Earth Observing System

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In this issue ...

Meeting/Workshop Summaries

Other Items of Interest

Regular Features

EDITOR'S CORNER

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I'm sure you share the same sense of loss and solemn reverence as I do over the tragic end to Space Shuttle mission STS-107 on February 1. The loss of Columbia and its crew is a major setback to the tremendous contributions the Shuttle program has made over the past several years, and will have significant impacts across NASA. At this point it is uncertain what these impacts will be, but it is certain that the same inspiration, dedication, and passion that embodied the crew of Columbia will remain in the Shuttle program, the Earth Science Enterprise, and throughout NASA. These characteristics are evident in the outstanding progress our program has made in recent years, and there are many new and exciting missions planned for the near future.

Two new Earth science missions were successfully launched recently. The Ice, Cloud, and land Elevation Satellite (ICESat) was successfully launched on January 12 from Vandenberg Air Force Base in California aboard a Boeing Delta II rocket. ICESat is the benchmark EOS mission for measuring ice sheet mass balance, cloud and aerosol heights, as well as land topography and vegetation characteristics. A minor performance issue with the Laser Reference System on the spacecraft's Geoscience Laser Altimetry System (GLAS) has been resolved, and the ICESat Science Team is currently conducting calibration and validation activities.

The ICESat mission will provide multi-year elevation data needed to determine ice sheet mass balance as well as cloud property information, including polar stratospheric clouds common over polar areas in winter. It will also provide topography and vegetation data around the globe, in addition to topographic coverage over the Greenland and Antarctic ice sheets.

The Solar Radiation and Climate Experiment (SORCE) was placed into orbit by

Continued on page 2

a Pegasus XL launch vehicle on January 25. The SORCE spacecraft and its instruments are exceeding our initial expectations, and there have been no significant glitches. The instruments have begun taking excellent science measurements, and initial investigations of the data are underway. Solar observations from the Total Irradiance Monitor (TIM), Spectral Irradiance Monitor (SIM), the XUV Photometer System (XPS), and stellar observations from the Solar Stellar Irradiance Comparison Experiment (SOLSTICE) are proceeding nominally.

SORCE instruments will provide state-of-the-art measurements of incoming x-ray, ultraviolet, visible, near-infrared, and total solar radiation. The measurements provided by SORCE specifically address long-term climate change, natural variability and enhanced climate prediction, and atmospheric ozone and UV-B radiation. These measurements are critical to studies of the sun, its effect on our Earth system, and its influence on humankind.

Congratulations to the ICESat and SORCE Science Teams on their outstanding performance in bringing these two important EOS missions to fruition. Congratulations also to Jim Watzin, currently the ICESat Project Manager, who will assume responsibilities as the new Project Manager for the NPOESS Preparatory Project (NPP) once the ICESat mission transitions to mission operations.

An EOS NRA titled, "Earth System Science Research Using Data and Products from Terra, Aqua, and ACRIM Satellites" was released on January 30, 2003, with Notices of Intent due February 28. Proposals are due by April 15, 2003. This NRA includes two categories of proposals: "EOS Algorithm Refinement Proposals," and""Science Data Analysis and Modeling Research Proposals." Research accomplished within these projects will significantly contribute to the science and applications enabled by EOS and its entire complement of Earth science satellites.

Finally, I'm pleased to announce a major redesign of the EOS Project Science Office web site at *eos.nasa.gov*. While the content and functionality of the site remain relatively unchanged, its design and navigation have been greatly improved. The EOSPSO web site has had over a million hits from over 54,000 unique visitors since it was redesigned and went online in early January. In addition to frequent access for EOS science program reference information, we've received 14,000 orders for our educational CD-ROM and 18,000 orders for our series of four Earth science posters since August 15 of last year. The EOS Project Science Office web site continues to be the primary clearinghouse for up-to-date EOS Project information, science reference materials, and a host of informal education resources.

ICESat successfully launched on January 12 from Vandenberg Air Force Base. The Boeing Delta II rocket carried it into space, where the satellite will measure Earth's ice sheet mass baalance, cloud and aerosol heights, and land vegetation.

The Earth Observing System's (EOS) Investigators Working Group (IWG) Meeting Minutes

— Alan Ward (Alan_Ward@sesda.com), EOS Project Science Office, Goddard Space Flight Center, SSAI

The Earth Observing System's (EOS) Investigators Working Group Meeting was held November 18-20, 2002, at the Turf Valley Resort and Conference Center in Ellicott City, MD. The meeting drew 159 participants and is the primary forum for sharing the latest EOS science and program activities. More detailed minutes of the November, 2002 IWG meeting, along with copies of the presentations by most of the speakers, are available from the EOS Project Science Office. Please contact Hannelore Parrish at *hannelore_parrish@sesda.com* or (301) 867-2114 for these items. The next Investigators Working Group meeting will be held in the fall of 2003. Additional details on the next meeting will be published in future issues of *The Earth Observer*.

DAY ONE: November 18, 2002

Session I: **ESE/EOS Mission Status**— *Michael King, EOS Senior Project Scientist, Chair*

Ghassem Asrar (Associate Administrator for Earth Science at NASA Headquarters) presented a talk on the status of the Earth Science Enterprise (ESE) and EOS. Asrar looked at three main areas: progress, promise, and vision.

In the last decade, ESE was focused on conducting a broad survey of the Earth System. The first Earth observation launches occurred toward the end of this period. ESE is now moving beyond this survey and plans to be much more focused on using Earth Science data to meet societal needs over the next couple of decades.

By the end of 2004, more than 20 Earth observing satellites will be in orbit. Recent launches are generating exciting new data and understanding of the health of our planet. More missions are planned beyond the 2004 timeframe. In addition, the intriguing new concept of multiple spacecraft flying in tight formation — so called satellite constellations — should lead to even more comprehensive observations and understanding of our home planet. Asrar also stressed the importance of information systems. These systems should provide end-to-end management from satellite to users.

Asrar reminded the audience of the NASA vision and mission statement. The important phrase to stress is, *"As only NASA can."* There are certain missions which NASA is uniquely suited to fulfill. He also stressed the fundamental importance of education. This is a key part of the mission statement. ESE cannot fulfill its goals if it does not prepare the next generation of scientists and engineers. ESE seeks to understand how our planet is changing and what consequences these changes will have on human civilization. He touched on the science priorities as articulated in the research plan: variability, forcing, response, consequences, and prediction. Each area has a set of overarching questions associated with it.

Asrar spoke about modeling and the key role these efforts play in fulfilling the ESE objectives. It is an important way to provide economic and policy relevant information to decision makers. Meeting societal needs is the major challenge ahead.

Another key issue is that of missions transitioning from a research focus to an operational focus. As of yet, no formal process has been developed to govern the path taken from research to operations. The discussions that are ongoing concerning the development of the National Polar-orbiting Operational Environmental Satellite System (NPOESS) are an example of where these types of issues are beginning to be discussed.

Asrar also touched briefly on the 12 National Applications that have been identified (covered in greater detail in Session V). These are partnerships with other domestic agencies. NASA's role is more to serve as a consultant and provide data and expertise. Once the applications prove viable, the partner agencies take control and institutionalize them. NASA continues to provide data, information, and technical support.

Asrar ended his talk by looking toward the future. He stressed the continued importance of domestic, international, and commercial partnerships, and advanced sensor capabilities including sensor webs, information synthesis, and the importance of improved access to knowledge. Roadmaps are being developed to map out how various

capabilities will be developed to enable the NASA mission of "understanding and protecting our home planet," for decades to come.

Jack Kaye (Director of the Research Division in the Office of Earth Science at NASA headquarters) spoke about Federal Planning for Climate Research. He began with some historical perspective, emphasizing the U.S. Global Change Research Program (USGCRP), which for more than a decade was the major coordinating activity for climate change studies in the U.S. Government. NASA has been (and continues to be) its biggest contributor.

In the 2000 time frame, the USGCRP was in the process of developing a long-term strategy, which changed when President Bush gave his "Rose Garden Speech" on June 11, 2001. In this address, the President announced the creation of the Climate Change Research Initiative (CCRI). The directive was that the CCRI should examine the "key gaps" in our understanding of climate change, emphasizing the near-term provision of scientific information to enable improved policy and decision making. On February 14, 2002, the President delivered another speech in which he emphasized the U.S. commitment to improve our knowledge of the climate system and defined a multi-tiered interagency coordinating structure that has been put in place to help implement the CCRI together with the prior USGCRP in an integrated fashion. This structure will also help implement the associated National Climate Change Technology Initiative.

Kaye then went on to discuss some of the highlights of the integrated USGCRP and CCRI as defined in the draft U.S. Climate Change Science Program Strategic Plan. [**Editors Note**: The CCRI was extensively reviewed in a major stakeholder meeting held December 3-5, 2002, in Washington, DC.] CCRI will accelerate the highest priority science and provide answers to decision makers. He reviewed the structure of the CCRI. The focus is on three main areas: emerging scientific issues, observations and monitoring, and decision-support. The emerging scientific issues, all of which are relevant to ESE, are the impact of aerosols on climate, carbon in North America, and feedback issues relative to clouds and water vapor and also to Polar Regions. He touched briefly on issues associated with climate quality observations, monitoring and data management, and ended by very briefly showing information on parts of the more disciplinary-oriented theme chapters. For each question that is posed, the state of knowledge is reviewed, illustrative research questions are given, research needs are described, and products and expected payoffs are listed.

Upcoming EOS Mission Status Reports

The series of talks that followed was an update on EOS Missions that are planned for launch in the near future.

Gary Rottman (Laboratory for Atmospheric and Space Physics [LASP] at the University of Colorado) and Bob Cahalan (Goddard Space Flight Center [GSFC]) gave a joint update on the Solar Radiation and Climate Experiment (SORCE). Launch is currently planned for the end of January. SORCE will measure both Total Solar Irradiance (TSI) and, more importantly, spectral irradiance over most wavelengths. A brochure has just been released that details the science of this mission. The spacecraft operations and data analysis system are both located at LASP. Rottman also reported that the instruments and spacecraft are all ready to go. Launch will be at the Kennedy Space Center at Cape Canaveral, Florida. [**Editors Note**: SORCE was successfully launched on January 25, 2003. Kudos to the SORCE team!]

Bob Cahalan continued the report on SORCE and discussed cooperation with other agencies and between the Earth and Space Science communities at NASA. This is an effort to study long-term variability in solar irradiance. There is still quite a bit of uncertainty in this area, and combined and overlapping measurements with previous missions are very important so that the long-term record can be continued. Cahalan reported that there is currently a gap between the SORCE mission and the next mission that is planned to study solar irradiance—NPOESS. A SORCE-2 mission (alternatively named Solar Irradiance Gap Filler [SIGF]) is being proposed. It may be co-manifested with another mission. Cahalan ended by speaking about calibration and intercomparison efforts that have been or will be conducted for SORCE.

Jay Zwally (GSFC) provided an update on the Ice, Cloud, and land Elevation Satellite (ICESat) that is scheduled to launch on December 19 from Vandenberg Air Force Base in California. [**NOTE**: The launch was delayed from the scheduled date but happened on January 12, 2003. Kudos to the ICESat team!] ICESat is planned as a three-year mission but it is hoped that the mission can be extended to five years. The instrument on ICESat is the Geoscience Laser Altimeter System (GLAS), a laser with channels at 532

and 1064 nm, respectively. Zwally went on to give some of the technical details about the GLAS instrument.

The primary objective of the ICESat mission is to study polar ice mass balance and its effects on sea-level change. Zwally showed some results from previous studies of ice sheet changes, emphasized the importance of these questions for climate change studies, and emphasized the need for long-term systematic measurements of ice sheet changes. The mission's secondary objectives include studying: clouds and aerosols, land elevation, sea-ice thickness and roughness, vegetation canopy height, and surface reflectivity. Zwally ended by discussing mission characteristics and data processing and distribution.

Ernest Hilsenrath (GSFC) provided an update on Aura. Aura is the third major EOS platform and will join Terra and Aqua in orbit, hopefully, in January 2004, and become part of the A-Train satellite formation. As its name implies, Aura focuses on studying our atmosphere, and will take observations of atmospheric chemistry in unprecedented detail. Hilsenrath reviewed the Aura science questions, which are derived from NASA's strategic questions. He then reviewed the specific areas for which Aura will make contributions, including: monitoring the sources and distribution of pollution and impacts on health and climate; ozone recovery and the impact of international protocols; and the roles of clouds, aerosols, water vapor, and ozone on climate forcing.

Hilsenrath next reviewed the instruments on Aura individually and discussed their status. The instruments are the High Resolution Dynamic Limb Sounder (HIRDLS), the Ozone Monitoring Instrument (OMI), the Microwave Limb Sounder (MLS), and the Tropospheric Emission Spectrometer (TES). He reported that the Aura flight operations and data processing systems are on schedule, and the instrument teams' Science Investigator-led Processing System (SIPS) are in place. Finally he discussed the proposed validation activities, which are being planned in conjunction with NASA's atmospheric research program.

Bob Murphy (GSFC) provided an update on the NPOESS Preparatory Project (NPP), a mission planned to bridge the gap between the EOS missions (Terra and Aqua) and NPOESS. Murphy discussed the main instrumentation that will fly on NPP. The Visible Infrared Imager/ Radiometer Suite (VIIRS) is a modified version of the Moderate Resolution Imaging Spectroradiometer (MODIS) that flies on Terra and Aqua. Also included will be a Cross-Track Infrared Sounder (CrIS) and an Advanced Technology Microwave Sounder (ATMS). Furthermore, an instrument of opportunity may also be added to the NPP suite. Candidates to fill this slot would be either an Ozone Mapping and Profiler Suite (OMPS), as is planned to fly on NPOESS, or another Clouds and the Earth's Radiant Energy System (CERES) radiometer, like the ones currently flying on Terra and Aqua. A decision on the instrument of opportunity will likely be made in the near future. [**Editors Note**: A decision has subsequently been made to fly OMPS on NPP].

Murphy reports that NPP will launch some time in the first half of 2006 on-board a Delta II rocket. He also discussed the ground system for NPP and pointed out that an NRA is to be released in late January to form a science team for this mission. A second science team will likely be assembled closer to the launch date.

Earth System Science Pathfinder Missions

Continuing with mission updates, the attention turned to the Earth System Science Pathfinder (ESSP) missions. **Marc Imhoff** (GSFC) is ESSP Project Scientist and introduced this series of talks. Imhoff presented a brief overview of the ESSP program; these are intended to be focused missions that look at issues of importance to climate change studies and supplement larger EOS missions. They are missions that are built quickly and on a constrained budget. Imhoff briefly touched on each mission and introduced each speaker. Since the focus of the morning was on missions that had not yet been launched, the Gravity Recovery and Climate Experiment (GRACE), which is already on orbit, was not discussed until later in the meeting (*see session IV*).

Jay Mace (University of Utah) provided an update on CloudSat. Mace acknowledged all of the partners who are working together on CloudSat. He also reported that CloudSat will be launched on the same launch vehicle as the Cloud Aerosol Lidar Infrared Pathfinder Science Observations (CALIPSO) mission to be discussed by the next speaker. The launch is planned for 2004. CloudSat is a mission to study the key role clouds play in climate; it will be the first mission to deploy a 94 GHz Cloud Profiling Radar system in space. CloudSat is part of the A-Train satellite constellation, and information from the other satellites in this formation can be combined with information from CloudSat to make

synergistic measurements. Products are being developed that will combine information from the radar on CloudSat and the lidar on CALIPSO. Data from MODIS on Aqua will also be used in conjunction with radar data from CloudSat. Mace ended by discussing two test data sets that helped to show the capabilities of CloudSat and illustrate how the raw data will be turned into meaningful results.

