial resolution of the MODIS data permits identification of small scale features like internal gravity waves. Global aerosol optical thickening (land and ocean) is a powerful new product that is performing quite well. For more information, visit the MODIS Atmospheres site: modis-atmos.gsfc.nasa.gov/

Chris Justice (University of Maryland) spoke on MODIS Land data products (MODLAND). All but two land products are now available, and are in provisional status. Web sites have been made describing product availability and known problems. The surface reflectance product is key as it underpins most of the other land products. Validation of this product has been initiated using AERONET data. Justice showed examples of the different MODLAND products including surface reflectance, BRDF/albedo, the NBAR global composite maps, the snow product, land-surface temperature for day and night conditions, the enhanced vegetation index (EVI), NDVI, LAI, FPAR, gross productivity, land cover, tree cover, and fire products. Validation activities are underway some of which have been in the context of the NASA SAFARI and LBA campaigns. Products will be revised as they are improved. There are, however, major concerns with the production system's limited processing capacity, especially with the additional processing demands of the upcoming Aqua launch. A more flexible distribution system is urgently required.

Wayne Esaias (NASA Goddard) spoke on MODIS Ocean data products. Beta level products are now available through EDG. There have been three initializations so far and the products have improved with each one. Scientifically useful, provisional products are planned to be distributed beginning June 1, 2001. Corrections have been made for detector striping and mirror side banding. Comparisons with the data from the MOBY calibration site have been invaluable, and look excellent. Comparisons with SeaWiFS data show the improvement in quality over time, with the potential for better atmospheric correction in the future. The new fluorescence product is working, and shows the expected inverse relationship with photosynthetic potential. MODIS data will be useful to explore the global teleconnection between iron input from dust and algal blooms, including red-tides in the Gulf of Mexico. The SST products show the

value of using the 4- μm split window in moist tropical regions at night. Instrument response vs. scan angle and mirror side corrections remain as the primary challenge. SST is being validated regularly with sea skin brightness temperatures on ships of opportunity. Key synergisms with Aqua data to address air sea fluxes are planned. Level-4 weekly ocean primary production maps, which use the Navy's mixed layer depth predictions, were described.

Second Afternoon Plenary Session (QuikScat Instrument Overview and Performance, and New Science Results)

W. Timothy Liu (JPL), SeaWinds Project Scientist, Chair

Frank J. Wentz and **Deborah Smith** (Remote Sensing Systems) gave a presentation on the calibration and validation of QuikScat. QuikScat takes four looks at the same place and calculates the surface wind vector from the received signals. Improvements are being made to the retrieval algorithm to deal with the problems of wind direction ambiguity and rain flagging. When the NSCAT-2 algorithm was applied to QuikScat, retrieval problems were detected at very low winds. These problems were corrected by replacing NSCAT-2 with an updated geophysical model function called Ku-2000. Buoy data are used for calibration and rms differences for wind speed are now 0.7 m/s. Comparisons between QuikScat winds and those derived from passive microwave sensors show rms differences in wind speed of 0.7 m/s. Rain and validation at high wind speeds are still problems for QuikScat. In the future, the synergism between SeaWinds and AMSR (a passive microwave radiometer) both to be launched on ADEOS II, should be exploited.

Robert Atlas (NASA Goddard) reported on the impacts of QuikScat on weather analysis and prediction. Atlas pointed out that there is an urgent need for improved weather forecasting over the

ocean. With QuikScat we now have 90 percent global coverage every 24 hours. QuikScat enables us to delineate weather features much better than before. Atlas is working on assimilating QuikScat data in models and also using them for calibration and validation. Experiments with the data assimilation office system show promising results. Because of the model's integration process, the whole ocean feels the effects of the QuikScat data six hours after they are fed into the model. One of the major results is that more precise location of weather systems is now possible. The under-predicted French storm of December 1999 is a good example.

W. Timothy Liu reported on the scientific impacts of better coverage and higher resolution of ocean winds. Global coverage of the ocean surface wind field is now 93% in one day at 25-km resolution. Data from TRMM and QuikScat agree very well. Liu pointed out several important effects of these improved measurements. It is now possible, for example, to see the precursors of Hurricane Floyd two days before it formed, and the better wind measurements have led to changes in the theory of cyclogenesis off western Africa. We can now observe daily the typical three-wave pattern in the surface wind field at the edge of the sea-ice field around Antarctica, believed to be the result of storm spin-up at the edge of the sea ice. Surface wind fields are correlated well with ENSO events and thus can be used to help predict El Niño.

Thursday, February 1

First Morning Plenary Session (EOS Interdisciplinary Science Investigations, Land Processes and Biosphere Studies)

Berrien Moore (University of New Hampshire), Chair

G. Robert Brakenridge (Dartmouth College) reported on MODIS capabilities for flood remote sensing. The Flood Observatory at Dartmouth College provides

flood information to national and international agencies, commercial vendors, and the public at large. It has created an historical record of floods making it possible to detect inter-annual variation. Inundation maps were produced in near real time from MODIS data for the UN for the catastrophic floods in Vietnam and Mozambique in 2000, and Landsat 7, MODIS, and Radarsat imagery have been used to map 43 other major flood events worldwide. QuikScat and SeaWinds data will soon be tested for their utility in early flood detection and in anticipation of the follow-on microwave sensors on ADEOS II and Aqua. The Observatory supports a Web site (www.dartmouth.edu/~floods/) from which files can be downloaded.

Robert Walker (Michigan State University) spoke about pattern to process: research and applications for understanding multiple interactions and feedbacks on land-cover change. Walker is a social scientist attempting to help policy makers by understanding more fully the connection between human social processes and land-cover changes. He has developed models that use remote sensing data to relate dependent variables, such as bio-diversity and human drivers, to independent variables such as land-use fragmentation. Two field campaigns are currently underway, one in Costa Rica and one in the Brazilian Amazon. The Costa Rica project concentrates on bio-diversity changes and the Amazon project on human drivers. These studies are complementary and the data from them will be used to develop more robust models for both regions.

Max Suarez (NASA Goddard) spoke about land-surface hydrological processes and climate change. Suarez is attempting to ascertain how well the effects of soil moisture on the atmosphere can be predicted. It is known that ENSO-driven SST anomalies are correlated well with precipitation for the tropics but not for the U.S., so SST is not a good parameter to use in order to improve skills in forecasting precipitation. For the U.S., precipitation is

correlated well with soil moisture on a month-to-month basis. The research involves understanding this connection more fully with the goal of gaining more skill in precipitation forecasting.

Berrien Moore presented work on predicting changes in regional and global biogeochemical cycles that are detailed in the IPCC's third assessment report. Some of the key findings are that carbon emissions are up, carbon oceanic uptake is down, and levels of carbon in the atmosphere are unchanged. Therefore, there must be a significant land sink of carbon. To address this issue, an Ecosystem Demographic model (ED) has been developed. ED bridges the gap between fine and large scales using statistical techniques and neural networks. High- and low-resolution satellite data and information from the flux-tower network are used to verify model results. In the U.S., the land-use term appears to be the dominant sink and, in this term, fire suppression is key. This term is changing and will have important implications for the future.

Jon Foley (University of Wisconsin) described his research on human activity in a changing biosphere with IBIS (Integrated Biosphere Simulator) that addresses issues such as land-cover change, flooding, and the transport of dissolved chemicals. Like the model ED, it links the large to the fine scale. Water resources are the defining issue for the 21st Century as we have already used 50 percent of fresh water run off. A study of the demise of Lake Chad showed that it is increased use of water from the lake during the Sahel drought that has caused the most damage. IBIS has been applied to the whole planet from 1800 to the present and an excellent movie of this simulation showing land-cover changes was shown. These results will be out on a CD in summer 2001. As nearly all the good land is already in use, two of the most challenging issues for the future are how to improve crop yield and food security. Foley's "Atlas of the Biosphere" can be viewed on the Web at: atlas.aos.wisc.edu

James Hansen (NASA Goddard Institute for Space Studies) spoke about climate forcings and the response on inter-annual and decadal time scales. Climate simulations have been conducted for the past 50 years with the most important five forcings, including ozone and water vapor, added one-by-one to assess model sensitivity. Results show changing patterns in SST (e.g., cooling of North Atlantic), changes in deep water formation, a decline in ozone concentration, a decrease in sea-ice cover and a warming of the troposphere. The first five forcings are well-defined but there are uncertainties with the next most important like the tropospheric aerosols (sulfate, black, and organic carbon). While some forcings lead to warming and others to cooling, the net effect is a warming of 1.6 Wm^{-2} . A Q-flux ocean model shows that heat storage in the ocean is a critical diagnostic.

Second Morning Plenary Session (Atmospheric Processes and Chemistry Studies)

Daniel Jacob (Harvard University),
Chair

Philip Russell (NASA Ames Research Center) reported on satellite- and aircraft-based studies of aerosol, water vapor and ozone. Aircraft sunphotometer (SP) measurements are used to validate satellite measurements. There have been several field campaigns (e.g., SAFARI). ACEAsia is planned for this year. An example of the group's work is the validation of aerosol optical depth (AOD) measurements of Saharadust during the ACE-2 (the Canaries) and PRIDE (Puerto Rico) field campaigns. The distribution of AOD as a function of wavelength does not change across the Atlantic. However, on its journey, the dust mixes down into the marine boundary layer.

Daniel Jacob spoke on chemistry, aerosols, and climate: tropospheric unified simulation (CACTUS). CACTUS is a fully coupled GCM that simulates climate forcing by aerosols and chemical species. It includes aerosol microphys-

ics, emissions, and land use. MOPITT, MODIS, and MISR data are used to test the model. CACTUS was used to model the period 1800 – 2000 and these results appear in the IPCC 2001 report. One of the findings is that there is a doubling of the radiative forcing due to tropospheric ozone whose background levels were established using 19th Century data from Europe. Predictions will be made for 2025, 2050, 2075, and 2100. Weaker inter-hemispheric exchange, stronger stratospheric circulation, and stratospheric/tropospheric exchange are expected in the 21st Century.

David Bromwich (Ohio State University) spoke about regional scale meteorological analysis and prediction using GPS occultation and EOS data. A method to use the GPS constellation of satellites to provide vertical profiles of atmospheric parameters was described. These profiles could be used over data-sparse regions. A mesoscale modeling effort using MM5 over Antarctica was also described. In situ data from approximately 100 automatic weather stations (AWSs) are included in the calculations with initial and boundary conditions coming from the ECMWF. Comparisons between model results and observations look good but there are still discrepancies.

