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EDITOR'S CORNER

Michael King
EOS Senior Project Scientist

I am happy to report that progress is being made toward a follow-on mission for Landsat. On August 13, John Marburger, Director of the Office of Science and Technology (OSTP), released a memorandum that places a Landsat-type instrument on NPOESS C1 in 2009. It also continues consideration of a bridge mission. On September 6, OSTP convened a workshop for Federal agencies that use Landsat data asking the importance of Landsat data and how critical it is to their mission. They also released an inquiry to the community of Landsat users. On August 5, a Request for Proposals (RFP) was released to industry asking for information on the ability to create a followon for Landsat 7. A summary of that RFP was presented to Ghassem Asrar September 29. Additional studies are being done at this time.

Aura is still performing well except for HIRDLS. MLS, TES and OMI have completed their exit briefings and have become operational. HIRDLS still has a problem. The HIRDLS Anomaly Resolution Board has determined that the likely cause of this anomaly is an internal blockage, probably between the scan mirror and main aperture. They believe it is Kapton. An anomaly resolution roadmap was outlined at a meeting on September 29, which will culminate on November 16 with a corrective action plan being presented to the board. There will be a special session on Aura at the AGU Fall Meeting in San Francisco in December.

ICESat's Laser 3 was turned on October 3 about 5:30 PM while the satellite was over Antarctica. The startup went well and the science data processing team has processed and distributed the first Laser 3 elevation profiles that were captured across Antarctica's Ross Ice Shelf. The output of the green laser pulse at 532 nm is too low to be unusable, whereas the laser output energy of the primary altimetry wavelength of 1064 nm is quite strong.

Continued on page 2

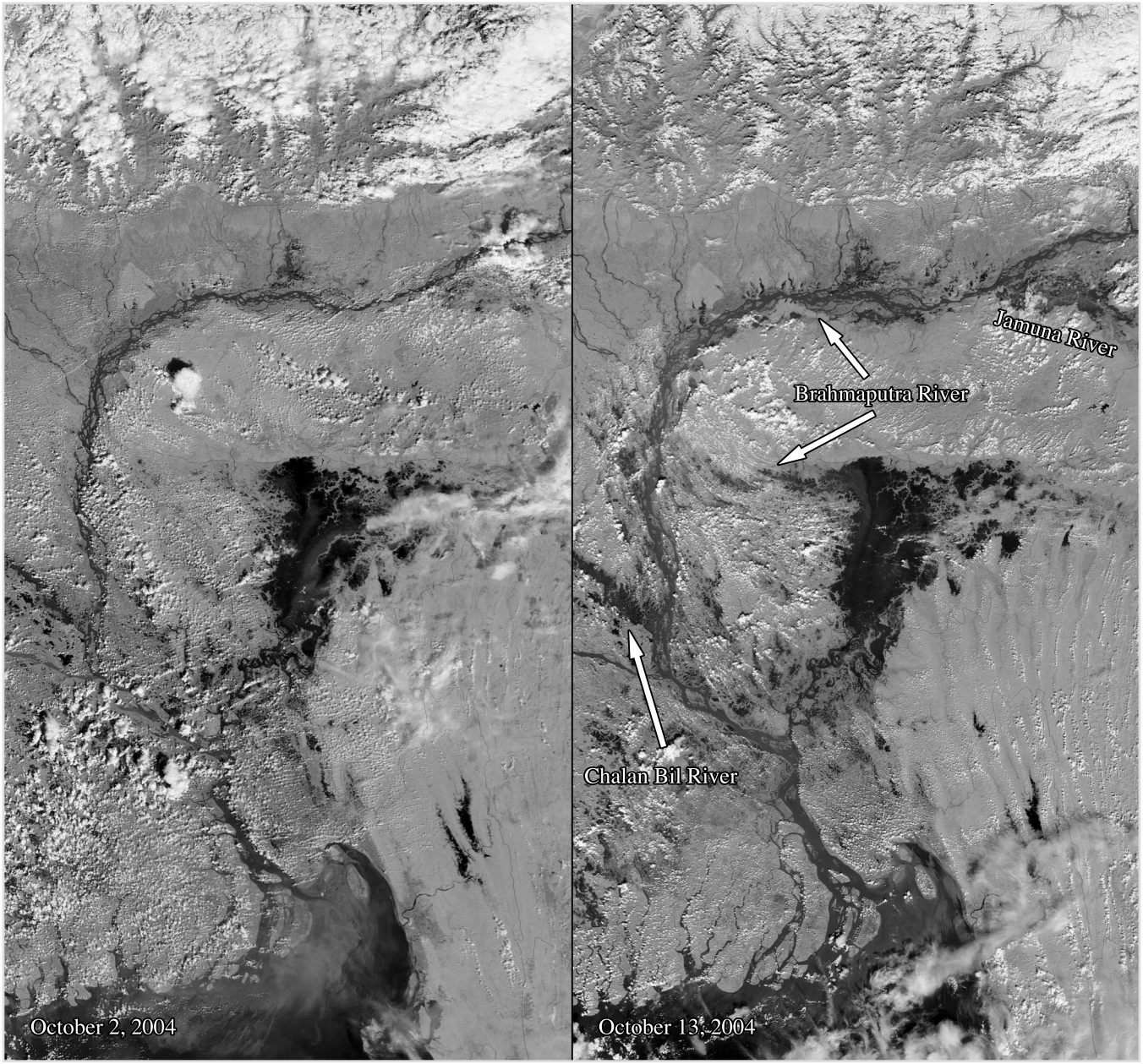
There will be a special session and a press conference on ICESat at the AGU Fall Meeting as well.