David Winker (Langley Research Center [LaRC]) reported on the status of the CALIPSO mission. As discussed above, this mission launches jointly with CloudSat and is planned for 2004. CALIPSO will make measurements of clouds and aerosols needed for climate change studies. Winker reviewed the three instruments on CALIPSO. The main instrument is the Cloud Aerosol Lidar with Orthogonal Polarization (CALIOP); in addition, a Wide Field-of-view Camera (WFC) and Infrared Imaging Radiometer (IIR) are included. He indicated some of the unique features of the instrumentation.

Winker then went on to talk about instrument specifications, flight hardware status, and accomplishments and issues. He showed some sample data of the sort that CALIPSO will return and spoke briefly about the data processing for the mission. He indicated that a science validation plan is also being developed. Finally, he spoke a bit about multi-platform synergism. CALIPSO, along with CloudSat, is part of the A-Train satellite constellation.

Chet Koblinsky (GSFC) provided an update on the Aquarius mission. Aquarius was one of three missions (two primary missions and an alternate were chosen, Aquarius is one of the primary missions) selected in the most recent round of ESSP selections. Aquarius will study sea-surface salinity in the ocean. It is a joint venture between GSFC, Jet Propulsion Laboratory (JPL), and the Argentine Space Agency. Koblinsky reviewed why salinity studies are important; salinity through its effect on ocean density impacts the vertical circulation of the oceans. The prospect of making a global measurement from space is very compelling. Koblinsky next touched on the science requirements for the mission. The primary mission is the salinity measurement, but the instrument will also provide data that can be used by the hydrology community to study soil moisture changes. He acknowledged the partners who are collaborating on this mission and the valuable contributions of the science team. The mission should launch in 2007 on a Delta II rocket. Validation plans are being developed, along with an education plan.

Charles Miller (Haverford College) provided a status report on the Orbiting Carbon Observatory (OCO) mission. OCO was also chosen as the primary mission in the most recent round of ESSP selections. The goal of the mission is the improved characterization of carbon dioxide (CO_2). A better understanding of the interchange of carbon between land, ocean and atmosphere should result. Another very important result should be an improved ability to distinguish between carbon resulting from human activities and carbon from natural sources.

Miller next briefly reviewed some of the details of the OCO instrument. He touched on the spectral sampling strategy and emphasized the importance of designing the bands to have maximum sensitivity near the surface, where most of the CO_2 would be found. Miller also discussed some of the details of the spacecraft and the operational strategy for the mission. He ended with a discussion of the plans for calibration and validation, the expected data products, and the planned schedule leading up to launch in 2007.

Dara Entekhabi (Massachusetts Institute of Technology [MIT]) spoke about the Hydros mission. Hydros was selected as the alternate mission in the third round of ESSP selections. Hydros will study soil moisture and the freeze/thaw state of the surface. This is critical input for Numerical Weather Prediction models, as it links the water, energy, and biogeochemical cycles together. Entekhabi presented information on how data from Hydros will enable important applications in areas such as national security and aviation. He also indicated that the algorithms that will be employed are well developed and that there is a long heritage of these types of measurements. The technical approach for Hydros is typical for a "Pathfinder" mission. This is a low risk mission with a high science return. Entekhabi closed with a short discussion on data products expected from Hydros and their importance to fulfilling research priorities within the NASA science community.

Yann H. Kerr (Centre d'Etudes Spatiale des Biosphere [CESBIO]) presented the Soil Moisture and Ocean Salinity (SMOS) mission after giving a brief overview of ESA's Earth Explorer Opportunity Missions (EEOM). These are essentially the ESA equivalent of NASA ESSP missions. Kerr thus first reviewed the missions that have been selected as EEOM's. Many of the

missions chosen by ESA as EEOM's complement missions were selected by NASA as ESSP missions.

Kerr next focused on a specific example of an EEOM — the SMOS mission for which he is the PI. He discussed the motivation for this mission. Atmospheric models have huge discrepancies on soil moisture, and more data are needed to more accurately determine this parameter. Likewise, improved information on sea-surface salinity is important to improve the accuracy of models. SMOS will use an interferometry technique to make measurements. He ended by discussing field-of-view issues and how soil moisture measurements are derived.

Session II: ***New Integrated Science Results from Terra and Other Data Sources***—**Jon Ranson**, Terra Project Scientist, Chair

Jon Ranson (GSFC) kicked off the afternoon session by presenting a Summary of Validated Data Products from Terra. All of Terra's instruments are doing fine, with a few minor correctable issues. Ranson reports that nearly all Advance Spaceborne Thermal Emission and Reflection Radiometer (ASTER) and Moderate Resolution Imaging Spectroradiometer (MODIS) products are validated. The Cloud and the Earth's Radiant Energy System (CERES), the Multiangle Imaging Spectro-Radiometer (MISR), and the Measurement of Pollution in the Atmosphere (MOPITT) have released validated, provisionally validated, or beta products. Ranson reviewed the objectives of Terra and the science questions the mission is trying to answer. He reported that products are now available to fulfill these objectives and begin to answer these questions. Ranson ended by briefly showing the new (since the last IWG) Natural Hazards section of the Earth Observatory website — *earthobservatory .nasa.gov*. He also mentioned that the EOS Science Working Group plans a workshop concerning data access and usability for April 2003.

Otis Brown (University of Miami) spoke on Radiometric Performance of MODIS Terra and Aqua for Sea Surface Temperature (SST) estimation. Brown discussed the status of the various MODIS SST products and noted that all would be validated as of the next code insertion. He also discussed active support for other EOS instruments and for international SST projects. Brown went on to discuss *in situ* validation data. He reviewed how surface validation data is obtained and showed a particular example. The latest validation results show no real latitudinal bias, and the quality is similar for both Terra and Aqua. He showed how improved SST information leads to an improved Hurricane Intensity Prediction capability. The National Hurricane Center is interested in incorporating MODIS information into its models.

Dennis Clark (NOAA/NESDIS) spoke about climate quality ocean color time series. He began by reviewing the Marine Optical Buoy (MOBY) and the Marine Optical Characterization Experiment (MOCE) activities over the past five years. He explained the oceanic color variability and why time series of *in situ* radiometric observations are required for the vicarious calibration of satellite ocean color observations. The MOBY system and operational infrastructure located at the University of Hawaii Marine Center and the ongoing collaborative research with National Institutes of Standards and Technology (NIST) personnel to improve the accuracy of the in-water radiometric measurements were presented. Results from the present vicarious calibration process, conducted with University of Miami team members, for Terra and Aqua were presented and demonstrated the necessity for retrospective calibrations and reprocessing if climate quality data sets are to be achieved.

Mark Abbott (Oregon State University) spoke about ocean biogeochemistry, productivity, and fluorescence from MODIS. Abbott characterized the 50 years of records on Global Ocean Primary Production as "50 years of educated guessing," because of the intense variability in light utilization by phytoplankton. He showed the MODIS productivity time series and then compared MODIS Chlorophyll to SeaWiFS. Both products match well. The question that needs to be understood is how phytoplankton turns light energy into biological matter. Abbott showed the fluorescence line height compared with ship measurements *in situ*. Fluorescence works better at estimating chlorophyll concentration in productive, near-shore waters. The next issue he wishes to consider is whether or not the Chlorophyll Fluorescence Efficiency (CFE) derived by MODIS can help to improve the Primary Production Algorithm.

Yoram Kaufman (GSFC) reported on the use of satellites (MODIS), ground networks (AERONET) and aerosol models (GOCART) to view the aerosol effect on climate. The attempt here is to combine information from these three sources and study aerosols and their impact on climate. Kaufman's group is particularly interested in sorting out the anthropogenic portion — that

portion due to human activities.

He showed a sample MODIS aerosol product, which is able to distinguish aerosol amount and aerosol type by separating out fine and coarse particles. Next, he showed a movie comparing GOCART data to MODIS data. Over time, GOCART data begin to look very similar to the MODIS data. Data from AERONET also match very well with data from MODIS.

Kaufman also discussed how to derive a measurement based on aerosol direct radiative forcing. They use data from MODIS and GOCART to distinguish anthropogenic smoke and pollution aerosol from dust and sea salt. Based on this result, they can calculate aerosol direct radiative forcing over the ocean.

Jun Li (University of Wisconsin, Madison) spoke about integration of MODIS, HIRS, and AMSU data for atmospheric studies. MODIS data led to considerable improvement in the accuracy of atmospheric products. Li showed a progression of satellite images that highlights how the resolution of instruments continues to improve. Using the multispectral radiance information, clouds are well separated into classes. Li described the algorithm used, which is based on statistical followed by physical retrieval. The new algorithm does improve the accuracy of the retrievals. In an attempt to further improve the data Li has also combined the data from MODIS with data from the Atmospheric Infrared Sounder (AIRS), the Advanced Microwave Sounding Unit (AMSU), and the Humidity Sounder for Brazil (HSB) on Aqua.

Dorothy Hall (GSFC) discussed the use of MODIS snow and ice maps in modeling studies. More accurate global scale measurements of snow-cover are needed in order to validate the models. Additionally, it is important to measure fractional snow-cover because models are becoming increasingly more sophisticated.

Hall discussed the MODIS climate modeling grid (CMG) product that has a resolution of 0.05°, or about 5 km at the Equator and is a daily and an 8-day composite product. This product is developed from 500-m MODIS snow maps. Fractional snow-cover information is available (1-100%) in each CMG cell.

Hall proceeded to discuss the Catchment-based Land Surface Model (CLSM) that is coupled to a snow physics model and can capture sub gridscale snow-cover, and the European Centre for Medium-Range Weather Forecasting — Hamburg Version 5 (ECHAM-5) GCM. MODIS will contribute monthly snow-cover and sea-ice maps that will be used to validate ECHAM-5.

In closing, Hall stated that information on snow water equivalent (SWE) is even more valuable than snow-cover maps. A future product could combine the good resolution of the MODIS snow-cover products with information on snow water equivalent derived from the Advanced Microwave Scanning Radiometer for EOS (AMSR-E).

David Edwards (National Center for Atmospheric Research [NCAR]) spoke about combining MOPITT and other satellite data to investigate transport and ozone chemistry in the troposphere. This was illustrated using examples of MOPITT carbon monoxide (CO) data in conjunction with *in situ* measurements taken during the Transport and Chemical Evolution Over the Pacific (TRACE-P) field campaign in Spring 2001.

Edwards described what he referred to as the "Tropical Tropospheric Ozone Paradox." In the early part of the year, regions of high tropospheric O_3 derived from Total Ozone Mapping Spectrometer (TOMS) measurements over the tropical Atlantic don't coincide with biomass burning observed by satellite in northern Africa. MOPITT CO data have been used to investigate transport of emissions from these fires. Measurements from the Global Ozone Monitoring Experiment (GOME) on the European Remote Sensing Satellite (ER-2) have also been used to indicate high concentrations of oxides of nitrogen (NO_x), another O_3 precursor.

Edwards went on to show some other examples of recent MOPITT observations. He showed images of the 2002 fires in the Western U.S. He correlated MODIS images that show the smoke with MOPITT images that indicate areas of high CO. As the fires worsen, the areas with high CO concentration increase and produce plumes that are transported long distances. Edwards indicated that using MOPITT and MODIS together offers the possibility of combining CO and fine/coarse particle measurements to examine the chemical origin and transport of anthropogenic aerosol.

Anne Kahle (Jet Propulsion Laboratory [JPL]) discussed ASTER applications. Kahle ran through numerous applications where ASTER data are being used and showed many colorful examples. Applications include studies of: surface energy balance, geology, wildfires, natural disasters (the La Plata, MD, tornado, floods in China), urban environmental monitoring, global land ice measurement,

volcanoes, water quality, and forest clear cutting.

Kahle concluded by reminding the group that ASTER data should be free to NASA investigators. If you are a NASA investigator and not on the list of free recipients, then please contact Kahle or someone on the ASTER team and let them know.

DAY TWO: November 19, 2002

Session III: ***Validation and New Science Results from Aqua*—Claire Parkinson**, Aqua Project Scientist, Goddard Space Flight Center, Chair

Claire Parkinson (Aqua Project Scientist; GSFC) reported on Aqua's early on-orbit progress. Aqua was successfully launched on May 4, 2002, then underwent a 120-day checkout period that ended on September 1. Parkinson described, in order, the turning on of each of Aqua's six instruments and illustrated, for each, some of the results that have been obtained so far by the Aqua science teams.

Parkinson showed early images from AMSU and HSB, including imagery of thunderstorms over Texas from June 16, using several channels penetrating to different depths in the storms. The AIRS Science Team has taken these data and those from other regions to map precipitation rates. One exciting new result with the AMSU/HSB data is the use of these data to track snowstorms in the Arctic. Calibration issues remain, especially in the snow rates, but the initial results are encouraging.

The Advanced Microwave Scanning Radiometer for EOS (AMSR-E), provided by Japan, was initially activated in its science mode on May 24. Parkinson showed a global sea-surface temperature map created by NASDA just days after the AMSR-E began operating, plus a nighttime image of a July 4 typhoon in the East China Sea. AMSR-E is providing the highest resolution passive microwave imagery to date, even allowing the identification of individual sea-ice floes.

The Atmospheric Infrared Sounder (AIRS) began transmitting visible/near-infrared data on May 26 and the main infrared data on June 12. The instrument has 2382 channels, and Parkinson showed an AIRS spectrum from off the coast of South Africa, provided to her on June 13 by the AIRS Team Leader, Mous Chahine. This spectra established the successful functioning of all 2378 of the AIRS infrared channels; the four visible/near-infrared channels are also working, although are not shown in the same spectra.

The two Clouds and the Earth's Radiant Energy System (CERES) instruments on Aqua were activated on June 18, one day after the spacecraft reached its final, 705 km operational altitude. Parkinson showed global maps of CERES longwave and shortwave fluxes for June 22, and then side-by-side October 1 longwave and shortwave maps centered on Hurricane Lili in the Gulf of Mexico.

The Moderate Resolution Imaging Spectroradiometer (MODIS) was the last of the six Aqua instruments to be activated into its science mode, with this taking place on June 24. A key first light image was a view of fires burning in Australia on June 24, and another was a chlorophyll map for the following day, from the MODIS Ocean Group. The high quality of both these images was highlighted as illustrative of the advances made by the MODIS Team, the MODIS manufacturer, and the data processing system since the launch of the first MODIS, on the Terra spacecraft. Combining data from MODIS on Aqua and Terra will improve the quality of many products, and Parkinson illustrated this with two examples: the Bidirectional Reflectance Distribution Function product and the Chlorophyll product.

Parkinson closed by stating that all six Aqua instruments are sending back high-quality data, and all are contributing to the Aqua mission goals of enhanced understanding of the global water cycle, enhanced understanding of the Earth's climate system, and improved weather forecasting.

Roy Spencer (University of Alabama in Huntsville) spoke briefly about monitoring climate variability with Aqua's AMSR-E. He gave an AMSR-E instrument update and touched on some of its applications. As stated in the previous talk, AMSR-E provides the highest spatial resolution ever obtained by a passive microwave sensor. This allows for much higher resolution in sea-ice, snow-cover, soil moisture, and precipitation studies. Global images of radio frequency interference (RFI) sources at 6.9 GHz, and of new vegetation-sensitive and soil-moisture sensitive parameters, were also shown.

Frank Wentz (Remote Sensing Systems) reported on AMSR-E on-orbit calibration and early science results. AMSR-E has a "hot load" problem, meaning that there are large temperature gradients within the load. The team puts geophysical parameters from existing satellites into a radiative-transfer model, and uses simulated

AMSR-E observations to provide an Earth calibration point. Wentz showed the suite of ocean products from AMSR-E, including sea-surface temperature (SST), wind, water vapor, cloud, and rain. He also showed some initial validation results. AMSR-E SST was compared to Reynolds Optimum Interpolated (ROI) SST, and the wind speed was compared with the Special Sensor Microwave Imager (SSM/I), TRMM Microwave Imager (TMI), and QuikSCAT. A complete daily map of SST with no holes is produced each day. Using this information, they can study SST cold wakes in the aftermath of hurricanes. They can also undertake air-sea interaction studies. To conclude, Wentz showed an animation that depicted SST gradients.