Andrew Dessler (University of Maryland College Park) described preliminary investigations of the tropical tropopause layer, a layer of the atmosphere extending from about 2 km below to about 2 km above the tropical tropopause. It is presently unknown how processes operating in this region, such as de/rehydration in deep convection, regulate the water vapor abundance of the stratosphere. Dessler and his co-investigators are investigating these issues. EOS data from MODIS, MISR, and TRMM are providing important new insights into this region.

Kerry Nock (Global Aerospace Corporation) spoke on the futuristic concept of global constellations of stratospheric scientific platforms. Constellations would

consist of tens to hundreds of small, long life balloons with 100-kg science payloads orbiting in the stratosphere at 35 km. Tethered 15 km below the instrumented gondolas are the trajectory control devices with sensors attached in between. They orbit the Earth in 10 to 20 days in controlled trajectories steered by the tethered wing and rudder systems. These balloons offer a low cost alternative or complement to satellites for Earth Science applications. Some elements of the concept have already been tested successfully. Presently a larger, super-pressure stratospheric test balloon is on the ground in Alice Springs being readied by NASA for launch. This balloon is 120 m in diameter and has a 1500-kg science payload capability. Next year a similar balloon will launch a multi-million dollar cosmic ray payload.


Afternoon Plenary Session (EOS Interdisciplinary Science Investigations, Ocean Processes)

Sirpa Hakkinen (NASA Goddard), Chair

C. K. Shum (Ohio State University) described the geophysical approach to studying the role of ice sheet mass balance in global sea-level change. Sea-level rise in the 20th Century was between 10 and 20 cm. In the 21st Century it will be between 19 and 71 cm. The contributions of the ice sheet melting will be between -0.2 to 0.6 mm/year and, of thermal expansion, between 0.3 and 0.7 mm/year. There are big uncertainties in the predictions for the Greenland and Antarctic ice sheets, but the new generation of radar and laser altimeters will reduce these. Problems with understanding the data from the global tide gauge network were discussed. Shum described his model of sea-level rise which includes solid Earth effects like the changing shape of the planet. GRACE, to be launched in 2001, will measure gravity and should lead to significant improvements in this type of modeling.

Sirpa Hakkinen (NASA Goddard) described results relating to tropical

Atlantic air-sea interaction and oceanographic variability on decadal time scales. She focused on model studies of the observed dipole in SST variability in the tropical Atlantic which is correlated with hurricane activity. The Princeton Ocean Model was adapted to study the phenomenon, which consists of SST anomalies in the north tropical Atlantic (NTA) and south tropical Atlantic (STA). The anomaly in the NTA is easier to understand and appears to be caused by a sub-surface heat flux. The anomaly in the STA appears to be caused by wind stress.

T. H. Peng (NOAA) spoke about the effects of salinity changes on CO₂ flux across the air-sea interface. We know from model studies that changes in surface salinity affect alkalinity, which causes changes in pCO₂ (partial pressure of CO₂) and hence the air-sea CO₂ flux. Sensitivity studies show that a change of surface water salinity in the equatorial Pacific from 34.5 to 34.6 psu causes a change of pCO₂ by about 12 μatm, which creates a change of CO₂ flux about 0.9 mol/m²/yr from a mean value of 11.5 mol/m²/yr, assuming total CO₂ remains unchanged. In the future, if we can detect salinity from space, the challenge will be how to use satellite salinity and temperature data for creating maps of global air-sea CO₂ flux. This involves the determination of surface water pCO₂, which can be calculated from thermodynamic relationships of carbon chemistry in seawater involving total CO₂ and alkalinity. Based on empirical equations derived from global ocean surveys, we know how to calculate total CO₂ and alkalinity from salinity and temperature. The goal is to produce real time global maps of the net air-sea CO₂ flux from satellite data. 

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

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



The 23rd Clouds and the Earth's Radiant Energy System (CERES) Science Team meeting was held in Williamsburg, VA, on January 23-25, 2001. The meeting focused on early CERES science results, status of CERES instruments and current data products, status of data products and algorithms in development, and validation, cloud properties, anisotropy models, surface/atmosphere fluxes, and temporal interpolation using geostationary data.

The team welcomed four official new Science Team Co-Investigators: Lin Chambers (educational outreach lead,

3-D radiative modeling); Takmeng Wong (temporal interpolation, decadal variability); Norman Loeb (Chair of the TOA Flux Working Group); and Kory Priestley (Chair of the Instrument Working Group).

Bruce Wielicki (LaRC), CERES Co-Principal Investigator, gave an Earth Observing System (EOS)/CERES status report. The Terra instruments and spacecraft are working well. New Terra products that the team approved at the September meeting are now in production and in the archive. CERES was the first Terra team to get validated Level

1, Level 2, or Level 3 data products to the community. The next major milestones include Tropical Rainfall Measuring Mission (TRMM) angular distribution models (ADMs) and Single Satellite Footprint (SSF) Edition 2, and top-of-atmosphere (TOA) and initial surface fluxes and geo-assisted temporal interpolations. The next two CERES Science Team Meetings will be May 1-3, 2001, at Langley, and September 18-20, 2001, in Belgium.

CERES Terra/Aqua Instrument Status

Kory Priestley (LaRC) presented the instrument status report. The Aqua spacecraft with the CERES Flight Models (FM-3 and FM-4) is preparing for thermal vacuum testing in March 2001. The Aqua Launch is currently scheduled no earlier than July 2001. Both CERES Terra instruments continue to perform very well on-orbit. The apparent ground-to-flight change in window (WN) channel gain of ~1% on the FM-2 instrument has been tracked to insufficient settling time in vacuum during ground calibration. On-board blackbodies will be used to correct the change in Edition 2 data.

There is no evidence of significant instrument drifts from Earth-viewing consistency checks, or from the on-board calibration sources for five of the six channels. The sixth channel, FM-2 total, has demonstrated a drift of ~0.5% per year over the first 10 months. Two of the four CERES Terra Mirror Attenuated Mosaic (MAM) solar diffusers that are used for stability measurements show drifts that appear to be a problem with the MAM coatings.

A decision on the Deep Space Offset Calibration maneuver is still pending. Technical studies are complete and the risk is very small. The Moderate Resolution Imaging Spectroradiometer (MODIS) and CERES teams favor the maneuver while the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) team opposes it.

Clouds and Aerosol

Patrick Minnis (LaRC) presented a summary of the results of the first six months of cloud properties derived with the public version of the CERES Edition 1 cloud algorithm. Initial validations reveal that a very accurate and useful product has been developed and is available for the TRMM satellite observations taken from January to August 1998.

Minnis showed that incorporation of N_2O gas absorption in modeling of $3.7\text{-}\mu\text{m}$ channel reflectance and emission has substantially reduced the earlier cloud particle size differences between the Hahn, Coakley, and CERES SSF results. Remaining differences appear to be explained by viewing zenith angle dependencies, and whether both broken and overcast cases are included.

Early comparisons of near simultaneous TRMM Visible Infrared Scanner (VIRS) and Terra MODIS cloud property retrievals are encouraging. The MODIS and CERES teams are planning a workshop in May. SSF Edition 1 aerosol retrievals have improved at both $0.6\text{-}\mu\text{m}$ and $1.6\text{-}\mu\text{m}$ wavelengths, but problems are found in the apparent zero level of the $1.6\text{-}\mu\text{m}$ VIRS data.

Angular Modeling

Early tests of new TRMM angular models shown by **Norman Loeb** (Hampton University [HU]) based on the recently released CERES SSF data product looked very encouraging, and are expected to be ready as scheduled for August 2001. These models will be used in the SSF Edition 2, a major advance in TOA flux accuracy (factor of 3-4), and in the ability to use TOA flux data for cause/effect studies of cloud, aerosol, and surface properties. Nitchie Manalo-Smith (Analytical Services and Materials, Inc, AS&M) presented a report on the preliminary set of longwave (LW) and window (WN) channel ADMs generated from CERES/TRMM data. The models are being

developed for CERES inversion of satellite radiance measurements to TOA radiant fluxes. The scene types for these ADMs are stratified by cloud cover, surface type, and atmosphere/cloud properties.

Terra ERBE-Like TOA Fluxes

Takmeng Wong (LaRC) updated inter-comparisons between CERES/Terra monthly mean FM-1 and FM-2 ERBE-like TOA fluxes using three additional data months from August to October 2000. Most of the differences between CERES/Terra FM-1 and FM-2 ERBE-like monthly mean fluxes can be explained by the differences in sampling patterns of the two CERES instruments. Users should avoid mixing CERES/Terra monthly mean data from different scan mode operations.

Diurnal Sampling

David Young (LaRC) presented preliminary results and initial validation of CERES second-generation monthly mean products. Cloud property retrievals are performed on global 3-hourly geostationary data that are used to provide information between the CERES observation times. Initial results reveal a good agreement between the derived cloud properties with other global data sets. Severe temporal sampling errors due to the TRMM orbit have been reduced by over 50% using this technique. This new product is scheduled for archiving in late 2001. Early tests of the incorporation of geostationary data to eliminate most of the diurnal sampling error for single-satellite time periods like TRMM and current Terra data were encouraging and are on schedule for delivery in Fall 2001.

CERES Validation Experiment

Bill Smith, Jr. discussed plans for the summer 2001 Chesapeake Lighthouse and Aircraft Measurements for Satellites (CLAMS) mission. CLAMS is a short-wave (SW) closure experiment focusing on the validation of Terra data products, specifically to improve Surface and

Atmosphere Radiation Budget (SARB) calculations for CERES, and to validate and improve MODIS and Multi-angle Imaging Spectro-Radiometer (MISR) retrieved aerosol properties. The centerpiece of CLAMS is the CERES Ocean Validation Experiment (COVE), an official Baseline Surface Radiation Network (BSRN) and Aerosol Robotic Network (AERONET) site that provides continuous, long-term broadband, directional, and spectral radiation measurements from an ocean platform. Three aircraft will participate in an intensive measurement campaign from July 17 to August 3, 2001. The ER-2 will map the horizontal and vertical distribution of aerosol properties with the Cloud Physics Lidar and provide a platform for the airborne versions of MODIS and MISR. The University of Washington CV-580 will provide *in situ* profiles of aerosols, profile broadband radiation, and measure ocean surface bidirectional reflectance. The NASA Langley OV-10 will measure and profile upward and downward spectral SW fluxes and broadband LW and SW fluxes in the boundary layer.

Surface and Atmospheric Radiation Budget

Tom Charlock (LaRC) updated the team on SARB progress in defining surface albedo data sets for the Fu-Liou code and in generating Clouds and Radiative Swath (CRS) validation data sets. A comparison of European Center for Medium-Range Weather Forecasts (ECMWF) and the Data Assimilation Office (DAO) GEOS (Goddard Earth Observing System) 3.3 has been delayed until March - May because of a six-week delay in getting test data from DAO.