At this writing, the launch of the CloudSat and CALIPSO missions that are co-manifest on a Delta launch vehicle have been postponed from March until May 26, 2005.

On October 13, 2004, the rivers of northeastern India and Bangladesh remained swollen after a tropical depression dumped heavy rain over the region for several days the previous week. The storm is being called the worst non-monsoon storm in a decade, and the floods it triggered were deadly. To date, over 150 people have been confirmed dead as a direct result of the floods, according to media reports. This pair of images, both acquired by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite, shows the extent of the floods.

The most deadly flooding occurred in the Goalpara district of India's Assam state, shown in the top right corner of these images. The largest loss of life occurred in floods along the Jamuna River and in the near Himalayan foothills. However, as the image taken on October 13 shows, other rivers were also flooded. The normally wide Brahmaputra has expanded further, and to its southeast, Bangladesh's Chalan Bil River is also swollen.

NASA images courtesy the MODIS Rapid Response Team at NASA GSFC



MODIS Science Team Meeting, Plenary Sessions Summary

— Yolanda Harvey, yrharvey@yahoo.com, Science Systems and Applications, Inc.

The Moderate Resolution Spectroradiometer (MODIS) Science Team Meeting (MST) was held July 13-15, 2004, at the BWI Marriott in Baltimore, MD. Presentations covered MODIS' new and existing products, with special emphasis on MODIS' changing focus as a result of the recent recompetition. Posters were also presented, many of which are available on the MODIS website. Following are the highlights of the plenary sessions; full minutes are available at *modis.gsfc.nasa.gov*.

Vince Salomonson, the MODIS Team Leader, opened the meeting, noting the new and continuing high-quality products that the MODIS instruments and team members produce. He welcomed the 62 new and 28 returning team members and stressed the need for everyone to continue working together to meet the goals and objectives of the NASA Earth Science Program. He also identified five overarching thrusts he is advocating for the Science Team to pursue now and in the future. These are:

- *To improve access to, and use of MODIS data products*. This includes supporting and collaborating with the relevant parts of the Earth Observing System Data and Information System (EOSDIS) or other entities pursuing the provision and use of MODIS data products for the general science and applications communities or the public at-large.
- *To pursue the programmatically necessary goal of providing climate-data-record-quality data sets of MODIS products*. This involves obtaining characteristics or requirements for these data sets from the science community via procedures approved, prescribed, or represented by NASA Headquarters Office of Earth Science program management.
- *To interact with the modeling communities*. This involves facilitating and expediting the assimilation of MODIS data products into such Earth-system and Earth-system component models. These models can include everything from global Earth systems processes and trends to regional- and local-scale model simulations, as well as applications specific to resource management and decision models support needs.
- *To pursue interdisciplinary efforts*. This includes efforts that use MODIS products and, where appropriate, ensuring that MODIS land products can be employed effectively by atmospheric efforts, MODIS atmosphere products can be used by land and oceans efforts, etc.
- *To educate and train students*. This involves teaching students to appreciate and be able to use remote-sensing, e.g. MODIS, data for doing Earth science and applications.