Joey Comiso (GSFC) discussed new sea-ice cover results from AMSR-E, along with the scientific motivation for these studies. AMSR-E continues the time series of sea-ice measurements and gives better accuracy. Comiso reviewed the characteristics of the AMSR-E instrument. He showed the general consistency in the retrieved ice concentrations from AMSR-E and SSM/I data. Clearly AMSR-E is superior to SSM/I because of higher resolution. Comiso also showed that AMSR-E data are more effective than SSM/I data in masking incorrect retrievals in open ocean areas. He also discussed cloud-cover effects and presented a new Ice Temperature data product that is currently obtainable only from AMSR-E.

Tom Jackson (U.S. Department of Agriculture) made a presentation on the Soil Moisture Experiments (SMEX). Jackson discussed the objectives of SMEX and noted that the next field campaign is planned for 2003. It is designed to study agricultural crops, multiple scales, and land-atmosphere interaction. He discussed sampling strategy to accommodate multiple scales. Jackson presented a short review of the most recent field campaign, which took place June 25-July 12, 2002, in Iowa. He focused on results from the numerous aircraft flights that took place over the study region, explained how AMSR-E data are also being used, and he also discussed the RFI issues. He feels that significant contamination issues will need to be resolved in order to use AMSR-E to make soil moisture measurements in North America. The next experiment in this series will take place in 2003. Three U.S. sites have been selected and a fourth site in Brazil.

Richard Armstrong (University of Colorado, National Snow and Ice Data Center [NSIDC]) discussed the blending of MODIS and AMSR-E data for enhanced snow-cover monitoring. Armstrong showed examples of the spectral signatures of bare soil compared to snow. Armstrong pointed out that most existing algorithms are regional, and thus are not appropriate for use at the hemispheric scale. NSIDC has developed an algorithm that is applicable at the global scale. He reported that the AMSR-E and MODIS blended product, which combines the particular advantages of optical and passive microwave, will be developed as a research product this year and will be available as a standard product in 2003.

Moustafa Chahine (JPL) gave an update on AIRS/AMSU/HSB performance and early results. To quote the speaker, "AIRS is doing fantastically well." AIRS will obtain images but clearly its main focus will be on studies of the infrared spectrum. It is expected that fields such as numerical weather prediction and spectroscopy will benefit from the data retrieved by AIRS.

Chahine proceeded to discuss the impact that the presence of clouds has on infrared retrievals. He showed that less than 5% of AIRS footprints are "cloud free" according to AIRS clear window channel at 2616 cm^{-1}, at night in nadir viewing over oceans. He showed the ability of AIRS-AMSU-HSB to recover "cloud-cleared" infrared spectra in the presence of clouds in all AIRS footprints and compared results with spectra from cloud free regions in the neighborhood.

George Aumann (JPL) discussed the first SST measurements from AIRS using the 2616 cm^{-1} super window channel and the 2607 cm^{-1} weak waterline channel. A comparison of the AIRS SST with the SST produced by the National Centers for Environmental Prediction (NCEP) shows a global average cold bias of 0.4 K, close to the cold bias expected between the skin and the bulk temperature. The ability to measure the (skin-bulk) gradient from space has very interesting implications for weather forecasting and climate research.

Mitch Goldberg (NOAA) gave a presentation on initial retrievals from AIRS. He reviewed AIRS-related activities at the National Environmental Satellite Data and Information Service (NESDIS). There has been excellent collaboration between NASA and NOAA. Goldberg discussed risk reduction benefits. He stressed that assimilating AIRS data is a very high priority for the NOAA/NASA/DOD Joint Center for Satellite Data Assimilation. He then reviewed the Numerical Weather Prediction

(NWP) Users and the NWP AIRS Products.

To close, Goldberg ran through a series of slides to show how accurate the various parameters in the model are. He showed that there are major deficiencies in the NWP moisture field, which AIRS should be able to correct.

Joanna Joiner (GSFC) discussed AIRS and data assimilation. She discussed a four-step process wherein a real-time data set is defined, radiance monitoring is performed, algorithms are developed, and data are assimilated and evaluated.

Joiner pointed out ongoing Data Assimilation Office (DAO) collaborative work with other government agencies, including the Joint Center for Satellite Data Assimilation (JCSDA) and the Earth Science Modeling Framework (ESMF), with objectives that include accelerating the use of new satellite data in operational numerical weather prediction.

Bruce Wielicki (LaRC) spoke on merging Terra and Aqua CERES data products. He began by showing some data from CERES on Aqua and then went over the Aqua CERES data status. The CERES instruments on Terra and Aqua have been intercalibrated in orbit.

Wielicki touched on some of the CERES team's recent work, which includes a Comparison of Observed Decadal Tropical Radiation Variation with Current Climate Models. CERES new Angular Distribution Models (ADMs) allow for studies of cloud radiative properties of specific cloud types. The new ADM flux data have been used to test the Iris hypothesis using a wide range of ice cloud definitions, but all cases confirmed that the Iris, if present at all, appears to be a small positive feedback, not a large negative feedback. Major improvements were still found to be necessary for cloud height, longwave flux, and especially for cloud albedo.

Session IV: ***Validation and New Science Results from Recent Missions***—**Marc Imhoff**, ESSP Project Scientist, Goddard Space Flight Center, Chair.

Byron Tapley (University of Texas Center for Space Research) gave an update on the Gravity Recovery and Climate Experiment (GRACE), the first ESSP mission on orbit. This mission responds to over 30 years of demands for a mission to map the global gravity field and study the time-variable changes in gravity.

Tapley briefly reviewed the science goals of GRACE, the mission systems, and the orbit details. He pointed out some of the key enabling technologies that make the mission possible, and showed some preliminary results from GRACE. The GRACE satellites provide highly accurate and homogeneous gravity measurements that cover the Earth every 30 days. So far the data obtained from GRACE provide a gravity model whose accuracy for wavelengths longer than 500 kilometers is an order of magnitude greater than the pre-GRACE models could obtain. Two orders of magnitude further improvement in gravity model accuracy is anticipated before the mission is finished.

Pat McCormick (Hampton University) showed some Meteor 3M/SAGE III early results. He showed zonal means of stratospheric aerosol optical depth (SOD) and pointed out that the SODs are the lowest ever measured. He also showed ozone trend data from SAGE II.

McCormick then reviewed the solar and lunar occultation technique as employed by SAGE III, and described details of the instrument. Lunar occultation gives SAGE III the ability to look at nighttime chemistry, which SAGE II was not able to do. The validation phase for SAGE III is ongoing. McCormick showed numerous comparisons, and indicated that initial results are very encouraging, matching very well with previous instruments, and will be able to continue, at least over the latitudes that SAGE III/METEOR 3M measures, the long-standing time series of ozone and aerosol measurements that are used to study trends.

Bruce Haines (JPL) reported on Jason-1 initial data and results. Jason-1 is a joint U.S./French follow-on mission to the venerable TOPEX/Poseidon (T/P) mission. Jason-1 was launched from Vandenberg Air Force Base on December 7, 2001. Haines discussed the scientific payload and the orbit of Jason-1. Jason-1 and T/P actually flew in formation for 7 months. Haines also described an experimental system that provides accurate (5 cm RMS) sea-surface height information from Jason-1 with 3-5 hour latency, enabling near real-time studies of the global ocean.

With the Jason-1 data meeting or exceeding all mission requirements, the precise geophysical data records will be broadly released beginning in February 2003. To continue the legacy of precise ocean altimeter measurements from space, the Ocean Surface Topography Mission (OSTM) is planned for a 2006 launch.

David Starr (GSFC) reported on the Cirrus Regional Study of Tropical Anvils and Cirrus Layers-Florida Area

Cirrus Experiment (CRYSTAL-FACE) field campaign in July 2002. The CRYSTAL-FACE addresses many key ESE science questions. Six aircraft were involved in the campaign with two of them serving as state-of-the-art satellite simulators. Two ground sites — east and west — were also chosen. There was also a very strong theoretical component, with modelers and forecasters on hand, that was well integrated into the daily operations.

Starr reviewed the instrumentation on the ER-2 aircraft used during the study in some detail and then briefly reviewed instrumentation on the other aircraft. Starr indicated that future plans include involvement in the Tropical Composition and Climate Coupling Experiment (TC3) campaign (planned for EOS Aura validation) and for a CRYSTAL-Tropical Western Pacific campaign. It is anticipated that data from the A-Train satellite formation will be very helpful in the future campaigns.

Session V: ***NASA's Earth Science Applications Strategy and Recent Accomplishments*—Ronald Birk**, Director of the Applications Division–NASA Headquarters, Chair

Ronald Birk (NASA HQ, Code YO) presented an overview of the Earth Science Enterprise Applications Strategy. The strategy for applying the results of NASA's Earth Science research and development is based on a "systems approach." The Earth Science Applications Program is establishing and/or expanding interagency agreements with NOAA, USGS, FEMA, EPA, USDA, USGS, DHS, CDC/NIH and DOT to work to systematically benchmark the use of NASA results in the decision-support tools being employed to deliver information services to our nation.

Birk shared more detailed information about a couple of the selected applications. Birk then reviewed some of the expectations and gave some specific examples where this approach has been shown to be effective, including the areas of: Wildfire management with the U.S. Forest Service (MODIS Rapid Response), hurricane predictions with NOAA, and establishing guidelines for aviation safety with the Radio Technical Committee of Aeronautics (RTCA). The gaps in measurements supporting models and decision systems define requirements for next generation science data; the process continues.

Greg Stover (LaRC) spoke about the Geosynchronous Imaging Fourier Transform Spectrometer (GIFTS), a revolutionary forecast tool. The GIFTS mission is the next scheduled New Millennium Program (NMP) mission. Like all NMP missions, GIFTS is to demonstrate technology and point the way toward future missions. Stover reported that GIFTS is a very high spectral resolution measurement that will obtain infrared measurements and soundings at the rate of 80,000 soundings a minute. Stover showed examples of the operational mode for GIFTS. He reported that there already has been some water vapor validation and showed a simulation of the data that will be collected. Stover ended by mentioning some specific applications for GIFTS data including: flight level wind measurements, convection initiation, aviation turbulence, in-flight icing, and oceanic weather prediction.

Ed Sheffner (NASA HQ, Code YO) discussed the applications objective of a carbon management regime. Such a regime would be based on the understanding of carbon exchange mechanisms, dynamics, and sources and sinks from research sponsored by NASA and other organizations. Sheffner showed a diagram of the carbon cycle exchange and pointed out some of the key questions and uncertainties in this process.

Carbon management was identified as a national application area within the Applications Division of ESE because it is a subject that meshes well with the NASA vision and mission. New technologies are the only way to reduce CO_2 in the atmosphere in the long term. Sequestration of carbon may reduce the rate of increase in atmospheric CO_2 in the near term. An approach is needed that blends different responses. Sheffner discussed the resources that NASA's ESE can bring to this discussion. The carbon application area provides an opportunity for the science community to extend its research into decision-support tools for issues of national importance.

Nancy Maynard (GSFC) presented a summary of the applications of NASA Earth science data and information to public health issues. She outlined a roadmap for moving NASA ESE observations, data, and research results into interdisciplinary research projects with health partners whose collaborations ultimately feed results into public health users and relevant decision-support systems.

Maynard outlined a number of examples of ongoing and potential applications of Earth science data to a variety of real and potential public health threats, such as infectious and vector-borne diseases including West Nile virus, malaria, Rift Valley fever, Ebola, St. Louis encephalitis, dengue

fever, meningitis, and filariasis. In addition, she described other ongoing or planned applications of NASA data to important health issues such as transport of African/Asian dust, contaminant transport in the Arctic, UV radiation, air- and water-quality issues, and problems related to oceans, water, and extreme weather.

Lawrence Friedl (NASA HQ) reported on the impacts of global monitoring on regional air-quality management. Friedl discussed overall benefits of this application in terms of policy, assessment and management and showed the 10-year roadmap for systematically employing NASA Earth observing systems and science results to serve Air Quality Management.

The observations and predictions resulting from NASA Earth science research can be used to assess global and regional transport of pollutants. Some other useful applications of NASA Earth science measurements would include improving the initiation and transport of emissions for input into compliance models and providing more accurate boundary conditions for air-quality models.

Friedl ended with a discussion of the Earth Science Applications Program's goals and activities; there are questions associated with each goal. He reviewed plans for FY '03 and '04 and pointed out that the plan is building toward the availability of EOS Aura products. He also reviewed the partners in this application, both within NASA and between federal agencies.

Steve Ambrose (NASA HQ) discussed the impacts of Earth observing satellites on decision-support systems serving Disaster Management, and went over the NASA approach to disaster management. They have sponsored Solid Earth and Natural Hazards Applications Research and have funded ten new proposals this year

Ambrose reported that over 100 projects are nearing completion. He discussed remote sensing and geospatial technologies including Open GIS. He also discussed some specific applications that have benefited from these new technologies, including an example where QuikScat and TRMM measurements have allowed for improvement in the accuracy of hurricane prediction and hurricane track.

The decision-support system being used for this application is the Natural Hazard Loss Estimation Methodology resident in the Federal Emergency Management Agency's (FEMA) Natural Hazard Loss Estimation Model for the U.S. (called HAZUS). It is used to determine the risk assessment caused by the impact of natural disasters. Ambrose also outlined the progress that is expected over the next decade in this area.

Roger King (NASA HQ) spoke about critical aspects of interoperability for systems solutions using Earth science results. Interoperability is at the core of much of what is being shared in this session. King defined interoperability as the capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units.

King discussed standards that are important to NASA, such as Open GIS (*www.opengis.org*) and the Federal Geographic Data Committee (FGDC) (*www.fgdc.gov*). New missions need to be designed with these standards in mind. Quite a few products produced by the ESE are already compliant with these standards and King listed them. King pointed out the specific example of HDF-EOS. NASA's activity with these organizations is coordinated through the Geospatial Interoperability Office (GIO) at GSFC.

DAY THREE: November 20, 2002

Session VI: ***New Findings with Forcings and Feedbacks in the Earth System***—**Berrien Moore** III, University of New Hampshire, Chair

Kingste Mo (Climate Predication Center [CPC]) gave a presentation on forecasting seasonal hurricane activity in the Atlantic. Both the analogue method and the ensemble canonical correlation prediction method are used to forecast seasonal hurricane activity from August-September-October (ASO). To determine a forecast, the conditions for the three-month period preceding ASO — May-June-July (MJJ) — are used as input. In addition to forecasts of hurricane activity, the CPC also monitors the atmospheric and oceanic conditions in the Atlantic associated with the hurricane activity from May thru November. Satellite data are being used for monitoring these conditions, including data on: infrared temperature, low level winds, water vapor flux, and outgoing longwave radiation.

J. Marshall Shepherd (GSFC) showed evidence of urban influence on rainfall patterns. They use Tropical Rainfall Measuring Mission (TRMM) data in their analyses and study rainfall anomalies downwind of urban centers. The particular emphasis for this study was on Houston, Texas; however,

Shepherd and his team are conducting studies in Atlanta, GA; Oklahoma City, OK; Tokyo, Japan; Johannesburg, South Africa; and Brasilia, Brazil.