Seiji Kato (HU) compared the average radiance and irradiance from SSF (Edition 1) and ES8 (Edition 2) for clear-sky ocean and desert. The average SW radiance for clear-sky ocean extracted from the ES8 is larger than that from SSF, which is presumably caused by cloud contamination in the ES8 scene identification.

Shashi Gupta (AS&M) reported mixed results from early tests of surface radiation algorithms. Longwave results looked good at all sites tested, but SW looked good at some surface sites and very poor at others. Suspicion of time/space matching errors in combining surface site/satellite data is under investigation.

Data Production Status and Issues

Jim Kibler (LaRC) discussed the status of CERES science data production and archiving. EOS Data and Operations System (EDOS) data delivery delays continue to slow production. In particular, the months of June, July, and November 2000 are missing about 15% of the data needed to produce final monthly products. Timing estimates for Terra/MODIS are larger than available computer resources. We are analyzing ways to reduce requirements before Terra archival processing begins with new ADMs this fall. Edition 1 Terra data products (BDS, ES8, ES9, ES4) and Edition 1 TRMM SSF products are now available at the Atmospheric Sciences Data Center (ASDC). Orders for CERES products totaled over one terabyte in the last six weeks, substantially higher than the 30 gigabyte per month average of last year.

Bruce Barkstrom (LaRC), CERES Co-Principal Investigator, presented a brief summary of the interaction between the Earth Science Data Information System (ESDIS) Project, the Science Working Group on Data (SWGd), and NASA Headquarters regarding funding of the additional hardware capacity need identified by the SWGD. Barkstrom requested the team to consider appropriate ways of reducing required hardware capacities.

Invited Presentation

Bill Collins (NCAR) gave an invited presentation on the results of aerosol assimilation in a chemical transport model. The model is initialized with global meteorological fields and aerosol

emission source data. Satellite retrieved aerosol optical depths (AOD) are assimilated into the model. Sources of sulfates, soil dust, sea salt, and black and organic carbon are taken into account. The model provides analyses and forecasts of AOD and was used to study aerosols over the Indian Ocean Experiment (INDOEX) region. Fields derived by the model showed AOD values of 0.4 or larger over India and China. Comparisons of model results with surface data from Kaashidhoo Climate Observatory (KCO) and NOAA RV Ron Brown showed good agreement. Maps of AOD partitioned by aerosol species were also shown. Aerosol radiative forcing (ARF) was computed with the NCAR column radiation model (CRM). Over some parts of India, ARF at the surface was found to exceed the cloud radiative forcing. Collins suggested that such large radiative forcings at the surface and in the atmosphere are likely to have a large effect on the atmospheric circulation in the region.

Investigator Presentation Highlights

Larry Stowe and Alexander Ignatov (NESDIS/NOAA) presented a report on the third generation aerosol algorithm which was developed and tested with SSF Edition-1 data for February and April 1998. Future plans call for simultaneous retrieval of aerosol properties from both VIRS channels 1 and 2.

V. Ramanathan (Scripps Institution of Oceanography) presented results of an investigation of atmospheric greenhouse effect. He showed that while WN radiation comes from near the surface, the non-WN radiation comes from the upper troposphere. Atmospheric greenhouse effect values derived from TRMM (July 1998) were considerably higher than those from Terra (July 2000).

Robert Cess (State University of New York at Stony Brook) discussed the impact of 1997-98 El Niño on cloud radiative forcing (CRF) over the tropical Pacific Ocean. The ratio SWCRF/

LWCRF, which he used as a diagnostic of the cloud vertical structure, increased from 1.12 during the Earth Radiation Budget Experiment (ERBE) period in 1987 to 1.54 based on TRMM data for January-April 1998.

Bruce Wielicki showed that the TRMM CERES and SAGE II data confirm that the large 1998 El Niño changes in cloud radiative forcing ratio in both the western and eastern Pacific oceans were caused by cloud height distribution changes dramatically larger than those seen in the 1987 El Niño. The changes appear to be a result of the normal East/West Walker Cell circulation almost shutting down in January-April 1998, while the north/south Hadley circulation increases in strength. Current climate models do not appear to predict these changes.

Elizabeth (Betsy) Weatherhead (University of Colorado) presented results of her work with a time-series analysis technique developed for detecting trends in environmental data. The desirable characteristics for a data set to be suitable for trend detection are a stable instrument, a representative site, a trend signal large relative to the noise, and a sufficiently long data record. She cautioned that it is very easy to detect false trends.

Q. Han (University of Alabama - Huntsville) presented his work on the effect of viewing geometry on droplet size retrievals in water clouds. His objective was to identify the causes of the differences between sizes retrieved from CERES, which covers all view zenith angles, and ISCCP (International Satellite Cloud Climatology Project) retrievals which were mostly for near-nadir viewing. Han concluded that off-nadir viewing yielded larger sizes because droplets are larger near the top of the clouds, and the top part is preferentially viewed in off-nadir viewing. Cloud shadowing effects also contribute to larger droplet size retrievals in the forward viewing direction.

Gerald (Jay) Mace and **Xiquan Dong** (University of Utah) summarized surface data sets for cloud property validation. Dong found good agreement between surface-measured cloud properties and corresponding MODIS retrievals. **Andy Heymsfield** (NCAR) presented results based on the observations of microphysical properties of tropical and mid-latitude ice clouds obtained during the Atmospheric Radiation Measurement (ARM) Intensive Observation Period in 2000 and a TRMM-related tropical program. Probes mounted on an aircraft measured temperature, particle size distribution and habits, and number densities during a spiral descent pattern. Observations with the 2-cm precipitation radar showed that particle sizes were smaller near the top of the ice clouds and larger near the bottom. The particle size growth was driven by aggregation. Particle shapes in the tropical clouds were found to be highly variable.

Bryan Baum (LaRC) presented results of day and night cloud phase retrievals using MODIS data. He examined the correlation between cloud temperature and phase, and the effect of spatial resolution on the results. Phase retrievals were based on a trispectral technique; cloud height and temperature were retrieved by the CO₂ slicing method. MODIS retrievals were in good agreement with data from the ARM Southern Great Plains site. Baum's future work will include analysis of supercooled water phase clouds.

Michael Friedman (Oregon State University [OSU]) investigated differences in cloud mean droplet radius derived from the CERES and OSU algorithms. Comparisons led to the inclusion of N₂O absorption at 3.7 mm in the CERES algorithm and resulted in better droplet size agreement. He also presented comparisons of cloud properties derived from partly cloudy pixels with those from the overcast pixels.

James Coakley (OSU) presented estimates of the direct ARF derived from

CERES/TRMM broadband radiative fluxes and AOD measurements at the surface over AERONET sites. Direct ARF at the TOA for the KCO site was considerably larger in magnitude than that determined from INDOEX observations. Direct ARF at the surface was about three times larger than at the TOA.

Bing Lin (LaRC) estimated vertically averaged cloud water temperature using Humidity Sounder for Brazil (HSB) simulations. He suggested that cloud base temperature can be estimated by combining thermal infrared satellite measurements (to determine cloud top temperature) and HSB microwave data (to obtain the average cloud temperature). Simulations showed that simple linear empirical methods could retrieve the cloud average or base temperature with errors of 9 to 13K when the uncertainties in sea surface temperature, wind speed, water vapor, and instrument noise are taken into account. A reasonable a priori estimate of the temperature and humidity profiles would reduce the errors significantly.

Zhonghai Jin (AS&M) reported on early steps to improve the SARB ocean surface spectral albedo with an advanced model that treats scattering and absorption in both the ocean and the atmosphere explicitly. The goal is to parameterize the ocean surface albedo using data from new sources (e.g., Sea-viewing Wide Field-of-view Sensor), and improve fluxes and optical depths retrieved in SARB. The new model will be verified with field observations from COVE, CLAMS, and the Asian-Pacific Regional Aerosol Characterization Experiment (ACE-Asia) cruise.

Wenyang Su (HU) compared COVE observations of upwelling SW spectral radiances with theory. Measured radiance was often smaller than results from the "6S" (Second Simulation of Satellite Signal in the Solar Spectrum) model, probably due to the strong absorption of coastal water. Su plans to participate in the upcoming ACE-Asia cruise in

the mid-Pacific which will provide an opportunity to understand the measurement/model differences.

Shi-Keng Yang (NOAA/National Centers for Environmental Prediction [NCEP]) analyzed the downtrend observed in water vapor and LWCRF in the NCEP Reanalysis II data set. The magnitude of this downtrend is about 10% over a 30-year period. Analysis of clouds from the same data set shows a downtrend in the mid-level clouds which is related to a similar trend in mid-tropospheric relative humidity (RH). Yang concluded that the LWCRF and water vapor trends could be artifacts of changes in RH measurements and cautioned against the use of data taken prior to the International Geophysical Year.

Kathryn Bush (Science Applications International Corporation, representing Lou Smith) used the 15-year data set of ERBE nonscanner radiative fluxes to investigate the interannual variability of TOA outgoing LW and reflected SW radiation. Monthly LW and SW variance maps and an empirical orthogonal function (EOF) analysis of the monthly mean flux anomalies both show that most of the variability is in the tropics and is associated with El Niño events. Variability over the Indian Ocean is likely associated with interannual variations in the Indonesian Throughflow. An EOF analysis of sea surface temperature (SST) monthly mean anomalies shows patterns similar to those seen in the flux data. The SST third EOF map shows high variability in the northern Pacific Ocean, which is likely related to the North Pacific Decadal Oscillation.

Xin Lin (Colorado State University, representing David Randall) reported the results of a theoretical study designed to determine the capabilities and limitations of satellite sampling. The study was performed by simulating three months of TRMM CERES and VIRS observations of meteorological fields produced by a General Circulation Model (GCM). Lin found significant dif-

ferences between LW global fields and zonal averages from the GCM (unsampled) with those obtained after satellite sampling. He stated that spurious low frequency signals generated by satellite sampling can be comparable in magnitude to the real climate signals.

Lin Chambers (LaRC) presented a brief update on her theoretical simulation of the CERES flux retrieval process, using realistic inhomogeneous clouds based on Landsat scenes. She showed a consistent trend in flux bias error from equator to pole which needs to be considered in future analyses of CERES data.

Mamoudou Ba (University of Maryland) compared CERES ERBE-like outgoing LW from both TRMM and Terra with LW derived from Geostationary Operational Environmental Satellite (GOES) sounding channels. The GOES technique is similar to that based on High Resolution Infrared Radiation Sounder (HIRS) radiances, where LW is estimated from a regression relation using radiances in five sounding channels. GOES estimates of LW fluxes, which showed large disagreements with CERES TRMM measured data, now appear to be in good agreement after NOAA corrections to the GOES calibrations and improvements in radiative models.