Diane Wickland, the MODIS Program Scientist from NASA's Office of Earth Science, spoke on the need to continue making and keeping the existing data products at the best quality possible, develop new data products to enable new science and applied usages, and use MODIS data to create and continue a new scientific understanding of the planet that will ultimately be used in governmental decision-making. Change is inevitable, and the MODIS project must continue adapting, especially as NASA aligns itself at the top level with the President's Exploration Vision. Regular reviews of Algorithm Theoretical Basis Documents (ATBDs) and other documentation will become a focus over the next few years, especially as NASA moves towards creating Climate Data Records (CDRs). Wickland also noted that she is switching to the NPOESS Preparatory Project (NPP), and that Paula Bontempi will be taking over as the MODIS Program Scientist.

Martha Maiden, the NASA Data Systems Program Executive, provided an overview and description of the current state of the Earth Science Enterprise (ESE) Data and Information Systems (DIS), noting that the overall structure is moving toward a more-distributive architecture. She pointed out that the ESE is transferring its attention from missions to measurements in an effort to focus the DIS on Earth Science communities and their data needs, especially as applied to CDRs. The DIS must

continue integrating into Earth System Science by increasing data usability and working with science research, application, and modeling communities. The primary goal is evolution to meet future ESE objectives and priorities, while additional goals include increasing life-cycle cost effectiveness, increasing end-to-end-data and data-system efficiency, and improving support for data use by end users. Maiden also discussed the Ocean Discipline Processing and Precipitation Processing System (OCDPS), which is providing prototyping activity for understanding the elements of measurement-based data systems.

Shaida Johnston, the MODIS Systems Engineering Advisor, gave an overview of MODIS data processing, archiving, and product distribution, primarily for the benefit of the new Science Team Members. She discussed how data flows overall, listed the current products, noted where each is processed, and how they are distributed. She reported that the Collection 4 Land and Atmospheres reprocessing efforts are almost completed, and gave a general update on how the MODIS ocean color processing is proceeding as it now is being accomplished within the OCDPS. Johnston explained that "Collection 4" refers to a processing status, or "event," and explained how collections work.

Ed Masuoka, the Science Data Support Team (SDST) Leader, reported on the MODIS Adaptive Processing System (MODAPS) processing details for Collections 4 and 5, and gave some statistics on the amounts of data the system deals with. For Aqua Collection 4, atmospheres data from 2003 and 2004 has finished, and 2002 data should be completed by mid-August of 2004. Land data will be finished around July 5, 2004. MODAPS is also processing a combined suite of Aqua and Terra products, and it should be finished around December of this year (the same time science testing for Collection 5 concludes). Aqua SST processing will be done around of April 27, 2005.

Chuck McClain, the Ocean Color Project Scientist, presented on the processing and validation side of ocean color. MODIS ocean color processing was reorganized by NASA HQ to coincide with the new MODIS Ocean Science Team selection. It picked up ocean color processing of Aqua MODIS data, while sea-surface temperature (SST) remains in MODAPS. The emphasis is on the Science Community. The ocean color group needs to be able to interact with the science community and the Science Team to ensure data quality. The ocean color processing strategy is to initially focus on MODIS Aqua, specifically on the quality of calibration, especially in water-leaving radiances. They'll also reduce the data suite to a more-basic level, and let the community decide what additional products the group ought to produce.

Gene Feldman, the Ocean Color Project Manager, discussed the distribution of data for the Ocean Color (OC) Team. NASA HQ's switch in focus from missions to measurements gives a good definition of where the team wants to go. The group develops expertise and addresses broader issues by working with the broadest user-community possible to come up with a collaborative system. The goal is to make available the highest-quality ocean color data to the broadest user community possible, and to do it in the most timely and efficient manner possible. For ocean color, calibration is the most important thing. The group must be comprehensive. A centralized calibration and validation program closely coupled to the data processing and quality-control system is also important, as is having a distinct software development program dedicated to providing user-friendly data-processing software to the community. The project's philosophy is designed to support and involve as a large a community as is possible.