Shepherd stated that an area is defined as an "upwind control region" and a "downwind" (urban impacted) region. For Houston, the location of the downwind area moves throughout the year as the prevailing wind patterns change. A rainfall anomaly downwind of Houston does show up fairly distinctly in the TRMM data as well as in the rain gage data. Effort is now being directed toward improving the parameterization of the land surface in the Fifth-Generation NCAR/Penn State Mesoscale Model (MM5) model so it can be used to study this urban influence in greater detail.

Menglin Jin (University of Maryland) presented on assessing human impacts on the climate system. To open, she showed a series of maps showing the rather dramatic growth of the human population over the last few centuries. Jin's work is an attempt to separate human induced changes from natural changes. She showed data that illustrate that most urban centers are in the Northern Hemisphere from 30 to 70°. The skin temperature observed over urban areas tends to be higher than in surrounding crop land. Also, the urban heat island influence tends to be more significant at night and in winter.

Urbanization also impacts surface properties, tending to reduce surface albedo and emissivity. It also changes atmospheric properties, and impacts aerosol optical depth and other important parameters. Jin showed data that hinted that there might be a weekly cycle of optical depth that seemed higher toward the end of the workweek and leveled off over the weekend. Certainly, much more work is needed to reach definitive conclusions. Future work will build on what has already been done.

Lori Glaze (Proxemy Research) reported on the EOS Interdisciplinary Science Team's (IDS) project "The Effects of Volcanism on the Environment." This IDS study focuses on four different volcanoes: Kilauea in Hawaii, Masaya in Nicaragua, Poas in Costa Rica, and Stromboli in Italy. Glaze pointed out that smaller eruptions that continue for extended periods of time (i.e., a low level of activity persisting for decades) are every bit as important as big eruptions like Pinatubo. These volcanoes are characterized by persistent low level emissions (at most a few thousand tons of sulfur dioxide per day) and there are significant health issues associated with these emissions. She spoke briefly about activities at each of these sites and closed by discussing some future plans and next steps for the program.

Matthew Hansen (University of Maryland) presented results from an integrated study of global vegetation cover. Hansen showed a MODIS product depicting Vegetation Continuous Fields. He then showed a subset, which gave a more detailed look at a smaller area. Tree cover is the most mature MODIS product and is one layer of the continuous fields.

Hansen discussed the problem of trying to assess the total amount of forest cover and how continuous fields help respond to this problem. Continuous fields allows for a standardized way to determine the amount of forest cover on a global scale. The technique also allows for unbiased change studies—automated determination of change instead of "expert" opinions. Hansen next spoke on the use of high-resolution and very-high-resolution data for these studies. Hansen ended by briefly mentioning two applications for high-resolution data: Carbon flux studies and ecoregion level monitoring.

Timothy Liu (JPL) presented some recent applications of scatterometer data. He reported that the ADEOS II instrument will be identical to the one currently in orbit on QuikSCAT. Liu reported on results from three different studies showing how typhoons at sea can actually enhance life through increasing biological productivity and taking up carbon dioxide; these processes have significant impacts on local fisheries and on global warming. Observations from QuikSCAT, TRMM, and SeaWiFS are combined in this study. In the second study, Liu showed results demonstrating extensive double intertropical convergence zones, using data from QuikSCATand TRMM, and postulated two different mechanisms governing air-sea interaction. In the third study, Liu reported on possible intra-decadal trends in global winds and meridional (north-south) heat transport in the ocean driven by winds.

Max Suarez (GSFC) spoke about land surface initialization for seasonal forecasts of precipitation and temperature. He began by looking at the science questions that this study attempts to answer, the approach used, and progress to date. He referred to this technique as a "Poor Man's" Land Data Assimilation System (LDAS). It is an approach to study how soil moisture initialization affects seasonal forecasts. Suarez gave a summary of how the model improves with correct soil moisture. He did a model-versus-

model comparison and also compared the model runs to actual data. He also discussed some potential error sources.

Michael Jasinski (GSFC) presented an overview of the Cold Land Processes Experiment (CLPX), a two-year winter hydrology experiment taking place in the Rocky Mountains of Colorado. The goal is to develop the necessary database and test a range of sensors eventually to put together a proposal for an Earth System Science Pathfinder mission.

Summary results were presented from the first two field campaigns that occurred in February (dry snow) and March (wet snow), 2002, involving numerous universities and agencies. Ground and aircraft efforts were concentrated in three distinct "meso-cell" study areas. Results were presented from Gamma and Microwave radiometry, radar polarimetry, and radar interferometry and how they compare to snow depth, snow density, and snow grain size in the three meso-cell regions.

Two additional campaigns are planned for February and March 2003. Field data will be analyzed in conjunction with AMSR-E observations obtained from the Aqua platform. Additional CLPX information can be obtained from: *www.nohrsc.nws.gov/~cline/clp.html*.

David Noone (California Institute of Technology) spoke on the influence of arctic sea-ice on the tropospheric and stratospheric circulation, the polar vortex, and ozone: an IDS approach to climate change. Noone showed model results that contrast Arctic conditions in the summer and winter. He also showed results from a general circulation model simulation to indicate how the climate responds to sea-ice removal. He also discussed the influence of variability in both the troposphere and stratosphere. A weaker polar vortex, as predicted by the model, is coincident with reduced meridional overturning in the stratosphere. Noone ended by emphasizing the important role that EOS data are playing in this analysis. The long time series of sea-ice and ozone data are very important in this type of analysis because of the subtle nature of the climate system response.

Jean Dickey (JPL) presented on recent Earth oblateness variations: causes and implications. She discussed the concept of Postglacial Rebound (PGR), which is the result of the Earth's response to the weight of glacial ice that accumulated during the last ice age being removed. This PGR phenomenon has been the main cause of the general downward trend in oblateness (departure from a spherical shape) that persisted until 1997, where research indicates that oblateness is beginning to increase.

Dickey reviewed a number of possible sources for this reversal in oblateness. Ocean bottom pressure studies reveal that the Tropical Pacific/Indian Ocean could be making a significant contribution to the observed departure from linearity. Most of remaining nonlinearity is accounted for by sub-polar glacier changes. Data from the GRACE mission are eagerly anticipated and are expected to contribute much to our understanding of climate.

The SORCE (SOlar Radiation and Climate Experiment) Satellite Successfully Launched

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The SOlar Radiation and Climate Experiment (SORCE) satellite was successfully launched on Saturday, January 25, 2003, from Kennedy Space Center (KSC) in Cape Canaveral, Florida. SORCE is one element of NASA's Earth Observing System (EOS), and is measuring solar radiation at the top of the Earth's atmosphere. This mission is a joint effort between NASA and the Laboratory for Atmospheric and Space Physics (LASP) at the University of Colorado, Boulder. LASP has full programmatic responsibility for this 5-year mission to further understand the influence of the Sun on the Earth system.

In near-perfect weather, SORCE was launched Saturday, January 25, from a Pegasus XL rocket provided by Orbital Sciences Corporation. The Pegasus was carried to 40,000 feet and dropped by an L-1011 aircraft carrier, also from Orbital. With the plane approximately 120 miles southeast of Cape Canaveral over the Atlantic Ocean, the KSC Operations Center gave the command to release the Pegasus and it went into a 5-second free-fall before the first of three stages ignited. Stage 2 ignited 90 seconds later, and Stage 3 completed the launch into orbit by igniting about 7 minutes later. Spacecraft separation occurred at 3:24 p.m. Eastern Standard Time. It was a perfect launch with no unexpected events.

The L-1011 and the Pegasus climbing to 40,000 feet — the elevation required for the drop.

The first signal from SORCE came through within seconds of separation via the NASA Tracking and Data Relay Satellite System (TDRSS). A high data rate contact was successful about 20 minutes later through a ground station in Hartebeesthoek, South Africa. The initial checkout and verification after launch showed the spacecraft to be in excellent shape. Within the first hour of the launch, SORCE was in Sun pointing mode, the solar arrays were deployed, and all systems were operating well.

The weeks following the launch were filled with commissioning activities for the spacecraft and instruments. During a three-week out-gassing period to reduce self-contamination, the instruments were sequentially powered up and tested. Instrument and spacecraft safety were given the highest priority during activation. By the end of February, all instrument doors were open, and science operations had begun. The first science data are expected to be released approximately two months after the launch or by late March.

Mission and Science Operations

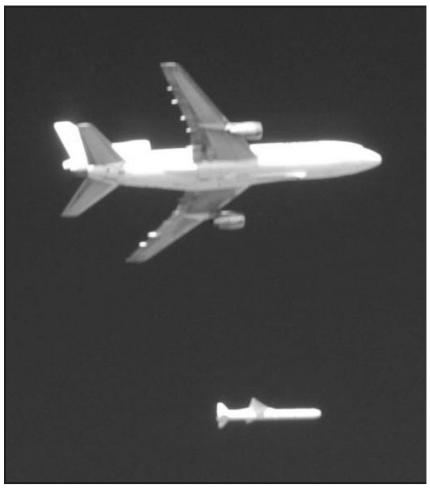
The SORCE satellite is orbiting the Earth every 96 minutes, or 15 times daily. Ground stations at Wallops Island, Virginia and Santiago, Chile are providing the communication links to the satellite two times each day. For the next five years, and hopefully much longer, LASP will continue to operate SORCE from its Mission Operations Center (MOC) in Boulder, Colorado. The MOC provides the computer hardware and software necessary to conduct real-time spacecraft operational activities, including command and control of the satellite, mission planning, and assessment and maintenance of spacecraft and instrument health. The science operations from the MOC include experiment planning, data processing and analysis, validation, and distribution of the finished data product.

Within 48 hours of data capture, all instrument science data and spacecraft engineering data are processed to derive Level-3 science data products in standard geophysical units (W/m^2 or $W/m^2/nm$). The Level-3 data consist of daily and 6-hour average solar irradiances, with higher time resolution data available to meet secondary

science objectives, such as studying the passage of bright faculae and dark sunspots across the visible surface of the Sun. All validated data (both Level 0 and Level 3) are delivered to the Goddard Space Flight Center Earth Sciences Distributed Active Archive Center (GDAAC) for distribution and long-term storage.

The SORCE instruments are taking Total and Spectral Solar Irradiance (TSI and SSI) measurements, which are used to produce two principal data products. The spectral solar irradiance data from SORCE are delivered as a file for each day of observations. The Total Solar Irradiance (TSI) data are a much smaller size and, to maximize ease of use to end-users, each delivered TSI product contains daily science results for the entire mission. Updates to TSI data occur monthly.

Science data processing is performed automatically within 24 hours of data reception, and a preview release of science data is made available to the public within 48 hours, following preliminary data inspection. Appropriate corrections for some time-dependent processes (such as instrument degradation correction) require in-flight calibration data from several months into the future; therefore the daily production of science products beyond provisional quality will lag by a period of several months. This results in two streams of data being created on a daily basis: the provisional stream of preview data that are available within 48 hours, and a secondary stream of finished validated data that supersede the preview data a few months after the initial preview release. The preview SORCE data are sent to the Goddard DAAC within 48 hours of reception, and the finished validated data products are sent to the Goddard DAAC approximately four months after initial data reception. All SORCE data products can be accessed via the DAAC web site at *daac.gsfc.nasa.gov/DAAC_DOCS/gdaac_home.html*.



The Pegasus is dropped and goes into a 5-second free-fall before igniting

Science Objectives

NASA's Earth Science Enterprise includes a space-based component consisting of a constellation of satellites to monitor the Earth system from space. These sustained and comprehensive observations include the measurement of solar irradiance as the dominant direct energy input to land, ocean, and atmosphere. The SORCE observations will facilitate a better understanding of the Sun and its impact on the Earth. The SORCE mission is:

- establishing a data set of Total Solar Irradiance (TSI) to continue a long-term record, with an absolute accuracy better than 100 ppm (1σ) and a relative accuracy between measurements of 0.001% (10 ppm) per year;
- establishing a data set of solar spectral irradiance from 1 nm to 2000 nm (excluding 31-120 nm, which is not covered by SORCE instruments, but covered by the TIMED SEE instrument) with an absolute accuracy of 2% to 5% in the ultraviolet, and 0.03% in the visible to near infrared; and
- improving our understanding and generating new inquiry by studying how the variable solar irradiance affects our atmosphere and climate, and how and why variability occurs at the Sun. This knowledge will then be used to estimate past and future solar behavior and climate response.

SORCE Instruments

All of the instruments onboard SORCE were developed, built, calibrated, and tested at LASP, and were reviewed in detail in the May/June 2002 issue of *The Earth Observer*. They are the Total Irradiance Monitor (TIM), the Spectral Irradiance Monitor (SIM), two Solar Stellar Irradiance Comparison Experiments (SOLSTICE), and the X-ray Photometer System (XPS). TIM, SIM, and SOLSTICE are measuring solar irradiance and the solar spectrum to help scientists understand the Sun's role in climate change. The XPS measures high-energy radiation from the Sun as a prime indicator of solar activity, such as flare events.

SORCE provides precise daily measurements of the TSI with the TIM instrument, as well as the spectral solar irradiance (SSI) at wavelengths extending from the far ultraviolet to the near infrared with the SOLSTICE, SIM, and XPS instruments. TIM monitors changes in incident sunlight to the Earth's atmosphere via an ambient temperature active cavity radiometer. Using a new development that incorporates state-of-the-art technologies in its Electrical Substitution Radiometers (ESRs), TIM

measures TSI to an absolute accuracy of 100 ppm, where 100 ppm = 0.0001.

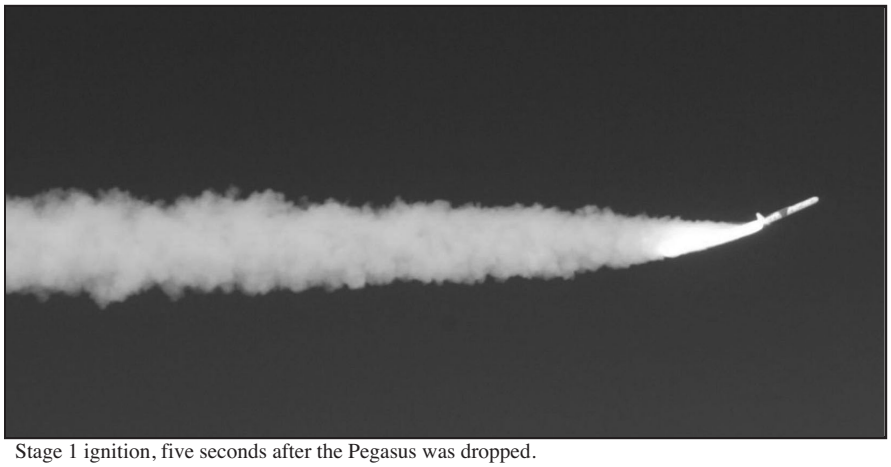
The newly developed SIM instrument incorporates an entirely different technique to make the first continuous record of the top of the atmosphere spectral solar irradiance in the visible/near-infrared region. It uses a prism as the self-calibrating, single optical element and a miniature absolute ESR as the primary detector. This instrument has a measurement requirement of 0.03% absolute accuracy and a precision and long-term relative accuracy of 0.01% per year. The SIM instrument measures spectral irradiance from 200 to 2000 nm.

There are two identical SOLSTICE instruments on SORCE to measure spectral irradiance from 115 to 320 nm, with a spectral resolution of 0.1 nm. These instruments are an evolution and refinement of the Upper Atmosphere Research Satellite's (UARS) SOLSTICE, and they observe bright blue stars as a long-term calibration standard. Previous solar measurements show that far-ultraviolet irradiance varies by as much as 10% during the Sun's 27-day rotation, while the bright 121.6 nm hydrogen Lyman-α emission may vary by as much as a factor of two during an 11-year solar cycle.