Robert B. Lee III (LaRC) reported on the status of CERES measurements of the moon-reflected solar SW and moon-emitted LW radiances. The CERES sensors are being used to place lunar radiances on an absolute radiometric scale. The Terra/CERES sensors were used successfully to measure lunar radiances during the January 2001 total lunar eclipse.


Nicolas Clerbaux (Royal Meteorological Institute of Belgium [RMIB]) presented a progress report on the data processing system being developed at the RMIB for the Geostationary Earth Radiation Budget (GERB) instrument on board the Meteosat Second Generation (MSG), which is scheduled for a launch in July

2002. RMIB is responsible for the inversion of GERB radiances to TOA fluxes and is developing its procedures based on CERES methods.

Martial Haeffelin (Virginia Tech) discussed how ultra-long duration high-altitude balloon flights can provide a new opportunity to measure radiative fluxes from the TOA with a spatial resolution comparable to radiance measurements by CERES. Comparisons between the CERES flux estimates and the balloon-based flux measurements will provide useful information about the validity of the CERES ADMs.

Education and Outreach

Charlie Whitlock (SAIC) described the commercial outreach effort which uses estimates of surface solar insolation to guide solar power and architectural applications. This effort is being used internationally, by the United Nations, and has led to a joint U.S./Canada collaboration and a data base for international solar industry use. From June 1999 to Sept 2000, there were 551 U.S. customer data orders, and 1388 international customer orders. Customers include the major U.S. energy companies. This has been a great success story of changing science data into the alternative forms which commercial groups need, and keeping the data set simple enough to use.

The CERES Students' Cloud Observations On-Line (S'COOL) educational outreach is now up to 46 countries and over 700 schools participating. Dave Young showed the first quantitative comparisons between students' cloud observations and CERES data. Through one of the CERES science team members (Shi-Keng Yang) education officials and high schools in Taiwan have become involved, along with a group of Taiwanese scientists in the DC area. They will be holding a week-long workshop for high school students as a spin off of the S'COOL project. 



Report on Landsat Science Team Meeting

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The Landsat 7 Science Team held its biennial team meeting November 7-9, 2000, at the Airlie Conference Center in Warrenton, Virginia. Landsat 7 Project Scientist Darrel Williams (NASA GSFC) and Science Team Leader Samuel Goward (University of Maryland) chaired. The meeting was the next-to-last for the Landsat Science Team, which will be discontinued in June 2001. Many of the topics were geared toward disseminating initial research results, exploring other funding opportunities within NASA, and looking toward the Landsat 7 follow-on mission. All agreed, however, that the current Landsat 7 mission has been an outstanding technical and programmatic success to date.

Following registration and a short introduction by **Darrel Williams**, **Jay Feuquay** (USGS EROS Data Center - EDC) gave a short overview of mission operations since the previous meeting (May 2000). Since that time, USGS has taken over operations of the Landsat 7 spacecraft and instrument from NASA. Feuquay reported that all systems continue to perform nominally, and that orders for data from EDC continue to rise. From August 1999-August 2000, the number of scene orders averaged slightly more than 50 per day, passing the break-even point for recovering operations expenses of the spacecraft. While there are no immediate plans to reduce the cost of ETM+ data products, orders for 25 or more scenes are eligible for a 20% discount from EDC.

Some concern was expressed by team members regarding the operation of two independent processing streams for ETM+ L1G data at EDC. While the LPSG system has been carefully validated by the Landsat Project Science Office (LPSO) at NASA GSFC, the NLAPS system built by McDonald-Detweiller has not undergone such scrutiny. Furthermore, there are some indications of differences in data products and data quality between the two systems. The Science Team strongly recommended that these discrepancies be investigated in a "cook off," and that the results be documented for Landsat users.

Terry Arvidson (Lockheed-Martin) presented an update on the Landsat Long Term Acquisition Plan (LTAP). The LTAP schedules global image acquisitions using a cloud-avoidance algorithm and knowledge of seasonal vegetation cycles in order to optimize data collection. The LTAP scheduler has continued to perform well, with over 130,000 scenes archived at EDC from launch until the time of this writing (February 2001). Furthermore, due to the cloud-avoidance algorithm used, cloud-free imagery is now available for essentially the entire globe.

Garik Gutman (NASA HQ), Landsat Program Scientist, gave a brief overview of upcoming research opportunities within NASA. In particular, team members were encouraged to apply for an upcoming NASA Research Announce-

ment focusing on the carbon cycle and land-use change. Team members questioned the extent to which NASA was offering support for projects supporting calibration and instrument characterization, which underpin much of the scientific work of the team. **Chris Justice** (University of Virginia) then gave an overview of the NASA Land-Cover/Land-Use Change (LCLUC) program.

The morning concluded with a discussion of the proposed Landsat Data Continuity Mission (LDCM) led by **James Irons** (NASA GSFC). The LDCM has been scoped to provide Landsat-type data to Earth Scientists beginning around 2005, near the end of the Landsat 7 mission design life. The 1992 Remote Sensing Act directs NASA to examine several possible paths for obtaining Landsat-type data, with a preference for a commercial solution. In this light, NASA and USGS are formulating a mission concept for an LDCM commercial data buy. Private spacecraft and instrument vendors will be invited to bid on a request for a fixed amount of data, which must satisfy a detailed data specification. The exact method of acquiring these data, including the spacecraft design, sensor design, and orbital parameters, will be left up to the commercial partner.

The Science Team voiced concerns regarding the commercial data buy option for LDCM. In particular, there was widespread fear that moving away from the open Landsat 7 data policy (no copyright, unlimited reproduction) would harm the scientific application of these Landsat data. It was also noted that past efforts to commercialize Landsat led to extreme price increases and a major reduction in use of the data by researchers. More information on the LDCM mission and data specification may be found at: ldcm.usgs.gov.

Two poster sessions in the afternoon and evening gave participants a chance to review the latest research results. Each session lasted about two hours, and included presentations from science

team members, USGS EDC, and NASA. The consensus among participants was that this method of presentation was a welcome change. Some of the research highlights included:

- Use of Landsat for assessing forest-stand ages, and rates of carbon sequestration (C. Woodcock, Boston U.)
- Assessment of vulnerability of Great Plains agriculture to climate change (A. Goetz, U. Colorado)
- Vicarious calibration results during Landsat 7 overflights (K. Thome, U. Arizona)
- Remote sensing of coral reef extent using Landsat 7 ETM+ (S. Andrefoute, U. South Florida)

The second day began with an overview of the ETM+ sensor calibration and instrument status by **Brian Markham** (NASA GSFC), **John Barker** (NASA GSFC), and **Jim Storey** (Raytheon/EDC). Integration of pre-launch calibration, onboard solar calibration, and vicarious (ground-look) calibration has led to a consistent understanding of ETM+ radiometric performance. These analyses suggest that little or no drift in calibration is occurring in Landsat 7, and that pre-launch calibration coefficients give at-sensor radiances within the 5% absolute specification. The onboard internal calibrator deviates significantly from this consensus showing pronounced post-launch drift. However, this drift is best ascribed to the calibrator itself, rather than the instrument. The onboard internal calibration lamp is not being used in the calibration process pending an improved understanding of its performance.

The geometric performance of ETM+ has exhibited no significant changes, with slight degradation of panchromatic band point-spread function, and consistent geodetic accuracy of ~50 meters for Level 1G products. Of some concern is an apparent increase in the turnaround

time for the scan mirror, which may be related to wear of internal bumpers. Eventually this could lead to a loss of scan synchronization some years from now, although current projections do not show an impact on mission life (five to six years).

Joanne Gabrynowicz (U. North Dakota) discussed new and upcoming legislation affecting the remote sensing community. She stressed potential conflict between commercial data rights and the scientific need for open data distribution. The morning then concluded with short presentations from members of the science team, giving their assessments of the success of the Landsat Science Team. Participants felt that interactions with other team members had been valuable. Particularly useful was having a mix of researchers, some focusing on global change questions, and others focusing specifically on instrument performance and calibration. At the same time, members expressed some concern that their advisory role in formulating the next (LDCM) mission had not been fully considered by NASA Headquarters, and that they had never been fully integrated into the EOS science "community."

The afternoon session featured a series of short talks focusing on initial impressions of SpaceImaging IKONOS data. IKONOS, launched in 1999, is a purely commercial mission collecting one-to four-meter resolution panchromatic and multispectral imagery. As part of the NASA Stennis Space Center Data Purchase initiative, Landsat Science Team members have been provided with IKONOS imagery in order to assess its utility for global change research. A variety of applications was presented, including the detection of small melt features in the Antarctic ice sheet, and the remote sensing of individual tree canopies for biomass and forest age estimation.

The afternoon concluded with a discussion of the Landsat 5/Landsat 7 cross-calibration experiment, led by **Phillipe**

Teillet (Canada Centre for Remote Sensing). During the ascent of Landsat 7 to its final orbit in 1999, it underflew Landsat 5 for several orbits. Images from both sensors that were acquired during this underfly permit a definitive cross-calibration between the two systems. The initial results have yielded a consistent set of coefficients for converting between Landsat 5 and Landsat 7 data, and confirm earlier studies indicating that the Landsat 5 pre-launch calibration has changed considerably in the last 15 years.

The final day of the meeting started with an overview of the NASA EO-1 mission by **Stephen Ungar** (NASA GSFC). EO-1 is designed to prototype advanced technologies that might be used by the LDCM, including an Advanced Land Imager (ALI). At the time of the meeting, EO-1 had not yet launched. However, on November 21, 2000, EO-1 did successfully launch, and has begun transmitting images during the last two months.

Two potential funding opportunities for Landsat investigators were outlined by NASA representatives. **James Collatz** (NASA GSFC) gave an overview of the Global Carbon Initiative, a cooperative venture between NASA, NSF, and other Federal agencies to understand and quantify the carbon cycle on Earth. In particular, the roles of land cover as both a source and sink of atmospheric CO₂ relate directly to Landsat observations. The NASA Research Announcement for this effort came out in October, 2000. **Doug Kahle** (NASA Headquarters) gave a short overview of applications'-related research opportunities within NASA. These initiatives strive to bring remote sensing technologies to end-users in business and state/local governments.

The final Landsat Team meeting will be held in Honolulu, Hawaii, May 22-26, and hosted by **Luke Flynn** (University of Hawaii). Those interested in participating should contact **Jeffrey Masek** (jmasek@ltpmail.gsfc.nasa.gov).