The XPS instrument measures the very energetic EUV and soft x-ray flux, where the solar variability exceeds a factor of two. Its precision and relative accuracy requirements are, therefore, on the order of ±10%. It measures broadband spectral irradiance from 1 to 34 nm, and is designed similar to the XPS on the TIMED (Thermosphere-Ionosphere-Mesosphere Energetics and Dynamics) satellite. The XPS extends the solar XUV irradiance measurements with improved accuracy, spectral range, and temporal coverage. The solar XUV radiation is emitted from the hot, highly variable corona on the Sun, and these high-energy photons are a primary energy source for heating and ionizing Earth's upper atmosphere.

Understanding the Sun

The SORCE research and data collection are very important for ongoing and future EOS science. There is much that we will learn about the Earth's radiation and energy balance through continuous TSI measurements. However, global energy balance considerations alone likely do not provide the entire story, and how TSI variations are distributed in wavelength will be critically important in understanding the Earth's response to solar variations. The Sun has both direct and indirect influences on the terrestrial system, and SORCE's comprehensive total and spectral solar measurements will provide the requisite understanding of this important climate system variable.



Stage 1 ignition, five seconds after the Pegasus was dropped.

SORCE Data Validation

A SORCE Instrument and Data Validation Workshop will be held April 28-30 to review the initial data coming from the instruments. This meeting will concentrate on the first results and plans to refine data processing and validate the irradiance data. For additional information, please contact Vanessa George at LASP, *vanessa.george @lasp.colorado.edu*.

Acknowledgements

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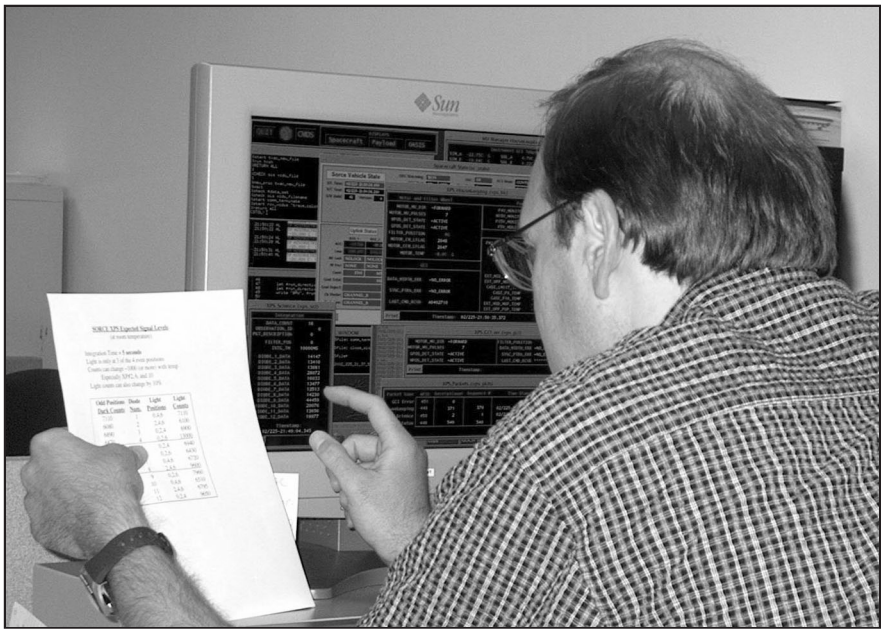
- **LASP, University of Colorado, SORCE Team Members**: Jerry Harder, Greg Kopp, George Lawrence, Bill McClintock, Tom Sparn, Mike Anfinson, Rick Kohnert, Tim Holden, and the entire engineering staff.
- **NASA Goddard Space Flight Center**: William Ochs, SORCE Project Manager; Douglas Rabin, SORCE Deputy Project Scientist; Debbie Dodson, Mission Business Manager; and Cary Lively, System Engineer.
- **Orbital Science Corporation, Dulles, Virginia**: Rob Fulton, SORCE Spacecraft Manager, Philip Burkholder, Ed Kozlosky, Dave Oberg, and the entire spacecraft engineering staff.

For additional information on the SORCE Mission, visit the website at *lasp.colorado.edu/sorce/* for the latest news and updates.



(right)
Tom Woods, SORCE Project Scientist at LASP, reviews preliminary data from the instruments.

(bottom)
Personnel working in the LASP Mission Operations Center at the University of Colorado, Boulder

Summary of the 22nd and 23rd ASTER Science Team Meetings

— *Andrew Morrison, andrew.d.morrison@jpl.nasa.gov, Jet Propulsion Laboratory*
— *Masatane Kato, kato@kachidoki.ersdac.or.jp, Earth Remote Sensint Data Analysis Center (ERSDAC), Tokyo, Japan*

22nd ASTER Science Team Meeting

The 22nd Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Science Team Meeting (ASTM) was held in Tokyo, Japan, May 21-23, 2002. The first two days of the meeting were filled with a plenary session, splinter meetings of each working group (WG), and the general meeting (there were 70 participants including U.S. and Japanese ASTER science team members). On the last day, a workshop to introduce ASTER data applications was held (with 170 participants including U.S. and Japanese ASTER science team members and general users). The following are the highlights of the discussion:

- ASTER equipment is operating smoothly without any problem.
- The number of ASTER scenes obtained totals approximately 414,000, which covers most of the land area on Earth. In response to this, the possibility of carrying out a second global mapping was discussed at the Operation and Mission Planning Working Group (OMPWG), and it was decided to monitor observation status until the next ASTM in order to investigate the possibility.
- The U.S. side has already started distribution of higher-level products, and the Japanese have also started distribution of Digitial Elevation Model/Ortho (DEM/Ortho) products in May. (Ortho is the term used for Level 3 products with features that can be viewed on geographic maps). Atmospheric Correction and Temperature Emissivity Separation (TES) products will be distributed as soon as possible.
- Both the Level 1 WG and the Radiometric Calibration WG discussed the issue of crosstalk correction. The next ASTM will address methods of crosstalk correction and optimum parameters (see summary of 23rd ASTM below).
- Since the ASTER data application workshop was open to the public, questions and comments were actively exchanged in reference to the 17 subjects presented by the U.S. and Japanese science team members, as well as by investigators of the Announcement of Research Opportunity on ASTER data use (ARO) users, which led to a better understanding of the ASTER data.

23rd ASTER Science Team Meeting

The 23rd ASTER Science Team Meeting was held at the Hyatt Regency Suites Hotel in Palm Springs, California December 3-5, 2002. Palm Springs was selected for its proximity to the Salton Sea ASTER test site. Approximately 70 attendees represented U.S. and Japanese Universities and Government Agencies.

Opening Plenary Session

Anne Kahle, U.S. ASTER Science Team Leader, opened the meeting, welcomed the attendees, and presented the agenda. H. Tsu, ASTER Science Team Leader, expressed his pleasure to be at the meeting and advised the attendees that M. Kudo and Y. Yamaguchi would not be attending the meeting — Kudo-san because he was ill and hospitalized and Yamaguchi-san because he was busy preparing a COE proposal. Bjorn Eng, U.S. ASTER Project Manager, welcomed the Team to Palm Springs and presented the meeting logistics.

Woody Turner, NASA Headquarters, presented the NASA Vision Statement (noting that 'Life' appears in all three statements), the NASA Mission Statement, 23 ESE research questions (broken up into five theme areas — Variability, Forcing, Response, Consequences, and Prediction), and 12 Applications Themes. He said that it has not yet been decided whether the proposals submitted in response to this recent Request for Proposals (RFP) will be evaluated just on the basis of their Research content or for both Research and Applications. Either way, the proposals submitted will be evaluated for their responsiveness to the 23 research questions. Additionally, if Applications are also part of the call, the proposals will also be evaluated in terms of their responsiveness to the 12 Applications Themes.

B. Eng reviewed the status of Level-2 product validation. He said that all the L2 products have now been validated with the exception of the Polar Classification product, which requires more data to complete. Validation using Moderate Resolution Imaging Spectroradiometer (MODIS) and Mulitangle Imaging Spectro-Radiometer (MISR) data will require updates to the software to accommodate the current MODIS and MISR formats. Eng asked the Team members to advise him of any bugs or problems with the products. Reports can be sent to him at *bjorn.eng@jpl.nasa.gov*. He will compile the reports in a free-form database. He asked for JPEG files illustrating the problems if they are available.

Isao Sato presented an update of the status of the Higher Level Data Products (HLDP), especially focusing on the ASTER Ground Data System (GDS) at the Earth Remote Sensing Data Analysis Center (ERSDAC). He reported that, since the last Team meeting, three products have been released. They are the D-Stretch, and the semi-standard DEM-Z and 3-D orthographic data products. He said that they've recently released atmospherically corrected Very Near Infrared (VNIR) and Short-Wave Infrared (SWIR) radiance and reflectance data sets. Most of the HLDPs, except for Temperature-Emissivity Separation (TES), have now been released from GDS at ERSDAC, and TES will be released toward the end of December. He reported the total number of scenes that GDS at ERSDAC has released and presented the daily averages of each product. Their future plans include producing 2-times enlarged browse products in the Information Management System Webpage (IMS/WEB) (these will be available in December) and the production of crosstalk-corrected HLDPs that may be 'optional' products.

Sato-san said that he hopes that these products will be available next year. B. Eng said that JPL is planning to crosstalk-correct L1A products to produce corrected HLDPs on demand. The corrected L1As will not be archived, just produced as the HLDPs are ordered. He said that the correction is being coded up now, and that test scenes have been solicited from the U.S. Science Team members. He also invited the Japanese Team members to submit test scenes and reported that the software will be tested soon. There was considerable discussion to clarify the differences between the U.S. and Japanese processes. It was agreed that the L2 products from each side will have some differences, and it will be necessary to compare them.

H. Watanabe presented the status of the GDS. He showed a chart of data acquisition over time, which showed periodic drops for calibrations and a slow drift downward that might be attributed to the increased scattering of acquisition targets as the map fills in. He pointed out increases in both volume and quality of the data distributed since the GDS switched to using Sony DTF-2 tapes, and he showed a summary of data processed and an analysis of those results, indicating that, although there was an improvement in success rate, there is still an approximately 10% failure rate, some of that due to a bit-flip problem.

Watanabe-san reported that about 3000 scenes have been distributed to paying users, and many more than that have been distributed to non-paying users, but he also noted a drop-off of nearly two orders of magnitude in total orders after a charge for all users was implemented on August 12.

He said that the reprocessing of data to compensate for sensor degradation is nearly completed, but he added that the increased rate of change of the data is creating the problem of keeping up with the changing calibration coefficients.

He then presented a list of five major upgrades of the ASTER GDS including:

- Public release of HLDPs
- Storage tape change
- Credit card ordering by web
- Data search by IWS for data (in Japanese) with 2X browse scenes provided
- Upgrade of IMS/WWW

Watanabe-san also reviewed what he saw as the major troubles and their counter-measures. Regarding the projected lifetime of ASTER/Terra, Watanabe-san noted that the spacecraft is now 3 years old; that based on its fuel-life history, it could last 9+ years; and that based on its pointing cycles resource, 6 years may be possible for the VNIR and 10 years may be projected for the Thermal Infrared (TIR). **A. Kahle** noted that the pointing resource limits are only estimates, and it could last more or less than the estimate. **Fujisada-san** said that inter-telescope registration problems might signal pointing degradation, but that no such problems have been detected yet. Watanabe-san noted that the biggest lifetime problem might be the budget. He said that there is no guarantee of funding after 5 years. **Woody Turner** noted that the U.S.-Japanese MOU commits the U.S. to

provide support for as long as the spacecraft is viable.

B. Bailey presented the Land Processes DAAC status report. He discussed implementation of L1A-to-L1B processing and explained that the proposal is to process only the pre-January 2002 L1As. There was some discussion on the proposal, which has not yet been approved by NASA Headquarters. Bailey also presented a summary of data ingest, production, and distribution, noting a puzzling drop off of ingest over the last Summer that will be studied. He also discussed the implementation and impact of the pricing policy implemented in August in which most users will pay $55/scene for L1A and L1B data and decorrelation products plus a $5 shipping fee (NASA and affiliated users as well as 'educational' users will still receive the data and data products at no charge). Finally, Bailey gave the DEM Generation System update: Lyle Mars noted that, based on his observations at the most recent USGS meeting, the ASTER DEM is its most important product for the Geology community.

There was considerable discussion about the extent of public knowledge and need to advertise the Distributed Active Archive Center (DAAC's) data pool that contains ASTER data over the U.S. and territories and is free to all users.

It appears in the preliminary data that the implementation of charging for ASTER scenes has resulted in a reduction of orders by two orders of magnitude (from ~200,000 orders/month to ~2,000 orders/month). **Simon Hook** suggested that the reduction is not due to charging for the data, but to the difficulty in paying for it. Bailey said that too much emphasis shouldn't be placed on this early data and some time should be taken to see the real impact.

M. Maekawa, in his Science Scheduling Support Group (SSSG) Report, showed ASTER total-coverage maps and 0%-20% cloud coverage maps for the globe, the U.S., and Japan from launch through November 20, 2002. The total global-coverage map included 518,264 scenes, while the 0%-20% cloud-coverage global map included 214,154 scenes. He broke down the observation achievements by km^2, number of scenes and percent satisfied for Data Acquisition Requests (DARs), Science Team Acquisition Request (STAR)-Local, STAR-Regional Monitoring, and STAR-Global Mapping and Engineering Team Request (ETR)-Observation. The Global Map requirement has been nearly 71% satisfied. He also presented a plan for a second round of Global Mapping (vs. attempting to complete the first Global Mapping STAR) to best utilize the remaining ASTER resources. The Science Team was asked to complete a questionnaire regarding possibly changing the sun elevation parameter (lowering it to enhance the topographic effect, widening it to lower the minimum sun elevation angle, or keeping it as is) for the second round.

M. Abrams summarized ASTER outreach activities. He listed the shows and presentations that ASTER has participated in during the last year and announced the redesign of the ASTER web site (*asterweb.jpl.nasa.gov*) that now features an ASTER "Image of the Week." He reported that the ASTER Handbook has been released and that ASTER personnel have been interviewed for an upcoming NASA video. Abrams solicited contributions from the ASTER Science Team members and offered his help and the support of the JPL PAO Office to get out ASTER results. **Woody Turner** noted that ASTER Outreach is very visible and important at HQ. Mike and Bjorn will forward their Quarterlies to Turner.

Prior to adjourning the Plenary Session, **A. Kahle** presented a list of issues she asked the Working Groups to consider in their Splinter Sessions. The list included Crosstalk-Correction, Calibration Coefficient updates, Atmospheric Correction Algorithm, Global Mapping Second Round, Geometrical or other data problems, and Workshops and Special Journal Issues. A discussion of known ASTER data problems and plans to address them also preceded adjournment of the Opening Plenary.

Splinter Sessions

Level-1/Geometric/DEM Working Group (M. Abrams)

This working group met to discuss the status of the Level-1 ASTER data. Fujisada-san provided an update on the Japanese Level-1 software validation. No changes were developed since the last meeting. An anomalous scene was found with excessive, uncorrected SWIR parallax. This was under investigation. **Iwasaki-san** showed the results of geometric analysis of Path 174 (36 scenes). Inter-telescope registration exceeds mission requirements for the entire strip, and underlines the stability of the instrument. Crosstrack jitter of 0.4 pixels was seen as a result of spacecraft harmonics. A pitch anomaly was identified that was also due to a spacecraft attitude "hiccup". Fujisada-san described a geolocation error that is a function of latitude. He presented model results, on-orbit measurements,

and a correction algorithm involving a higher order polynomial. He proposed to ERSDAC that they incorporate the fix in a future version of the Level-1 software. The U.S. side will investigate how to pass on the information to users. Three presentations on DEM software and status were discussed. **Rick Wessels** described ongoing developments by the Global Land Ice Measurements from Space (GLIMS) project to produce DEM software. **Mike Abrams** showed a beta version of a commercial DEM generation package that runs as a plug-in to ENVI. **Bryan Bailey** discussed the Land Processes DAAC (LPDAAC) status for DEM generation. Already 1500 DEMs have been produced and archived. Production is running at the rate of about 120/month. Nevertheless, there is still a backlog of orders stretching for about 6 weeks. **Lyle Mars** noted a geolocation error for scenes taken with extreme pointing angles, and at high average ground elevations. This error is inherent in the data, and only ortho-rectification could remove it. **Fujisada-san** pointed out that an orthorectified image product is available to users from GDS.