Summary of the Third Joint TOPEX/ Poseidon and Jason-1 Science Working Team Meeting

— Lee-Lueng Fu, Jet Propulsion Laboratory, California Institute of Technology,
Pasadena, CA
— Yves Ménard, Centre National d'Etudes Spatiales, Toulouse, France

Introduction

The 3rd joint TOPEX/Poseidon (T/P)/Jason-1 Science Working Team (SWT) meeting was held November 15-17, 2000, at the Radisson Deauville Resort in Miami Beach, Florida. This was the last SWT meeting before the launch of Jason-1. The objectives of the meeting were to provide updates on the status of the Jason-1 mission, reach closure on issues that require SWT's inputs for mission operation, and review the performance of T/P and science results. The meeting was organized into plenary sessions on the status of the programs and projects, poster sessions on the science results and plans, and splinter sessions on special topics.

Jason-1 Status (updated since the meeting)

Project Overview

- Satellite integrated and tested in Cannes Alcatel Facility in France.
- Ground system is under final integration and testing.
- Launch campaign (seven weeks) will begin in May.
- Launch readiness date: June 27. The actual launch date is pending on the decision of the Flight Planning Board.
- Launch activities will take place at three sites:

Vandenberg (launch site); Toulouse (control center); Brest (Oceanopolis exhibit and museum).

Satellite and Ground System

- Satellite qualification review was held November 29-December 1, including NASA red team participation.
- Software and functional chain validation will be completed by the end of March.
- A delta satellite qualification review (with NASA red team participation) will be held in April.
- Operational readiness review (ground system and operation teams) will be conducted by the end of April (with NASA red team participation).
- Shipment of the satellite to Vandenberg Air Force Base is scheduled for early May.

System Performance

- Satellite pointing accuracy exceeds the requirements.
- The noise level of the dual-frequency Poseidon-2 altimeter measurement exceeds the requirements (1.4 cm vs. 1.7 cm rms with significant wave height [SWH] = 2 m).
- The JMR (Jason Microwave Radiometer) performance meets the requirement (1.2 cm). Dominant

error (the retrieval algorithm error) could be reduced significantly with an improved model for vapor absorption.

- DORIS, GPS (TRSR), and the Laser Retroreflector Array have all passed performance tests.

Launch Preparations

Launch Vehicle Target Specification Peer Review was held on October 31, 2000. No major issues or problems were identified.

Algorithms and Products

Issues to be resolved at the meeting are:

- waveform correction for low-pass filter effects;
- land-contamination correction for JMR;
- tropospheric corrections from meteorological models;
- long-period ocean tide models;
- de-aliasing of high-frequency signals;
- mean sea-surface models;
- ocean tide models;
- data distribution during the Verification and Observation Phase; and
- Jason-T/P tandem processing plans.

Cal/Val Preparations

- Cal/Val accuracy goal of 1 cm (by the end of the Verification Phase).
- Cal/Val accuracy goal of 5 mm for T/P Jason-1 relative bias (by the end of the Verification Phase).
- Calibration measurement system stability at 1 mm/year.
- Cal/Val Kickoff Meeting was held in May 2000 (Washington, DC).
- New Cal/Val Plan is now available on the Web (restricted access).
- A Cal/Val Web site (restricted access) opened in October 2000.
- A priority issue is the consistency between T/P and Jason-1 data for both the Verification and Observational Phases.

TOPEX/Poseidon Status

Satellite and Mission Operation

- Data retrieval rate exceeds 99.8 %.
- 10+ years' lifetime is likely.
- Two of the three tape recorders have degradations, but high data return rate is expected to be maintained.
- New software was successfully run on SSALT (the French single-frequency solid-state altimeter) (July 18-28, 2000, cycle 289) allowing quicker acquisition over the land-sea boundaries.
- The increase in single-event upsets on SSALT is probably due to radiation effects and hardware aging.
- The mean noise level of the redundant side of DORIS (a Doppler orbit determination system receiver) (turned on in December, 1998), 0.50-0.55 mm/s, is slightly better than that of the primary side, 0.55-0.60 mm/s.
- Progressive handover of the DORIS/Poseidon ground system to the newly established SSALTO (Segment-Sol d'ALTimetrie, d'Océanographie et de localisation précise) facilities is taking place.

Measurement Performance

To the extent of SSH (sea surface height) ~ 1 cm, σ_0 (normalized radar backscatter cross-section) ~ 0.1 dB, SWH ~ 0.2 m, ALT-B (the backup for the NASA dual-frequency altimeter) performs at the same level as ALT-A (the primary NASA dual-frequency altimeter) before cycle 160. Calibration mode data from ALT-B indicate no significant changes since its turn-on in February 1998.

Poster Sessions

Scientific results were presented in the form of posters on the following topics:

- ocean currents and eddies;
- wave dynamics;
- ocean temperature and heat;
- data assimilation, integration, and analysis;

- seasonal-to-interannual variability;
- tides and high-frequency variabilities;
- sea-surface processes;
- precision orbit determination and geoid;
- calibration and validation; and outreach.

A total of 88 posters was presented. Some of the posters can be viewed at the following Web site: www.tp-jason.oceanobs.com

Special Topics and Conclusions

The following topics were discussed in splinter meetings:

- tides/high-frequency aliases;
- sea-surface effects;
- precision orbit determination and geoid;
- calibration and validation;
- high-resolution altimetry;
- algorithms and products;
- ocean-surface currents; and
- outreach.

The key conclusions of the meeting are given below:

T/P-Jason-1 Science Tandem Mission

A key output of the meeting is the recommendation on the phasing of the orbits of T/P and Jason-1 after the Verification Phase of the Jason-1 mission. The SWT recommends that T/P should be moved to an orbit that produces interleaved groundtracks with a 1.4° longitude spacing from the Jason-1 tracks, which are identical to the present T/P tracks. The time offset between the two satellite's equatorial crossing times is yet to be determined based on the degree of risk of orbit maneuver of T/P.

Such a tandem mission will provide a unique opportunity to address the following objectives:

- double the spatial sampling to enhance the resolution of Rossby waves and eddies;
- quadruple crossover points for cur-

- rent velocity vector estimation;
- enhance coastal tide models; and
- provide continuous cross-calibration with Jason-1 for global change detection.

Jason-1 Science Plan

A Jason-1 science plan will be produced from inputs of the Principal Investigators and published as a special issue of the AVISO Newsletter in the same format as the T/P Extended Mission Science Plan. Such a plan is scheduled for publication before the launch of Jason-1.

Algorithms and Products

High-frequency aliasing – three sources of corrections were identified as potential candidates during the Jason Verification Phase. Two are derived from ocean modeling. These are the ocean model run by V. Zlotnicki et al., and the one run by F. Lyard et al. A third solution has been proposed by P.Y. Le Traon et al. It is an empirical solution derived from altimeter data analysis. The Project Team proposed that a standard correction be defined, the basis for which being the files made available by V. Zlotnicki et al. for T/P. The interface between the Project Team and the three providers should be defined as soon as possible.

EM (electromagnetic) bias – the non-parametric EM bias algorithm developed by Gaspar et al. will be used for Jason-1 processing.

Windspeed – the new algorithm developed by Vandemark et al. will be used for Jason-1 processing.

Mean sea surface model – the Goddard model was selected.

Geoid – EGM96 was selected.

Tides – the GOT99 and FES99 models were selected.

Cal/Val

The consistency of T/P and Jason-1 data during the Verification Phase is a key issue. It will be provided through the generation of delta T/P files during the Verification Phase, including the corrections derived from the Jason models which are different from the ones used for T/P. This is the case for the tides, the mean sea surface, the inverted barometer correction, the sea-state bias correction, the dry and wet tropospheric meteorological model corrections, and the rain flag. This information could be added to the delta T/P product generated by JPL including the re-tracked TOPEX altimeter data. An adjusted TMR (TOPEX Microwave Radiometer) correction, taking into account the drift of the TMR, based on algorithms provided by C. Ruf and E. Obligis, may be included in this delta T/P file.

Precision Orbit Determination (POD)

Transition to the ITRF2000 reference system by both NASA and CNES POD systems is recommended to take place as soon as the final ITRF2000 solution is validated. In addition, a strategy to manage the introduction of new additional stations has to be elaborated in order to maintain the consistency of the reference system over the long term.

Next Meetings

Due to the delay of the launch of Jason-1 (revised to late June 2001 after the meeting), it was proposed to have a first mid-term verification meeting in November 2001, at which the first Cal/Val results would be discussed and the ending time of the Cal/Val tandem phase mission would be decided. Then the final verification workshop would be held around February 2002, right after the end of the Verification Phase, (however, these dates will be further revised based on the final launch date).



Goddard Earth Science (GES) Distributed Active Archive Center (DAAC) User Working Group (UWG)

- Steven J. Kempler (steven.j.kempler@gsfc.nasa.gov), NASA Goddard Space Flight Center
- Stan Morain, University of New Mexico

On November 14 and 15, 2000, the GSFC Earth Sciences (GES) Distributed Active Archive Center (DAAC) User Working Group met at Goddard Space Flight Center. This group of GES DAAC users represented their colleagues in various fields of remote-sensing-related science research and applications to provide recommendations that would further improve the use and usefulness of the GES DAAC. Because this was the first meeting of the individuals of this group, much time during the first day of the meeting was spent describing the goals and objectives of this meeting, describing what the GES DAAC does, and describing the accomplishments and future directions of the GES DAAC.

This provided all members with a basic understanding of the philosophy, structure, and some insight into how the GES DAAC works, prioritizes, and accomplishes its tasks.

The purpose of the GES DAAC UWG is to acquire from GES DAAC stakeholders, guidance and recommendations that would better prepare the GES DAAC to serve the Earth science community in the future within the constraints of available DAAC resources.

The GES DAAC UWG is chartered to:

- become knowledgeable about the GES DAAC's philosophy, operating environment, mission, direction, constraints, issues, choices, etc;

- provide clear recommendations on the data management issues facing the GES DAAC;
- advocate activities (internal and external to the GES DAAC) that are consistent with the GES DAAC goals, to facilitate science; and
- remain engaged with GES DAAC activities and issues throughout the year so as to maximize their effectiveness, and be better prepared for consultation.

The desired outcomes of the UWG Meeting include recommendations that would best serve the GES DAAC community; consultation on policy development (e.g., reprocessing, distribution); providing community opinion/advice on billing and accounting, operations, etc; and community feedback on GES DAAC operations.

Finally, the GES DAAC staff felt that UWG effectiveness can be maximized by providing GES DAAC information and dialogue prior to the meeting to ensure a good understanding of the DAAC by the UWG members; members actively participating in UWG meetings; and GES DAAC personnel and UWG members remaining engaged, active, and attentive to GES DAAC activities between meetings.

After describing the meeting expectations, a lengthy interactive discussion

regarding the GES DAAC's philosophy, activities, accomplishments, highlights, and directions ensued.

The GES DAAC Status and Highlights

As part of the learning process for UWG, the members asked excellent questions, made insightful observations, and requested key clarifications in fully attempting to understand the inner and outer workings of the GES DAAC, its accomplishments, issues, and constraints. Comments were on target, and concerns were legitimate in bringing out and discussing the GES DAAC state of affairs.

The GES Data and Information Services Center (DISC) consists of an Engineering group led by Chris Lynnes, a Data Management group led by George Serafino, a Science Integration group led by Bruce Vollmer, and a System Execution group led by Gary Alcott. Each group collaborates, as necessary, to ensure continuous performance of the DAAC systems and to explore new Products and Services Cooperative (PSC) work.

It was further explained that the GES DAAC actually contains three systems:

- V0 for heritage data management systems before 1998;
- V1 developed in house for TRMM system, starting November 1997; and
- V2, also known as ECS, developed by ECS to service Terra, Aqua and Aura.

The following key activities/accomplishments were presented by the DAAC to the UWG:

- Continued improvement of heritage systems (V0/V1) to take advantage of the latest technical advances
 - Released DAAC Quick Response System version 1, allowing users easier access to

general information regarding the DAAC.

- Fully supported the deployment and enhancement of EOSDIS (V2).
 - Worked with ESDIS and Raytheon contractor to ensure that ECS is functionally and operationally acceptable to the widest user community.
 - Developed extensions to the ECS to enhance operability (e.g., metrics tools, data manipulation tools, user requested interfaces).
- Fully supported users
 - Adding value to data: regional subsetting, on-demand subsetting, data conversion to GIS, data mining, others.
 - Providing alternatives to accessing data, based on technology advances and user inputs.
- Fully supported science teams
 - Supported major reprocessing campaigns for SeaWiFS and TRMM.
 - Completely engaged with and dedicated to the MODIS processing, calibration, and science requirements and wishes.
- Actively participated in areas of technology advancement for improving data management and data usability.
 - Developed and reused Simple Scalable Script-Based Science Processor (S4P) to simplify and, therefore, enhance data processing throughput on SGI and Beowulf systems.
 - Actively participated in the Digital Earth (DE) initiative. Developed a real application prototype of DE's Web Mapping Testbed, as part of our Environment & Health prototype.

- Supported new missions
 - Triana, QuikTOMS
 - Field experiments
 - Became involved in several new opportunities
 - Prototyped the Environment and Health Research and Information Center of Excellence
 - Distributed data to Remote Sensing Information Partners (RSIPs) and initiated redistribution by RSIPs
 - Initiated center of excellence concepts in atmospheric chemistry with scientists
- Involved in various outreach activities
 - Actively attended conferences, giving several papers of scientific content
 - Passively attended conferences, with posters and booths
 - Created the MODIS Data Support Team (MDST) in preparation for the expected increase of MODIS data users

The GES DISC is moving ahead in new and interesting directions in the following ways:

SYSTEM ENGINEERING

- Continue data processing prototype on Beowulf.
- Adapt S4P to new data processing systems(e.g., Direct Broadcast).
- Develop alternative data system components to supplement and/or enhance existing ECS functionality and performance.
- Develop a data mining engine for TRMM, bringing experience to TERRA and future mission data mining arenas.
- Integrate Distributed Oceanographic Data System (DODS) servers to broaden the GES DAAC user audience and support Digital Earth.

- Continue ARCHER data management system support.

SYSTEM EXECUTION

- Continue to integrate V0/V1 and V2 operations to reduce cost and consolidate the organization
- Continue to perform V0/V1 operations activities more efficiently
- Continue to develop operational strategies to maximize the science that can be extracted from a resource starved and complex ECS.

SCIENCE INTEGRATION

- Integrate and test atmospheric, hydrologic, and oceans color science software, and otherwise prepare for EOS mission data processing, archiving, distribution, and data management, using ECS.
- Provide and operate alternative (non-ECS) data processing, archiving, distribution, and data management implementations for EOS and non-EOS mission data.
- Further engage and partner with Earth science teams to better serve their current and future needs (e.g., assign appropriate science-trained personnel to each partnering science team).

DATA MANAGEMENT

- Collaborate with atmospheric scientists on efforts that would capitalize on the GES DISC data and software products and services for the purpose of creating discipline specific centers of excellence, thereby maximizing the return on the data support effort (e.g., Human Health Initiative; World Data Center for Atmospheric Chemistry Studies).

- Implement services to facilitate the accessibility of data (e.g., data subsetting, development of browse software, data distribution vs. user model analysis).
- Implement services to facilitate the usefulness of data (e.g., conversion to GIS, package and distribute data management tools).
- Implement data processing capabilities to provide the option of eliminating data transfer development and operation costs, remove interface complexities, and facilitate data integrity.

At the conclusion of these presentations, members of the UWG told the DAAC manager that they were impressed by the innovation, user responsiveness and range and breadth of skill exhibited by these activities.

UWG Meeting Observations, Recommendations, and Actions

Since this was the first meeting of this UWG, members listened carefully, making key observations and recommendations where they can be most effective. The two days of discussion centered around the following topics:

- The GES DAAC purpose, mission, goals, philosophy, accomplishments
- Value Added Data Management
- Data Distribution Issues
- Science Involvement in Data Management
- Using New Technologies to Enhance Data Management
- Availability of Products & Services
- GES DAAC External Involvement
- Long Term Archive Issues
- Issue: Recovering Data Distribution Costs
- Issue: How to maximize the 1X Distribution Capability
- EOSDIS Core System (ECS) Issues
- Open discussion

In addition, a tour of the GES DAAC

was given, five short demonstrations characteristic of the GES DAAC workmanship were provided, and a UWG interim chair was selected.

The UWG provided the following comments, observations, and recommendations during the presentation of the above material, and actions were assigned, as noted:

1. OBSERVATION: In order for the GES DAAC to fully embrace supporting the entire solution in satisfying user data problems, there needs to be a “translator” who can understand and define user data and information needs in terms of the remote sensing products available.

This observation, made by Steve Prince, has been recognized for some time by the GES DAAC, and is re-enforced here. Bill Rossow added that many people can benefit by helping a few people make use of the GES DAAC data. In addition, Stan Morain suggested that a charge of this group is to help provide the feedback so that the GDAAC can be better translators. On the second day, Sheila Weiss made a similar comment on how to use the data being displayed in the demo.

2. OBSERVATION: Providing real-world references to the Ames Intelligent Systems initiatives, for exploring new data management approaches like data mining, may prove to be mutually beneficial for both Ames and the DAAC.

Gail McConaughy pointed out that providing references to the Ames initiative, collaborating with funded technology researchers, and providing an applied research environment is recognized within the GES DAAC as giving GES DAAC individuals hands-on experience with advances in data management that may well provide solutions to key issues (e.g., using data mining techniques to reduce data volume distribution), provide opportunities to further

develop a ‘plug and play’ architecture to support insertion of new discipline oriented services, and identify the GES DAAC as an intellectual leader in next generation data management techniques (an area in which GSFC has been asked by HQ to provide center of excellence skills).

3. **OBSERVATION:** Data access needs to be more coordinated in EOS in terms of recognizing user registration across all enterprise data systems.

It was noted by a representative of the ESDIS project that EDG was designated as “the” place to access data; however, serving in that capacity makes it more “generalized.” It was stated that ‘generalization’ often is not satisfying to a user who wishes tailored services. It was also noted that policy direction from HQ indicates that they want to support unique and tailored access. It was noted that the ESDIS project is pursuing an effort, called ECHO, that will ‘externalize’ metadata and permit more users to develop their own unique interfaces. It was recognized that these policy directions placed constraints on the GES DAAC, and on the ESDIS Project itself, to pursue heterogeneity. Rossow concluded that this may be fine for user access interfaces, but he would like a single ‘accounting’ interface that recognizes him across all of the data systems that he uses. The GES DAAC will forward these recommendations to the ESDIS Project.

4. **OBSERVATION:** Approaches to resolving issues surrounding data reprocessing, such as algorithm selection and required capacity, need to be addressed.

Software and sufficient capacity for reprocessing has primarily been provided to the GES DAAC as a result of the funding exercises. Whereas, the GES DAAC is funded to support the execution of specific software, it has little influence on the budget allocated for reprocessing. The GES DAAC wel-

comes this opportunity to articulate approaches for resolving issues that negatively affect its user community.

5. **ACTION:** The UWG will provide guidance on how to maximize the amount of data that can be distributed to meet growing user demands (i.e., what methods of data reduction would be most acceptable to users, and would maximize available resources).

This action resulted from a discussion regarding the limited resources available to distribute Terra data from the GES DAAC. Specifically, the GES DAAC has the capacity to distribute each day of data, just once (1X distribution). With 1X distribution, during reprocessing, either processed or a 1X portion of reprocessed data could be distributed, but NOT both.

Implementation options were presented that would allow the GES DAAC to increase the density of the data sent out, thereby increasing the amount of data distributed beyond 1X. These include on-line analysis, redistribution sites, and use of direct broadcast, improved data selection tools, lending library, tape exchange, subsetting, and data mining.

6. **ACTION ITEM:** The GES DAAC will document and provide to the UWG, high volume data requests, and the UWG will respond with recommendations on how to prioritize these data requests.

Related to the distribution problem is a very real problem currently facing the GES DAAC. The GES DAAC is turning away users because they cannot fill data request orders given the limited distribution capacity in V2. (The true distribution capacity has not yet been determined because when the advertised distribution capacity is approached, the system reacts unfavorably). In particular, data is not being distributed to commercial users and users requesting all data. The general sense of the UWG is

that data should go to the science community first for use in science missions. This is consistent with the current GES DAAC plans which are to distribute to the smaller volume science researchers first, and build (and expand) distribution slowly to better understand how the system will react. Until this occurs, guidance, as a result of the above action item, is being requested from the UWG.

7. **OBSERVATION:** This is an opportune time for the GES DAAC to further engage the growing community interested in applications of remote sensing data. Current and additional efforts to assist specific applications users should be pursued.

UWG member comments supported the GES DAAC in forming liaisons with intermediate applications groups (i.e., Remote Sensing Information Partners – RSIPs) for data redistribution and developing thematic web pages (e.g., Health). The group recognized the importance of supporting NASA’s science mission, but also recognized and encouraged the GES DAAC’s continued efforts to provide remote sensing data to the applications community.

8. **RECOMMENDATION:** The GES DAAC should advocate a position that ensures a long term commitment to the availability and quality of the data

Issues surrounding the long term stewardship of NASA data at the GES DAAC were being discussed when Yoram Kaufman stated that we must ensure that future data is as safe, reliable, and accessible as it is today. Others supported the need for the data to be reliably available. It appeared to be more important that the current level of service be maintained than prematurely transferring the function to a data archive at another location.