Ecosystems/Oceanography Working Group Report (M. Abrams)

This working group was excited to hear eight presentations on scientific research with ASTER data. **Kenta Ogawa** described estimation of land surface window emissivity and broadband emissivity in a part of the Sahara Desert. He has developed a mosaic using over 200 ASTER scenes for his analysis. **Tsuneo Matsunaga** reported on validation of a split-window algorithm to measure water surface temperature. The results were in excellent agreement with buoy measurements taken on Tokyo Bay. **Andy French** described estimating evapotranspiration over central Oklahoma, examining the effects of spatial resolution, comparing ASTER's 90 m data with 1000 m derived data.

Tsuneo Matsunaga next reported on ASTER Japanese Science Team members activities, including coral reef mapping; vegetation change in the Taklamakan Desert; water quality monitoring at Lake Kasumigaura; and vegetation mapping in Kyushu. **Tom Schmugge** compared land-surface emissivity and radiometric temperature derived from MODIS and ASTER sensors. Shuichi Rokugawa presented a study on the relation between seashore erosion and local environmental change in a Thai delta. His work took advantage of all of ASTER's spectral bands to derive temperature, land use, and water quality. **Michael Abrams** described a comparative study using ASTER, Earth Observer-1 (EO-1), and Thematic Mapper data to measure water penetration at Lake Tahoe. The new, shorter wavelength blue band on EO-1 gave better penetration than existing sensors. **Mike Ramsey** described a new project for urban monitoring in Pittsburgh and Sao Paulo, Brazil.

Geology Working Group (L. Rowan)

The Geology Working Group reports spanned a wide range of topics, including glacial studies, volcano monitoring, lithologic mapping, and geomorphological-tectonic studies. The GLIMS project now involves 23 regional centers, and during this past year ASTER data have been acquired at numerous important glacial deposits. ASTER data were used in support of emergency efforts in two glacier-related floods in Belvedere, Italy and in southern Russia. Significant progress was reported for estimating velocity of ice movement in the Himalayas.

Three different investigator groups presented updates on volcano monitoring using ASTER data. Spectral reflectance analysis of ASTER data of areas in Morocco, Mexico, and Australia demonstrated the potential of ASTER data for mapping mineralogical constituents, and the need for improved calibration, particularly in ASTER band 9. Subtle compositional variations across active faults may prove to be very useful means of documenting offsets due to tectonic activity.

STAR Committee Splinter Session (L. Maldonado)

Japanese and U.S. Science Team members met to review New STAR Proposals. There was one new proposal presented by Japan that is to be evaluated using the new STARtool operated at GDS. The new STARtool will provide an online review process for the respective Working Group Chairs, and Science Team Members. Proposals can be approved or rejected after the respective groups have communicated online using the new tool.

Users must still contact an associated ASTER Science Member (WG Chair or Science Team Member) in order to propose a new STAR. The ASTER member will become the "sponsor" for the user and will submit the request using his or her assigned username and password. Notification to the user will be done either by the respective Science Scheduling Support Group (SSSG), Sponsor, or WG chair. Details are still forthcoming.

The last issue discussed concerned DARtool allocation. Japan and U.S. Science Team Members agreed to

appropriately address each request for an increase based upon science needs. The respective countries will review the request and will be able to increase the total allocation up to three times (based on the user category). Details are still forthcoming.

ASTER Operation and Mission Planning Working Group (OMPWG) / SSSG Splinter Session (L. Maldonado)

Japan has proposed submitting a revised version of Global Map with a Global Map-II that will raise low-priority and Medium-priority GM-STARs accordingly. The priorities will be based upon completion rate of GM-I. The revised version includes a request to limit sun-angle (between 30-60 degrees) for mid-latitude acquisitions during Autumn and Spring. Another option is to widen the sun-angle limit range (30-90 degrees). Each option has pros and cons that need to be further evaluated by the Science Team in the U.S. before agreement is reached. A decision will be made by the end of January 2003.

The pointing-limit function, which controls the total number of telescope pointing maneuvers, has been above the nominal operating parameters for the VNIR telescope. The effect is a reduced number of observations for the Area of Interest (AOI) requiring pointing adjustments along the track line. The current threshold is based upon the expected life of the instrument and calculations derived by the instrument engineers. Given that no other indicators that would raise a concern for the telescope life expectancy have been experienced, a GDS team member was asked to communicate with instrument engineers to re-evaluate the current allowable 20,000 lifetime pointing values. Unless instrument engineers can guarantee that increasing the current allowable pointing limit will not affect the life of the instrument telescope, there will likely be no change in the current operating parameters.

The last issue for OMPWG was to consider a request by the GLIMS PIs to update current STARs in the system and re-prioritize low-coverage areas with those where good coverage has occurred. The first idea is to temporarily suspend existing STARs and replace them with the new updated versions for a one-year period. Due to the amount of requests needed to be updated/suspended, a batch update tool would need to be developed. Other options would require many man-hours to handle each request individually. Due to the scheduler capacity limits, simply adding a batch of new requests would not be a viable option without being able to suspend the equal number of existing STARs. Both scheduling teams are in the process of finding a reasonable method to accommodate the request. In the interim, the Science Team is evaluating the request and considering effects of the modifications on other high-interest areas.

Temperature/Emissivity Working Group (A. Gillespie)

Agenda and discussion summary:

- TES status update — Gillespie
  validated product released 8/02 with minor adjustments
- T/E separation in the TIR/MIR (MTI satellite) — Mushkin
- Status of L1B re-sampling problem due to geometric correction — Tonooka
  -"noisy" stripes (2-5 K; 0.05-0.10) in TIR (worst); VNIR & SWIR also
  - not as obvious with bilinear interpolation
  - recommendation to use bilinear interpolation for L1B-L2 default
  - exact source of problem still needs to be established
- Anomalous behavior over warm/hot targets — Ramsey
  - temperature differences of 4 K between TES & NEM, source unclear
  - emissivities appear to agree but may be unrealistic
- Comparison of ASTER TES and CIMEL emissivity spectra — Matsunaga
  - agreement at Railroad Valley is better than 0.01 over 3 years
  - long-term variability for both ≤ 0.03 (band 10)
- ASTER TES follow-on activity

Action Items Summary

1 Add soil spectra to ASTER library — Simon Hook, Will Stevanov. Status: spectra are queued and will be added to ASTERLIB at next update
2 Striping in emissivity images — Shuichi Rokugawa. Status: striping results from geometric correction. Exact cause must be identified. Gillespie will summarize one hypothesis. Recommendations made to HLDP WG.
3 Final U.S. product release — Alan Gillespie. Status: Validated products released on schedule. Action item closed.
4 TES performance evaluation — Mike Ramsey. Status: Possible temperature anomalies over warm/hot targets reported. Ramsey will continue documentation over Soufriere and track down source of problem.

The group heard from **B. Eng** of JPL

and **C. Cattrall** of the University of Arizona regarding the inclusion of MISR-derived aerosol and MODIS products in the atmospheric correction of the reflective bands of ASTER. It was determined that a new look-up table for the atmospheric correction could be completed within two months using the new aerosol models being implemented by MISR. The topic of a new look-up table was also discussed by **K. Thome** of the University of Arizona with regard to reducing artifacts in the atmospheric correction product at the boundaries of the 15-km scale of the input parameters. Cattrall and Thome will investigate an appropriate method for a pixel-to-pixel correction. Thome also raised the difficulties that will be encountered in the atmospheric correction of band 9 of ASTER even after the band has been corrected for crosstalk effects. The uncertainty in this band will be dominated by absorption due to water vapor with 10% uncertainty in column water vapor leading to a 5-10% error in the band 9 reflectance for typical column water vapor amounts and moderate sun angles.

Further discussions in the working group centered on validation results. **R. Welch** showed that the ASTER polar cloud mask algorithm applied to over 2000 MODIS images of various sites (including several Atmospheric Radiation Measurement [ARM] sites) showed good agreement with ground-based instrumentation and image-based assessments. Validation using ASTER scenes still awaits a significantly larger number of ASTER scenes to be collected. **H. Tonooka** completed the working group meeting with a presentation of a modified atmospheric correction for the TIR bands of ASTER. This new method is not as susceptible to water vapor variations and was found to provide more accurate emissivity retrievals over water than the current algorithm. Work will be done over the next six months to investigate incorporating this new approach into the operational algorithm.

Radiometric Calibration Working Group/ ASTER Calibration Team Meeting (F. Palluconi)

Both the onboard and vicarious calibration results for 2002 were examined with the trends seen in previous years generally continuing (there is some evidence the decline in gain is decreasing in the VNIR and TIR channels). The gain of the VNIR and TIR channels continues to slowly decline, and the SWIR gain is nearly constant with time. To account for the gain changes observed, the Radiometer Calibration Coefficients (RCCs) applied in the generation of Level-1B products for the VNIR will be updated as indicated by the onboard lamps/ vicarious calibration results and the TIR RCCS will be updated every 3 months based on the onboard long-term calibration results verified by the vicarious calibration results. As the TIR radiances have been validated to the equivalent of a few tenths degree Kelvin, **Tonooka-san** developed an easy to use method, which can be used to correct existing L1B TIR data for the month-to-month trend in instrument gain. At 300 K, use of this method would reduce the error due to gain changes to 0.2 K. This method is to be made available to users through the ASTER web sites in Japan and the U.S. An ASTER SWIR crosstalk algorithm (operating on L1A image data) is being developed in the U.S. for use in generating a pre-Level-2 correction, which will allow Level-2 data products to be corrected for this effect.

ASTER team planning continues for the deep-space maneuver and Lunar look in March 2003. The Lunar calibration will provide an estimate of the calibration accuracy for the VNIR and SWIR bands and a stray light estimate for the TIR bands.

Closing Plenary Session

The Closing Plenary convened mid-afternoon on December 5. The Working Group Chairs summarized the presentations, discussions, and conclusions from their respective splinter meetings (see above). **H. Tsu** summed up the meeting by saying that this was a short 2 1/2 days, but a great deal had been accomplished. He said that in Japan they are beginning to consider possible post-ASTER projects. Upcoming workshops and special issues of journals will provide good opportunities for planning post-ASTER projects. However, he noted that ASTER could last 10 years or longer so that it is not necessary to hurry, but it is necessary to begin to think about it. **A. Kahle** said that the U.S. Team would be glad to work with the Japanese on post-ASTER planning. The meeting was adjourned at 5:00 pm.

Minutes from HDF / HDF-EOS Workshop VI

— *Lori J. Tyahla, lori_tyahla@sesda.com, Global Science & Technology, Inc.*
— *Richard Ullman, richard.ullman@nasa.gov, Goddard Space Flight Center*

The sixth annual Hierarchical Data Format (HDF) and HDF-EOS Workshop was held December 4-5, 2002 in San Francisco, CA in conjunction with the Fall meeting of the American Geophysical Union (AGU). Several overlapping sessions took place including, "How to Obtain NASA EOS Data," "How to Program in HDF and HDF-EOS," "Status and Plans for HDF and HDF-EOS," and a poster session on "EOS Data Access and Manipulation: Tools and Techniques."

The session on obtaining NASA EOS data provided a full day of training on the web-based interfaces used to select and order NASA EOS data as well as demonstrations of many tools designed to view or assist in analysis of HDF and HDF-EOS data. For those developing HDF or HDF-EOS products or developing tools to work with HDF-EOS products, NASA and the National Center for Supercomputing Applications (NCSA) provided a full day of hands-on tutorials in how to program with HDF under the instruction of the developers of the HDF and HDF-EOS software. Attendees were also able to address their specific needs via one-on-one discussions with the HDF and HDF-EOS developers.

The HDF/HDF-EOS Standards session occurred in parallel with the tool training session and featured presentations on the status of HDF and HDF-EOS, and provided an opportunity for community feedback and discussion on the future direction of the standard.

Copies of all presentation materials are available on the HDF-EOS Tools and Information web site: *hdfeos.gsfc.nasa.gov*. The following HDF and HDF-EOS-related talks were presented:

Introduction and ESDIS Status and Plans, HDF-EOS Web Site

Richard Ullman (NASA Earth Science Data and Information System [ESDIS] Project) provided an overview of ESDIS Science Data Services, including Earth Science satellite missions supported, volume of data flowing into and out of the archives, and a profile of the overall user community. The Earth Observing System Data and Information System (EOSDIS) Core System (ECS) has moved from development to operational mode. Ullman highlighted two major areas of new capability — those of Data Pools and the EOS Clearing House (ECHO). Overviews of each area were presented. Ullman also discussed the features of the upgraded HDF-EOS Tools and Information web site.

HDF Status and Developments

Mike Folk (NCSA) gave a brief summary of HDF library and tool development during 2002 followed by future plans. Plans for 2003 include releasing HDF5 v1.6 in the Spring (expected to include szip compression), completing work on high-level Application Programming Interfaces (APIs) for HDF5, replacing older viewing tools with a single viewer/editor (begun in 2002), upgrading other tools , and releasing a tool that will compare the structure and content of two HDF5 files and report the differences. Additional future activities may include investigating using HDF data in a web environment (XML, Java server pages, etc.). A list of various groups and activities considering or already using HDF was presented, among them were the National Polar-orbiting Operational Environmental Satellite System (NPOESS) and the National Archives and Records Administration.

HDF-EOS Library Development and Status

Larry Klein (L3 Communications, Inc.) presented a brief description of HDF-EOS2, a more detailed description of HDF-EOS5, and a list of tools that will operate on one, the other, or both versions of HDF-EOS. One tool (heconvert) will convert HDF-EOS2 objects to HDF-EOS5 objects. A list of the supported operating systems and compilers was provided. A few remaining issues still need to be addressed including use of the gzip compression method, a 2 GB file size limit, and that metadata are not updated for swath stitching in the unlimited dimension.

HDF5 I/O Performance

Elena Pourmal (NCSA) gave an overview of the HDF5 Library tuning knobs for sequential and parallel performance. Sequential performance can be tuned at the file level or the data set transfer level, and Pourmal described specific instances of each. She also discussed application memory and

file space management using techniques such as chunking, compression, and data shuffling. Three file-level tuning knobs for parallel HDF5 were presented. Several performance tests were conducted and Pourmal described both the test and the results.

Transition from HDF4 to HDF5

Robert McGrath (NCSA) expects that for many years, most environments will use both HDF4 and HDF5 data and software. Current NASA Earth Science Enterprise (ESE) holdings are HDF4-based (Terra, Aqua, Landsat 7, etc.), but in the near future HDF5-based holdings will come on-line (Aura, possibly others). He presented four important goals for NCSA and NASA:

- support both formats and libraries;
- interoperation of data and libraries;
- conversion of data; and
- conversion of software.

McGrath discussed the issues relevant to each goal and provided suggestions for users.

Strategy for Evolution of ESE Data Systems (SEEDS)

Richard Ullman (NASA EISDIS) described SEEDS as a strategy for NASA's ESE to maximize the science and applications utility of ESE data, a formulation study of best practices, a process for incorporating lessons learned, and a tool for engaging communities of ESE data providers and users. He listed seven formulation study areas and provided the schedule status. Ullman presented a flow diagram of the SEEDS Standards Process for approving and developing standards, and a list of the types of standards the process will address. A Standards Working Group whose members represent NASA-ESE funded activities will guide the formulation process. Ullman also provided the status of the process as well as some near-term study findings. Additional SEEDS information can be found at *eos.nasa.gov/seeds*.