Regarding the expected levels of continued service, the UWG provided the following recommendation:

9. RECOMMENDATION: The UWG made it very clear that as long as ‘appropriate’ levels of service are provided to the users, the location of the data is not relevant to them. However, the UWG did feel strongly that the DAAC should take a proactive role both in ensuring the definition of what an appropriate level of service is and in ‘certifying’ that that level is obtained by the Long Term Archive (LTA) prior to DAAC discontinuation of service.

The GES DAAC personnel feel this is an excellent recommendation that would maximize the ability to steward Earth science data long term. In addition, the UWG made the following points for future discussion:

- Reprocessing required after data is under the auspices of LTA will occur in ‘partnership’ with the archiving data center.
 - Moving data should occur after it is being minimally accessed (i.e., stable).
 - Testing or metrics to measure adequate dataset documentation, prior to LTA, should be considered.
 - Understanding why datasets, resident at the GES DAAC, originally acquired from NOAA, are effectively being thrown away. Need to better understand why data was brought to the GES DAAC in the first place, and the impacts to costing LTA.
 - Archiving ECS data comes with many hidden costs (i.e., V2 data implies formats and much ECS software to access the data).
10. ACTION ITEM – The UWG group will review the document, “Global Change Science Requirements for Long Term Archiving” by January 15, 2001. Most helpful: Inputs on level-of-use services, reprocessing requirements, level of services, etc.

Specifically, the GES DAAC is looking for the UWG’s comments on the LTA requirements, assumptions, and directions outlined in this document, to ensure that they are satisfactory to the GES DAAC user community.

11. ACTION ITEM – The GES DAAC will determine which datasets are eligible for LTA in the next two years.
12. RECOMMENDATION: Announce plans to charge, and state the policy far enough in advance to allow users to get funding set up in their future budgets so they can pay for the data.

The subject of charging for data in the future was extensively discussed, and generally accepted. The discussion was tremendously beneficial, and was highlighted by the following points:

- People are willing to pay if the data can be reliably used and the service is of a high level.
- Frivolous acquisition of data will be greatly reduced.
- Bill Burgess mentioned that the State of Maryland charges a flat rate per CD, and collects payments in advance.
- Make data available to all users by offering various media, depending on the heavy versus lighter data users, and associated hardware affordable to the user.
- Stan Morain at the University of Mexico requires credit card purchasing.

It was noted that this discussion clearly articulated the acceptability and experiences about data charging by this representative group of users, providing insightful ideas for future DAAC-wide discussions on this subject.

13. RECOMMENDATION: GES DAAC should analyze methods to move 1 Terabyte of data, so that a suite of media is available to accommodate heavy data volume users to light data volume users.

Wayne Esaias initiated discussion regarding issues with ECS, beyond the GES DAACs control, that directly affects the GES DAAC’s performance. Most noteworthy are the inefficient development of Earth Science Data Types (ESDTs), (a required implementation construct). This inefficiency has slowed the process of validating products prior to more extensive scientific research, and has been unaffected by user expectations.

14. ACTION: DAAC UWG requests presentations at the next UWG from the ESDIS or ECS Projects on an analysis of the issue of unresponsiveness identified by Esaias. The discussion topics need to include analysis of the root cause of the unresponsiveness.
15. ACTION: The UWG is concerned that the AVHRR long-term data set at the GES DAAC will be interrupted. The GES DAAC will reiterate this concern in parallel to any actions taken by UWG individuals.

Prince expressed concern over continued support for AVHRR data production at the GES DAAC (funding to the DAAC has been eliminated for this). A good long term dataset since 1981 has been gathered at the GES DAAC, and it contains much value, even with the arrival of MODIS data.

16. ACTION: The GES DAAC will provide diagrams to show interactions, bottlenecks, and points of failure regarding the GES DAAC V2 activities.
17. RECOMMENDATION: Have a Project Scientist involved with the GES DAAC, to be able to engage and help with tradeoffs as a repre-

sentative of the community's needs.

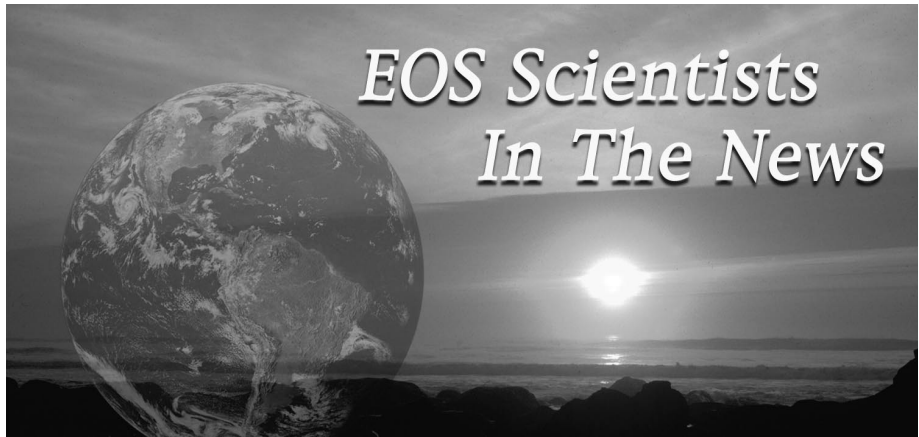
Steve Wharton agreed to follow up on alternatives to a DAAC Project Scientist. One alternative is to have an Instrument Liaison ("kitchen cabinet") to the DAAC.

18. ACTION: At the next meeting, the GES DAAC will discuss in detail the following 'Big Topics':

- 1X distribution capacity.
- System bottleneck issues (e.g., ESDTs)
- How are decisions made to add/remove datasets from the DAAC
- How the DAAC is dealing with the parts of ECS that are not being responsive to the users
- Thematic web sites developed by DISC that address specific applications
- Redistribution issues

Stan Morain agreed to serve as interim chair of the group. Congratulations, Stan.

Members of the GES DAAC UWG and participants in this meeting can be provided upon request. 



Attention EOS Researchers:

Please send notices of recent media coverage in which you have been involved to:

Rob Gutro, EOS Project Science Office
Code 900, NASA / Goddard Space Flight Center, Greenbelt, MD 20771
Tel. (301) 286-4044
Fax: (301) 286-2322
Email: rgutro@pop900.gsfc.nasa.gov

"Scorched Earth in the Tropics Linked to Europe's Storms" (January 1) *San Francisco Chronicle* — **Daniel Rosenfeld's** (Hebrew University) research on the effects of African smoke on European rainfall is highlighted.

"Pollution in India May Affect Climate," (January 6) *Science News* — **William Collins** (NCAR) discussed how sulfate aerosols over the Indian continent are preventing 15% of the sun's light from reaching the ground.

"Snowpack Chemistry Can Deplete Ozone" (January 6) *Science News* — **Leonard Barrie** (Pacific Northwest Laboratories) discussed how snowpack chemistry is depleting low level ozone and leaving mercury vapor in the lower atmosphere.

"Globe Wetter When El Niño, La Niña Around" (January 16), USA Today.com

— The research of **Scott Curtis** (University of Maryland Baltimore County) and **Robert Adler** (NASA/GSFC) on more extreme precipitation patterns during ENSO events.

"U.S. East Cooled While Globe Warmed" (January 16) USA Today.com — **Walter A. Robinson** (University of Illinois-Urbana-Champaign) discussed his findings on why the eastern U.S. was cooler than the rest of the world over the last several decades.

"Antarctic Ice Closer to Breakup" (January 22) MSNBC.com, ABC News.com, Fox News.com — Research by **Christina Hulbe** (NASA/GSFC) and colleagues have shown how meltwater can cause splintering of Antarctic ice shelves.

"Dry Pattern May Foretell El Niño" (January 21) USA Today.com, Weather.com, Science News — **Curtis** and **Adler** made news again with their tropical rainfall research that indicates drier than normal conditions over the Indian Ocean may hint at an oncoming El Niño.

"Terra Cognita" (February/March 2001) *Air & Space Magazine* — A pictorial feature of new imagery from the Terra satellite, SeaWiFS, Radarsat 1, and Landsat 7.

(continued on page 25)

Earth Science Education Program Update

— Blanche Meeson (bmeeson@see.gsfc.nasa.gov), NASA Goddard Space Flight Center
— Theresa Schwerin (theresa_schwerin@strategies.org), IGES

Sun-Earth Day: Have A Solar Blast

April 27, 2001 will be national awareness day for NASA Sun-Earth Connection science. Teachers and students, amateur astronomers, scientists, and planetaria staff are invited to participate. For more information see: solarevents.org and sunearth.gsfc.nasa.gov, or contact: solarevents@ssl.berkeley.edu.

IPCC Approves Major Report On The Science Of Climate Change

Over 150 delegates from about 100 governments met in Shanghai, China, January 17-20, 2001 to consider the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) "Climate Change 2001: The Scientific Basis."

The full report, which runs to over 1000 pages, has been over three years in production and is the work of 123 lead authors and 516 contributing authors from around the world. The report went through extensive review by experts and governments. In accordance with the IPCC Principles and Procedures, after line-by-line consideration, the governments unanimously approved the Summary for Policymakers and accepted the full report.

The Summary for Policymakers is available at Web site www.usgcrp.gov/usgcrp/new.htm. The full report will

be published by Cambridge University Press.

Online Journal Of Math And Science Examples For Pre-College Education


PUMAS (Practical Uses of Math and Science) is a collection of one-page examples of how math and science topics taught in K-12 classes can be used in interesting settings, including everyday life. The examples are written primarily by scientists and engineers, and are available to teachers, students, and other interested parties via the PUMAS Web site. The site's goal is to capture, for the benefit of pre-college education, the flavor of the vast experience that working scientists have with interesting and practical uses of math and science.

The journal currently includes 34 examples, many in the Earth sciences, and is seeking new entries. Interested in contributing? See pumas.jpl.nasa.gov or contact Ralph Kahn, ralph.kahn@jpl.nasa.gov.

NASA, FEMA Partner To Use Science And Space Technology For Disaster Prevention

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

operative 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, 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. For more information see earth.nasa.gov/ebn/news00037.html. 


(continued from page 24)

Scientists In The News

"Other Greenhouse Gases" (February 5) Earth and Sky Radio — **James Hansen** (NASA/GISS) discusses soot and their effect on global warming.

"Aerosols and Climate" (February 11) Earth and Sky Radio — **Ralph Kahn** (NASA/JPL) explains that aerosols can brighten or evaporate clouds and reduce precipitation.