Selecting HDF5 as the Standard for NPOESS

Alan Goldberg (MITRE Corp.) presented the products and data delivery requirements of the NPOESS and related issues. He also discussed a schedule with a target date of mid-2008 for system operational readiness in anticipation of the first NPOESS launch in mid-2009. Goldberg listed and described seven reasons that HDF5 was chosen as the standard for NPOESS. These included familiarity, maturity, capability, compatibility, availability, interoperability, and efficiency.

"Ask the Experts" Discussion

Richard Ullman, **Robert McGrath**, and **Larry Klein** led this open discussion about the future direction for HDF and HDF-EOS.

Tool Training and Demonstrations

The workshop provided an opportunity for attendees to receive training on several data analysis and search and order tools and to see demonstrations of others. A few of the presentations provided updates of previously available tools; these included misr_view, the HDF-EOS-to-GeoTiff (HEG) Converter tool, the EOS Imaging Tool (formerly the Polar HDF-EOS Data Imaging and Subsetting Tool), HDF Explorer, and the HDF-EOS Web-based Subsetter (HEW). Many new tools were also presented and are summarized below. More detailed information on all of the tool presentations can be found on the HDF-EOS Tools and Information web site (*hdfeos.gsfc.nasa.gov/workshops/workshops.cfm*).

HDFView

Peter Cao (NCSA) presented HDFView. This is a Java-based tool for browsing and editing NCSA HDF4 and HDF5 files. HDFView allows users to browse through any HDF4 and HDF5 file starting with a tree view of all top-level objects in an HDF file's hierarchy. HDFView's editing features allow a user to create, delete, and modify the value of HDF objects and attributes.

Algorithm Development and Mining System (ADaM)

Steve Tanner (Information Technology and Systems Center/University of Alabama-Huntsville - ITSC/UAH) presented a tutorial on the ADaM system. The ADaM system enables users to mine large scientific data sets for geophysical phenomena detection and feature extraction. Tanner presented an overview of the ADaM architecture, components, and data formats. He explained what a "Mining Plan" was and how to create one using the ADaM Plan Builder. He then demonstrated how the tool can be used to identify cancerous breast cells using a Bayes Classifier.

EOS Data Gateway (EDG)

Mark Nestler (Global Science & Technology, Inc. - GST) provided training on the EDG. The EDG is a user interface that enables users to access the data holdings in NASA's Distributed Active Archive Centers (DAACs) and other data centers worldwide. Its primary function is data search and order; secondary functions include summary and detailed document searches. Nestler demonstrated step by step how to

create a user account and how to build a primary data search using keywords and using data granule IDs. He also showed how to evaluate the search results, how to place a data order, discussed changing user preferences, discussed common errors encountered, and gave some helpful hints.

Web-based Hierarchical Ordering Mechanism (WHOM)

James Johnson (Science Systems and Applications, Inc./Goddard Space Flight Center Earth Sciences (GES) DAAC - SSAI/GES DAAC) gave a tutorial on WHOM. This is a data search and order tool to access data archived at the Goddard Space Flight Center Earth Sciences (GES) DAAC. Johnson provided an overview of the layout of the WHOM interface. He then showed how to locate and order specific data granules by beginning at the dataset level. He also showed how to locate, subset, and download data in the GES DAAC online Data Pool.

NASA Web GIS Server (NWGISS)

Liping Di (Laboratory for Advanced Information Technology and Standards/George Mason University) defined NWGISS as a "suite of software making HDF-EOS data easily accessible to GIS data users through Open GIS Consortium (OGC) specifications." The server and its tools provide on-the-fly reformatting, georectification, resampling, and subsetting capabilities as well as automatic data ingest and catalog creation for data providers. By combining with the NWGISS Multiprotocol Geoinformation Client (MPGC), users can assemble data from multiple providers online that exactly match their needs. Liping provided a detailed account of how to download and install all NWGISS components and described four MPGC usage scenarios.

McIDAS-Lite

Dave Santek (Space Science and Engineering Center/University of Wisconsin-Madison) gave a presentation on McIDAS-Lite. He provided brief overviews of McIDAS and the International MODIS/AIRS Processing Package (IMAPP) and showed Cloud Top Pressure products generated by each. He then discussed the features and input and output data formats of McIDAS-Lite.

HDF5 Tools in IDL

Chris Torrence (Research Systems, Inc.) presented information on the HDF5 Module that is now available with Interactive Data Language (IDL) 5.6. He discussed the module's capabilities and the data types it supports. Torrence also showed some sample HDF5 code, discussed the HDF5 parser and graphical browser, and listed new features in IDL5.6.

Programmable EOS Visualization with Python

Patrick Moran (NASA Advanced Supercomputing Division/NASA Ames Research Center) explained how the open source Python scripting language can be used with a C++ open source field model to produce a Programmable Data Analysis tool that utilizes both standard and custom modules. Moran also identified a list of routines (both completed and under development) that comprise an HDFEOS module.

Intel Array Visualizer

John Readey (Intel Compiler Laboratory/Intel) gave a detailed presentation on the Intel Array Visualizer and its four main components: Array Viewer, Library Routines, Object Model, and ActiveX Controls. He also provided code examples written in C++, C#, and JavaScript. The current version (7.0) supports HDF5, XML, BMP, GIF, JPG, and PNG formats. It is expected that the next version (7.0.1) will also support HDF4 and will be released during the second quarter of 2003.

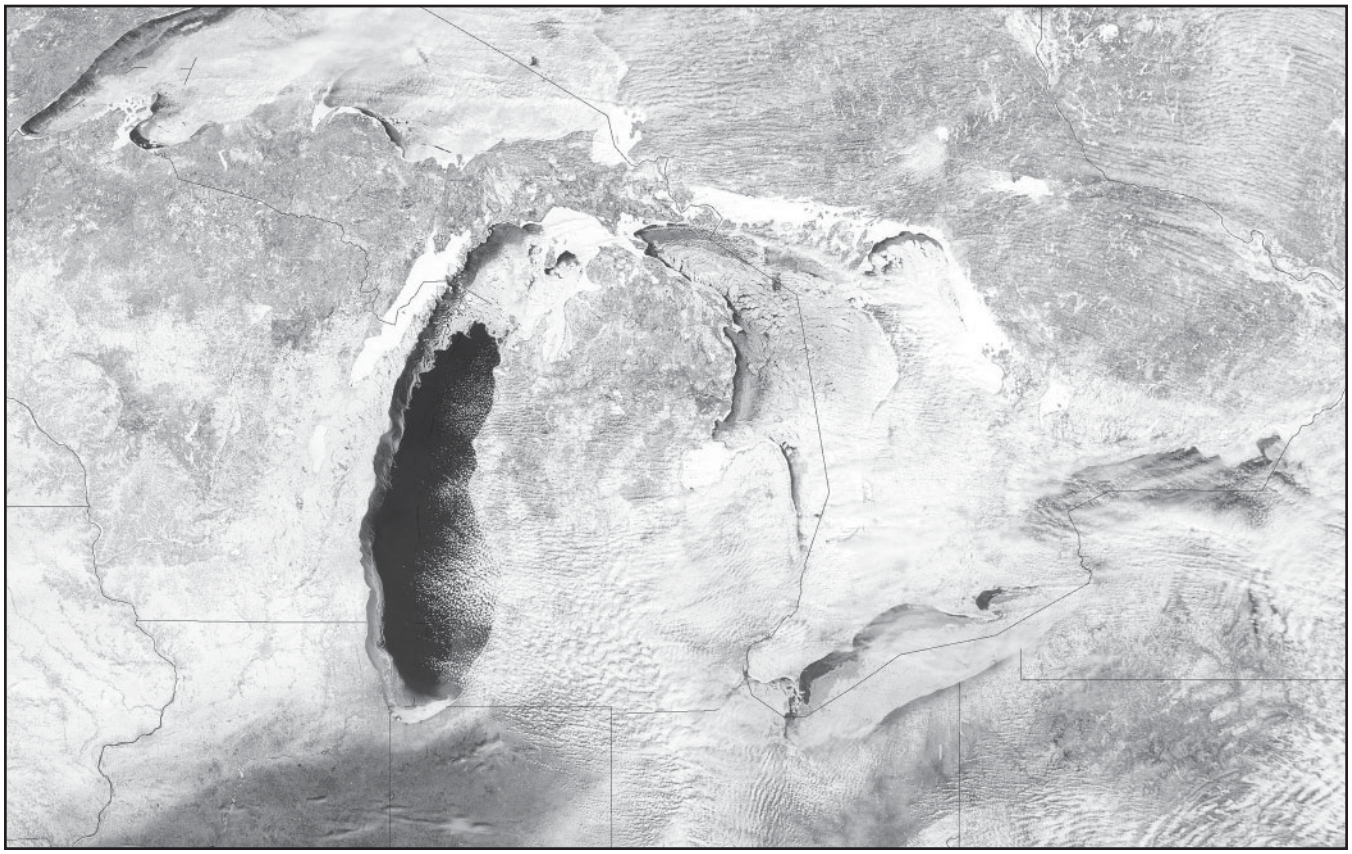
Kudos

The National Academy of Engineering (NAE) has elected 77 new members and nine foreign associates. Among those elected was "**Michael D. King**, senior project scientist, Earth Observing System, NASA Goddard Space Flight Center, Greenbelt, Md. for advancing our understanding of the effects of aerosols and clouds on Earth's radiation and for leading programs to improve climate prediction."

Election to the National Academy of Engineering is among the highest professional distinctions accorded an engineer. Academy membership honors those who have made "important contributions to engineering theory and practice, including significant contributions to the literature of engineering theory and practice," and those who have demonstrated accomplishment in "the pioneering of new fields of engineering, making major advancements in traditional fields of engineering, or developing/implementing innovative approaches to engineering education."

The *Earth Observer* Staff and the entire scientific community wishes to congratulate King on this outstanding accomplishment.

This image from MODIS, taken March 9, 2003, shows ice almost completely covering several lakes, including the largest lake—Lake Superior, at upper left. Lake Michigan, center, shows a ring of ice around its shores and at its northern end, while Lake Huron, to the east, is almost completely covered. South of Huron, ice covers all but the northern parts of Lake Erie, while Lake Ontario, to the northeast, appears relatively ice-free.



Earth Science Education Program Update

— *Blanche Meeson, blanche.w.meeson@nasa.gov, NASA Goddard Space Flight Center*
— *Theresa Schwerin, Theresa_schwerin@strategies.org, IGES*

Digital Library for Earth System Education - Annual Meeting

The Digital Library for Earth System Education (DLESE) is preparing for its Fourth Annual Meeting to be held August 3 though 5, 2003 at the University of Colorado in Boulder, Colorado, with an optional skills workshop on August 2. The meeting, sponsored by the National Science Foundation, will focus on the theme "Broadening DLESE." Specific goals are to develop strategies to:

- Expand the number and diversity of users and contributors to DLESE
- Facilitate and encourage efforts to develop Earth science data/tools for educational use
- Expand DLESE's collection of excellent Earth science educational materials
- Broaden the ties between research and educational practice.

The organizers hope for strong participation from teachers at all levels, curriculum developers, materials developers, content/data providers, scientists, service providers, evaluators, administrators, and library creators. This meeting will provide a unique opportunity for these stakeholders to collaborate and participate in DLESE's continuing development. For more information, see: *www.dlese.org/annualmtg/2003/CallForm.html*.

NASA Selects Colorado Organization to Operate Globe Program

NASA has selected the University Corporation for Atmospheric Research (UCAR), Boulder, CO, for operation of the GLOBE Program. GLOBE is a worldwide hands-on, primary and secondary school-based education and science program. A Federal interagency program in partnership with colleges and universities, state and local school systems, and non-government organizations leads it. Internationally, GLOBE is a partnership between the United States and 100 other countries.

UCAR is primarily located in Boulder and the headquarters of GLOBE will be moved to UCAR facilities there. The principal investigator is Dr. Jack Fellows of UCAR. The key partner in this offer, Colorado State University, will have responsibilities for GLOBE's information systems and for education including the development of classroom-ready materials. Full story at: *www.gsfc.nasa.gov/news-release/releases/2003/h03-087.htm*.

Continuing the Dream: NASA Explorer School Program

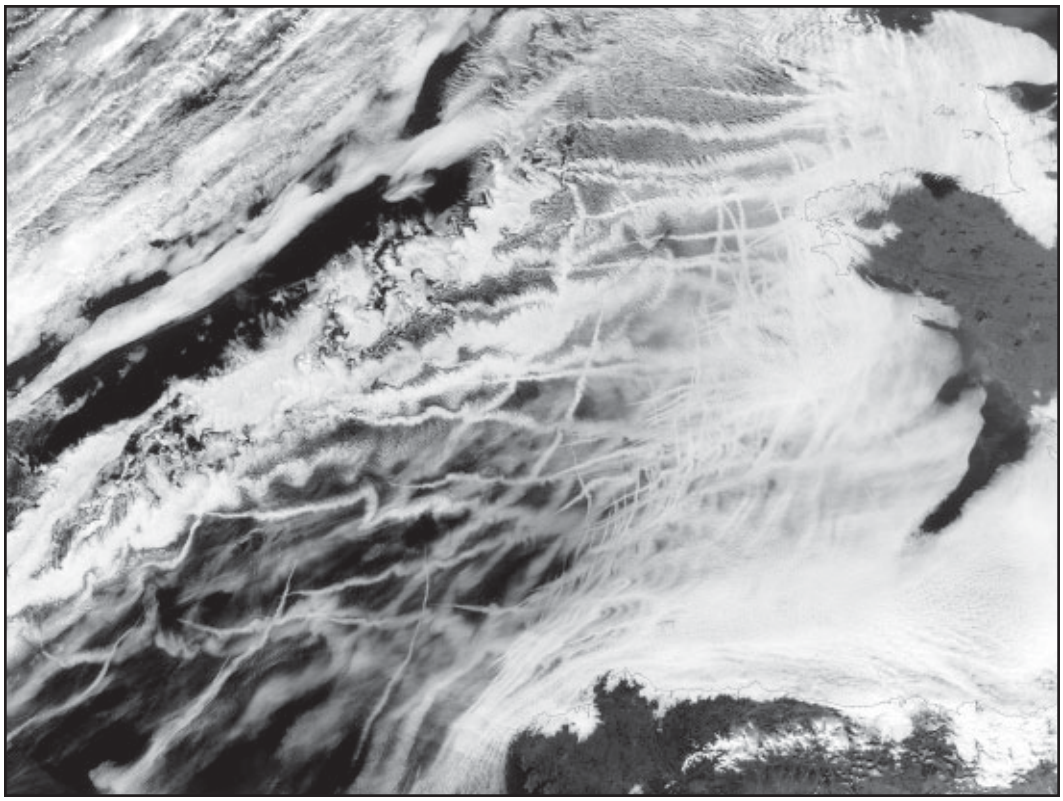
Deadline: Applications due April 4, 2003

Reaffirming its commitment to education, NASA is announcing a new initiative to bring exciting learning opportunities to educators, students, and their families.

The NASA Explorer Schools Program (NES) will provide a unique relationship between schools and the agency to "inspire the next generation of explorers." The program is designed to provide customized, extended professional development for educators. It will also provide authentic mathematics and science experiences for students and their families.

Fifty NES teams consisting of 3 or 4 science, mathematics, or technology educators and an administrator will be chosen from around the country. The teams will have a week of intensive training at one of NASA's 10 Field Centers in July.

Selected educator/administrator teams will work with NASA specialists to integrate agency science content into their curriculum through problem-solving activities and to incorporate challenges into their mathematics and science curriculum. Students will have opportunities to apply science, mathematics and technology to real-world issues and problems and to learn about the vast array of career options at NASA. To learn more about the program, visit *explorerschools.nasa.gov*.



This MODIS image, taken January 27, 2003, shows an unusually high number of ship tracks off the coasts of France and Spain. Ship tracks form when very small airborne particles emitted in the exhaust of large ships attract water molecules, acting as "seeds" for clouds, forming the thin, streaky clouds, in this image. Instead of showing the past location of the ship, like the contrail of an aircraft would, ship tracks reflect the direction and speed of the wind.

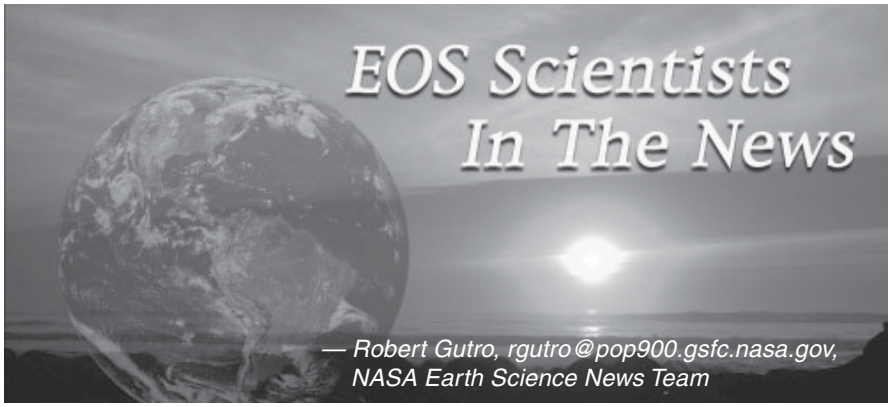
2002 NASA DAAC Alliance Annual Now Available

The 8th edition of the NASA DAAC Alliance Annual publication, titled "Distributed Active Archive Centers Alliance: Supporting Earth Observing Science 2002," is now available from the National Snow and Ice Data Center (NSIDC) Distributed Data Archive Center (DAAC). The annual is a multidisciplinary publication designed to highlight applications and research uses of satellite data archived at NASA's DAACs.

This year's edition of the DAAC Alliance Annual highlights research on volcanic domes, African ecosystems, the breakup of the Larsen B Ice Shelf in Antarctica, the spread of viruses and dangerous organisms, and improving meteorological forecasts

Articles from the DAAC Annual are also available electronically on NASA's Earth Observatory at http://earthobservatory.nasa.gov/ and on the DAAC Alliance Web site at nasadaacs.eos.nasa.gov/. Researchers working with NASA DAAC data are invited to contact Laurie Schmidt, Editor, to explore possibilities for developing a future DAAC article.

For a free copy of the DAAC Annual, contact NSIDC User Services at nsidc@nsidc.org. To access all articles in current and past editions, visit *nasadaacs.eos.nasa.gov/newsfeatures.html*.



Ocean Surface Salinity Influences El Niño Forecasts, January 31, *KBCI-TV* (Idaho), *Navakal.com* (India), *Spacedaily*, *SpaceflightNow*, *UPI.* **Tony Busalacchi**, **Joaquim Ballabrera**, and **Ragu Murtugudde** (Univ. of MD) have discovered that by knowing the salt content of the ocean, they may be able to improve predictions of El Niños.

L.A. Has Its Warmest January Ever, Jan. 31; *Los Angeles Times.* **Bill Patzert** (NASA JPL).

Warm, Sunny January Leaves County High, Dry, Jan. 31; *San Diego Union-Tribune*. **Bill Patzert** (NASA JPL).

Pacific's Hot and Cold Moods Dictate Drought, Jan. 31; *Denver Post*. **Bill Patzert** (NASA JPL).

Are We or Aren't We Facing El Niño?, Jan. 29; *Los Angeles Times.* **Bill Patzert** (NASA JPL).

El Niño's Rain So Far a No Show, Jan. 24; *Pasadena Star-News.* **Bill Patzert** (NASA JPL).

Weather Phenomenon Not Living Up To Its Reputation So Far, Jan. 24; *San Jose Mercury-News*. **Bill Patzert** (NASA JPL) discusses the current progress of El Niño.

Satellite, Shuttle Pair for Ozone Studies, January 27; *Associated Press, CNN, Discovery.com, FoxNews, UPI.* **Gary Rottman** (Univ. of Colorado) was quoted in this article on the launch of the Solar Radiation and Climate Experiment (SORCE) satellite.

NASA Begins New Year with International Ozone Study, January 21; *Journal of Aerospace and Defense Industry News.* - More than 350 scientists from several countries are working together in the Arctic to measure ozone and other gases. **Michael Kurylo** (NASA HQ) is quoted.

NASA Dryden Personnel Help Measure Earth's Ozone, January 20; *Antelope Valley Press.* **Walter Klein**, NASA DC-8 mission manager (NASA Dryden), commented of the aircraft's flights over desolate areas in support of SOLVE II.

First Full-Body Scan of an Evolving Thunderstorm, January 16; *Scripps Howard News Service, MSNBC, Reuters, ABC News.* Research from **David Atlas** (NASA Goddard) is highlighted where radars unusual created a unique "full body scan" that shows the inner workings of storm clouds in the tropics.

NASA Instrument Captures Early Antarctic Ice Shelf Melting, January 14; *SpaceDaily.* **Mark Drinkwater** (ESA), **David Long** (Brigham Young Univ.), and **Steve Harangozo** (British Antarctic Survey) used data from NASA's SeaWinds has detected the earliest yet recorded pre-summer melting event in a section of Antarctica's Larsen Ice Shelf.

Two NASA Research Satellites Launched to Study Environment, Space, January 13; *Spacedaily*. ICESat and CHIPsat satellites were launched to study global ice and conditions in which stars are formed.

Tree-Ring Study Reveals Long History of El Niño, January 6; *SpaceDaily*. El Niño is not a new phenomenon, according to **Hector D'Antoni** (NASA Ames). His study looked 750 years into the past using tree-ring records.

Sea Changes by Satellite, January 6; *Earthwatch Radio.* **Watson Gregg** (NASA Goddard) said that phytoplankton levels fell by 6 percent globally between the early 1980s and the late 1990s.

Expert's Research Increases Understanding of Global Warming, Jan. 6; *The Newport News Daily Press*. **Bruce Wielicki** (NASA Langley) leads the Clouds and the Earth's Radiant Energy System (CERES) science team to understand how clouds affect the Earth's energy budget and global climate change.

NASA Funds New Crop of Remote Sensing Instruments, Jan. 6; *Space News*. **Eastwood Im** (NASA JPL) is using radar to track hurricanes through NASA's instrument incubator program.

Mapping With GRACE, Jan. 4; *Science News.* **Michael Watkins** (NASA JPL) discusses the objectives and progress of the GRACE mission.

The Altus Cumulus Electrification Study (ACES), January; *Unmanned Vehicles Magazine.* **Richard Blakeslee** (NASA Marshall) is using data acquired from research flights using

uninhabited aerial vehicles to gain a better understanding of thunderstorms.

Atmospheric "Waves" Reduced Ozone Hole, December 23; *Canada's Village, ScienceaGoGo.* **Paul Newman** (NASA Goddard) was quoted about his research. A greater number of large "planetary sized waves" in the atmosphere that move from the lower atmosphere into the upper atmosphere were responsible for the smaller Antarctic ozone hole this fall.

Flurry of Satellites to Monitor Earth and Examine Galaxy, December 10; *CNN, NY Times, Washington Post.* **Ghassem Asrar** (NASA HQ) and **Jay Zwally** (NASA Goddard) were quoted about the launch of ICESat, and **Mark Hurwitz** (Univ. of California at Berkeley) was quoted about CHIPSat,s launch.

Earth's Weight Watched Monthly, December 12; *Nature Science Update*. **Byron Tapley** (Univ. of Texas), **James Morrison** (Univ. of Washington) and **John Wahr** (Univ. of Colorado at Boulder) are all quoted in this article about the GRACE satellite mission.

Typhoons Help Ocean Life, December 7, *Associated Press*. **Tim Liu** (NASA/JPL) noted that NASA satellites have detected upwellings of nutrient-rich water from deep in the ocean that spark massive blooms of phytoplankton, after typhoons pass over an area.

NASA-Funded Research Looking at El Niño Events to Forecast Western U.S. Snowfall

— Krishna Ramanujan, kramanuj@pop900.gsfc.nasa.gov, Goddard Space Flight Center

Excerpts from Release 03-25

A NASA-funded study uses a computer model to understand an observed link between winter and spring snowfall in the Western U.S. and El Niño Southern Oscillation. Almost 75 to 85 percent of water resources in the Western U.S comes from snow that accumulates in the winter and early spring and melts as runoff in spring and summer. Understanding this connection and using it to predict future snowfall rates would greatly help both citizens and policy makers.

One of the missions of NASA's Earth Science Enterprise (ESE), which funded this research, is to better understand how the Earth system is changing. Within this framework, NASA is committed to studying variability in the water cycle, how well we can predict future changes in the Earth system and the consequences of change in the Earth system for human civilization.

Lead authors Jiming Jin and Norman Miller of the U.S. Department of Energy's Lawrence Berkeley National Laboratory, Berkeley, Calif., in collaboration with Soroosh Sorooshian and Xiaojang Gao at the University of Arizona, Tucson, find that higher and lower tropical Pacific sea surface temperatures (SSTs) that characterize El Niño and La Niña change atmospheric wind patterns in the mid-latitudes in winter and spring, shift the way moist air gets transported in the atmosphere, and directly affect Western U.S. precipitation and snow accumulation.

El Niño / Southern Oscillation (ENSO) marks a see-saw shift in surface air pressure between Darwin, Australia and the South Pacific Island of Tahiti. When the pressure is high at Darwin it is low at Tahiti and vice versa. El Niño, and its sister event La Niña, are the extreme phases of this southern oscillation, with El Niño referring to a warming of the eastern tropical Pacific, and La Niña a cooling.

By better understanding the connections between these processes, scientists can update their computer climate models to improve their ability to forecast future snowfall and water availability in the west.

For more information, please see: *www.gsfc.nasa.gov/topstory/2003/0210snowpack.html*

NASA Partners with USDA on Variety of Products

— *Elvia Thompson, elvia.thompson@hq.nasa.gov, NASA Headquarters, Washington*

— *Sandy Miller-Hays, smhays@ars.usda.gov, USDA*

NASA Administrator Sean O'Keefe and Agriculture Secretary (USDA) Ann M. Veneman announced the two agencies will join forces on a series of programs drawing on NASA's capabilities in monitoring, mapping, modeling and systems engineering to help protect the environment and enhance American agriculture's ability to compete in the world market.

NASA and USDA representatives participated in a workshop this week in Denver to identify collaborative research and development programs for the joint program. The workshop concentrated on five "focus areas" identified as national priorities of mutual interest: carbon management, agricultural competitiveness, air quality, water management and conservation, and management of invasive species.

"NASA is pleased to be part of this worthwhile effort, benefiting all Americans and humankind in general," said NASA Administrator Sean O'Keefe. "NASA's ability to view the Earth from the unique vantage point of space provides data to enhance our ability to predict climate, weather and natural hazards, as well as to mitigate and assess the effects of natural and human-induced disasters. As NASA works to understand and protect our home planet, the relevant and concise information we provide will allow USDA and other U.S. government agencies to make critical, accurate, and timely decisions," he said.

"We in USDA are very excited about the possibilities opened up by this new collaboration," Veneman said. "For example, to improve our agricultural competitiveness, we need a better understanding of weather and climate, especially the ability to predict weather events with more accuracy and longer lead times. The results from NASA research and development of earth science and technology could lead to weather and climate predictions and observations that can be integrated into local and regional support systems used in agricultural management," she said.

Participants discussed USDA policy and program needs that might be fulfilled by remote sensing information provided by NASA; identified current research and capabilities of both NASA and USDA that could help address those needs; pinpointed gaps in existing knowledge and research. They also outlined opportunities for collaborative research and development efforts between USDA and NASA to develop products and solutions to serve decision makers.

Information from this week's workshop will be used by a USDA/NASA Interagency Working Group in evaluating and establishing new research efforts, remote sensing systems, and models for decision support in agricultural systems. The information resulting from the workshop will also be incorporated into the plans of NASA's Earth Science Enterprise, which seeks to meet NASA's mission of understanding and protecting our home planet.

For more information about NASA or NASA's Earth Science Enterprise on the Internet, visit: *www.nasa.gov*

EOS Science Calendar

April 29 - 30

ASTER Users Workshop, Arcadia, CA. Contact: Michael Abrams, Email: michael.abrams@jpl.nasa.gov, URL: asterweb.jpl.nasa.gov/workshop

May 6 - 8

CERES Science Team Meeting, Norfolk VA. Contact: Shannon Lynch, (757) 864-2458, Email: s.m.lynch@larc.nasa.gov.

May 28-29

Aqua Science Working Group Meeting, Greenbelt, MD. Contact: Claire Parkinson, Email: Claire.L.Parkinson@nasa.gov

Global Change Calendar

March 31 - April 2

Challenging Times: Towards an operational system for monitoring, modeling, and forecasting of phenological changes and their socio-economic impacts, Wgeningen, The Netherlands. Contact: Mark Grutters, Email: Mark.Grutters@wur.nl, URL: www.dow.wau.no/msa/epn/challengingtimes/

April 6 - 11

AGU / European Geographical Society (EGS) / European Union of Geosciences (EUG) Joint Spring Meeting, Nice, France. Email: EGS@copernicus.org, URL: www.copernicus.org/EGS/egsga/nice03.

May 5 - 8

Final Open Science Conference, "A Sea of Change: JGOFS Accomplishments and the Future of Ocean Biochemistry." Washington, DC. URL: usjgof.whoi.edu/osc2003.html

May 7 - 9

American Society of Photogrammetry and Remote Sensing, Anchorage, AK. Contact: Thomas Eidel, Email: teidel@gci.net, URL: www.asprs.org/alaska/2003/.

June 2 - 3

16th Annual Geographic Information Sciences Conference, Towson University, Baltimore, MD. Contact John Morgan, tel. (410) 704-2964, Fax: (410) 704-38888, Email: jmorgan@towson.edu, URL: cgis.towson.edu/tugis2003/

June 4 - 6

Oceanology International (OI) Americas, New Orleans, LA. URL: www.oiamericas.com.

June 30 - July 11

International Union of Geodesy and Geophysics 2003, Saporo, Japan. Email: IUGG_service@jamstec.go.jp, URL: www.jamstec.go.jp/jamstec-e/iugg/index.html.

July 21 - 25

IGARSS 2003, Toulouse, France. Email: grss@ieee.org, URL: www.igarss03.com.

August 30 - September 6

Second International Swiss NCCR Climate Summer School: "Climate Change — Impacts of Terrestrial Ecosystems." Grindelwald, Switzerland. Contact: Kaspar Meuli, Email: nccr-climate@giub.unibe.edu, URL: www.nccr-climate.unibe.ch.

September 8 - 10

Sixth Baiona Workshop on Signal Processing in Communications, Baiona, Spain. Contact Carlos Mosquera, Email: baiona03@baionaworkshop.org, URL: www.baionaworkshop.org

September 23 - 26

Oceans '03, San Diego, CA. Contact: Brock Rosenthal, Email: brock@o-vations.com, Tel: (858) 454 4044, URL: www.o-vations.com.

November 10 - 14

30th International Symposium on Remote Sensing of Environment, Honolulu, HI. Email: isrse@email.arizona.edu, URL: www.symposia.org.

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