"NASA Tests Satellite on Argentina Landscape" (February 15) Reuters — **Steve Unger** (NASA/GSFC), Earth Observing-1 satellite Project Scientist, discussed how the team of scientists in Argentina is confirming what the EO-1 sees from space.

"Glacier Loss Seen as Sign of Human Role in Warming" (February 20) New York Times — **Richard Alley** (Pennsylvania State University) notes that human actions are responsible in part for the melting ice cap atop Africa's Mount Kilimanjaro. 

Africa's Lake Chad Shrinks By 20 Times Due To Irrigation Demands, Climate Change

— Lynn Chandler (Lynn.Chandler.1@gssc.nasa.gov), Goddard Space Flight Center, Greenbelt, Md.

In the 1960s, North Central Africa's Lake Chad was larger than the state of Vermont but is now smaller than Rhode Island. NASA-funded researchers, using computer models and climate data, now understand why Africa's freshwater Lake Chad has been disappearing over the last 30 years.

Michael T. Coe and Jonathan A. Foley of the University of Wisconsin-Madison cite a drier climate and high agricultural demands for water as reasons why what was once one of Africa's largest freshwater lakes is shrinking. "Lake Chad was about 25,000 square kilometers in surface area back in 1963," Foley noted. Now the lake is about one-twentieth the size it was in the mid 1960s.

Their paper titled "Human and Natural Impacts on the Water Resources of the Lake Chad Basin," is being published in the American Geophysical Union's Journal of Geophysical Research. In their paper, Coe and Foley used an integrated biosphere model (IBIS) with long time-series climate data. They simulated the exchange of energy, water and carbon dioxide between vegetation, soil and the atmosphere, and tracked the changes in Lake Chad since 1953. They input the data from the biosphere model into a hydrological model and were able to estimate changes in river discharge and in the amount of water in wetlands and in Lake Chad.

Using model and climate data, Coe and Foley calculate that a 30 percent

decrease took place in the lake's size between 1966 and 1975. Irrigation only accounted for 5 percent of that decrease, with drier conditions accounting for the remainder. They noticed that irrigation demands increased four-fold between 1983 and 1994, accounting for 50 percent of the additional decrease in the size of the lake.

"NASA Landsat satellite imagery taken of the lake over the last 30 years really capture the model conclusions and visualize them very well," the researchers noted.

Lake Chad and the Chari/Logone river system, which transports 90 percent of the runoff generated in the area basin, are important water resources for the local population. The lake is 820 feet (250 km) above sea level and is shared by Chad, Cameroon, Nigeria, and Niger. Lake Chad has always undergone seasonal and inter-annual fluctuations because it is less than 23 feet (7 m) deep. In recent decades, during wet periods, the lake expands up to 10,000 square miles (25,900 square km). The warming climate and increasing desertification in the surrounding Sahel region have dropped water levels far below the average dry season level of 4,000 square miles (10,000 square km) to only 839 square miles (1,350 square km).

The Northern Africa Sahel region has experienced numerous devastating droughts over the last three decades. "Climate data have shown a great

decrease in rainfall since the early 1960s largely due to a decrease in the number of large rainfall events," Coe said.

Lake Chad's primary source of water comes from the monsoon rains that typically fall in June, July, and August. Meanwhile, the use of water for irrigation has increased, in response to the drier climate. Over the last 40 years, the discharge from the Chari/Logone river system at the city of N'Djamena in Chad has decreased by almost 75 percent, drastically reducing the input into the lake. Between the increase in agricultural water use and the drier climate, there has been a massive decline in the amount of water in Lake Chad.

With a drier climate and less rainfall, agricultural areas become more desperate for water to irrigate their crops and will continue draining what is left of Lake Chad. Foley said, "The problem is expected to worsen in the coming years as population and irrigation demands continue to increase."

Regional officials have noticed the dramatic effect the shrinking lake is having on its surrounding inhabitants. In the summer of 1998, the President of Chad hosted the 10th Lake Chad summit with leaders from Nigeria, Niger, the Central African Republic, Cameroon, and Sudan to discuss how to boost water levels.

NASA's Earth Observing System funded the Lake Chad study. The overall goal of NASA's Earth Observing System is to advance the understanding of the entire Earth system on a global scale by improving our knowledge of the components of the system, the interactions between them, and how the Earth system is changing.

Images and additional information can be found on the Web at www.gssc.nasa.gov/gssc/earth/environ/lakechad/chad.htm.



EOS Science Calendars

April 25-27

NSIDC DAAC User Working Group Meeting
NSIDC, University of Colorado, Boulder, CO.
Contact: Ron Weaver, tel. (303) 492-7624;
e-mail: weaverr@kryos.colorado.edu.

May 1-2

SAGE III Science Team Meeting, Hampton
University, Hampton, VA. Contact: Pat
McCormick, e-mail:
pat.mccormick@hamptonu.edu.

May 1-3

CERES Science Team Meeting, The Omni,
Newport News, VA. Contact: Jennifer
Hubble, e-mail: j.m.hubble@larc.nasa.gov.

May 8-9

Terra Cloud Mask Conference, University
of Wisconsin, Madison, WI. Contact: Janine
Gumley, UW-Madison, tel. (608) 262-6739;
e-mail: Janine.Gumley@ssec.wisc.edu.

May 15-16

AIRS Data Assimilation Workshop, Camp
Springs, MD. Contact: George Aumann,
e-mail: aumann@jpl.nasa.gov.

May 21-24

ASTER Science Team Meeting and Joint
Science Team Meeting, Tokyo. Contact: Anne
Kahle, e-mail: anne@lithos.jpl.nasa.gov.

May 22-27

Landsat Science Team Meeting, Hilton
Hawaiian Village, Honolulu, HI. For logistics
contact: Kathy Regul, e-mail:
kregul@westover-gb.com. For meeting
contact: Darrel Williams, e-mail:
darrel@ltpmail.gsfc.nasa.gov.

June 19-21

AIRS Science Team Meeting, Pasadena,
CA. Contact: George Aumann, e-mail:
aumann@jpl.nasa.gov.

July 24-26

Federation of Earth Science Information
Partners, University of North Dakota in
Grand Forks. Contact: George Seielstad,
e-mail: gseielst@aero.und.edu.

August 2

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

Global Change Calendar

April 23-27

ASPRS: The Imaging and Geospatial Informa-
tion Society, St. Louis. tel. (410) 208-4855; Fax:
(410) 641-8341; e-mail: wboge@aol.com; URL:
www.asprs.org.

May 7-10

14th Annual Geographic Information
Sciences Conferences, Baltimore, MD.
Contact Towson University, tel. (410)
830-3887; e-mail: jmorgan@towson.edu; URL:
www.towson.edu/cgis/tugis2001.

May 14-18

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

May 29-June 2

2001 Spring AGU (American Geophysical
Union) Meeting, Boston, Massachusetts. tel. 1
(800) 966-2481 or 1(202) 462-6900; Fax: 1 (202)
328-0566; e-mail: meetinginfo@agu.org; URL:
www.agu.org

July 9-13

International Geoscience and Remote Sensing
Symposium, Sydney, Australia. tel.
61.2.6257.3299; Fax: 61.2.6257.3256; e-mail:
igarss@ausconvervices.com.au; URL:
www.IGARSS2001.org/.

July 10-13

Global Change Open Science Conference
"Challenges of a Changing Earth,"
Amsterdam. Contact Will Steffen, e-mail:
sec@igbp.kva.se; URL: www.sciconf.igbp.
kva.se.

July 10-18

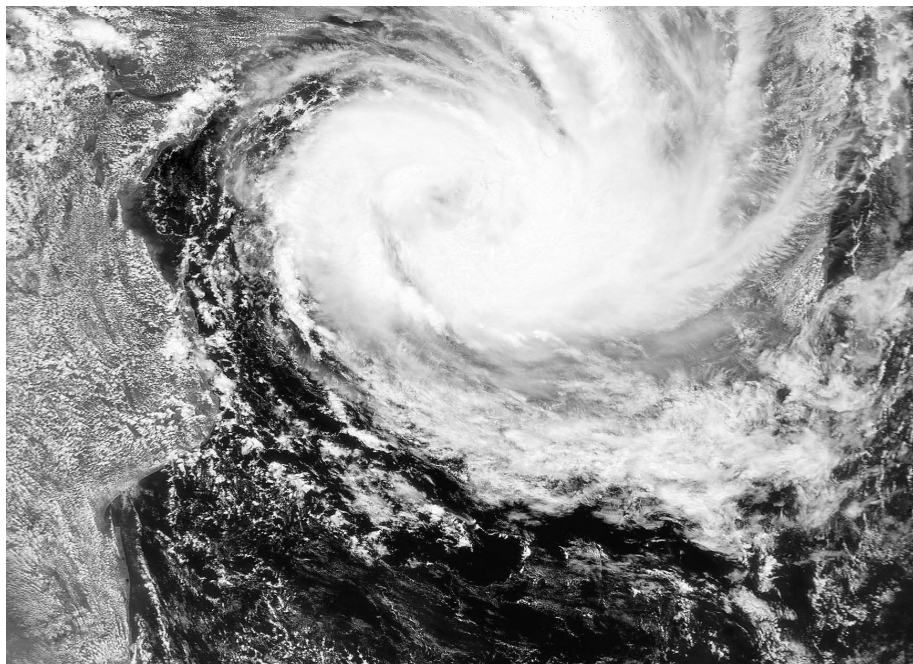
International Association of Meteorology and
Atmospheric Sciences 2001 Conference,
Innsbruck, Austria. For more informaiton see
URL: meteo.uibk.ac.at/IAMAS2001.

October 7-10

2001 International Conference on Image Pro-
cessing, Thessaloniki, Greece. Call for Papers.
Contact Diastasi, tel. +30 31 938 203, Fax: +30
31 909 269, e-mail diastasi@spark.net.gr.

December 10-14

2001 AGU Fall Meeting, San Francisco, CA.
For more infomation, tel. 1 (800) 966-2481 or
1(202) 462-6900; Fax: 1 (202) 328-0566; e-mail:
meetinginfo@agu.org; URL: www.agu.org.



The Sea-viewing Wide Field-of-view Sensor (SeaWiFS, flying aboard OrbView-2) saw Tropical Cyclone Dera shortly after it formed (March 9, 2001) over the Mozambique Channel. Mozambique is visible to the left of the storm, and the island of Madagascar is partially visible on the right side of the storm. According to the U.S. Joint Typhoon Warning Center, Cyclone Dera now has sustained winds of 55 knots (about 63 mph or 102 km per hour), with gusts of up to 70 knots (81 mph or 130 km per hour). Image Provided by the SeaWiFS Project, NASA / Goddard Space Flight Center, and ORBIMAGE

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