On the last day of the MODIS Science Team (MST) Meeting, the plenary session focused on the discussions that took place over the past two days. Each major group within the team presented their conclusions.

Jack Xiong, the MODIS Characterization and Support Team (MCST) Leader, presented the MODIS instruments' statuses and prospects. On-orbit performance has been very good overall; the only real issue is with Band 6 on Aqua MODIS. In the reflective solar bands, there are three noisy detectors all in Band 6, and 15 inoperable detectors (13 from pre-launch: 12 in Band 6 and one in Band 5). Another issue with Aqua MODIS is a 450-m shift in both the along-scan and along-track directions for the Shortwave Infrared/Longwave Infrared (SWIR/LWIR) Focal Plane Assemblies (FPA) (relative to Near Infrared (NIR) FPA). Otherwise, Aqua MODIS performs better than Terra MODIS. Terra MODIS has a history of noisy detectors, and Aqua MODIS has a few of its own. Xiong discussed a number of instrument-configuration changes partially responsible for, or in response to, these issues, including switching from A-side to B-side electronics and back. This has had some effect on the data. The MODIS Characterization Support Team (MCST) has worked hard to minimize the impact to the science products. Indeed, the instruments have performed well, according to their

design specifications. Terra MODIS has been operating for more than 4.5 years, and Aqua MODIS for more than two years. MCST has made constant efforts to maintain and improve instrument calibration and characterization, including working closely with science group representatives and the Santa Barbara Remote Sensing (SBRS) instrument vendor representatives.

David Herring, the Chief Editor of NASA's Earth Observatory website (*earthobservatory.nasa.gov*), presented on the NASA Earth Observations (NEO) Gateway. The NEO mission is to significantly increase demand for NASA ESE data while simultaneously simplifying access to geo-referenced browse imagery. The system will work very much as a gateway by marrying images to data availability. It will be a centralized repository of geo-referenced browse images, as well as a tool providing a flexible user interface for varied user groups to meet the needs of both novices and advanced users. It will provide functionality to link directly from browse images to source data, as well as a resource that will make browsing for and ordering data much simpler and faster, and will be a site where data-related outreach and education can be centrally coordinated and disseminated. The project is still in development/testing, but will likely begin ingesting production data in February 2005, and will hopefully be publicly launched with selected MODIS data sets in April of 2005.

Mitch Goldberg, Chief of the National Environmental Satellite and Information Service (NESDIS) Climate Research and Applications Division, described the motivation behind the plan to transition some MODIS operations to the National Oceanic and Atmospheric Administration (NOAA)/NESDIS—in part because of problems associated with the Advanced Very High Resolution Radiometer (AVHRR) instrument on the NOAA 16 satellite. This and the broader issue of use of MODIS data by NOAA would lead to a report containing a "Statement of Needs" (recommendations and budget estimates), which will be presented to Greg Withee and NESDIS Office Directors and NASA management some time in October 2004. It will also include end-to-end requirements for MODIS quasi-operational products. These products are important for getting users ready for NPP and NPOESS, and also to obtain important feedback from users so that they can maximize the investment of NPP and NPOESS.

Chuck McClain, the Ocean Color Project Scientist, presented the Ocean Color Group's discussions. Major topics included coordinating data collection activities within the team; reviewing data policies for data investigators; expanding the product suite; and aligning data quality between SeaWiFS and Aqua MODIS. The team has also instituted a Calibration Working Group; the reasons for doing so include thrusts toward CDRs and losing the Marine Optical Buoy (MOBY) and the Sea-viewing Wide Field-of-view Sensor (SeaWiFS), which are the backbone of the group's calibration program. On the topic of Salomonson's Team Leader Thrusts, the group discussed the following:

- *Data access*. The OCDP strategies for reduced file size, SeaDAS support, and direct browse and distribution are working extremely well. Aqua MODIS distribution now exceeds SeaWiFS.
- *Data assimilation.* OC product assimilation into numerical ecosystem models is a fairly recent development by a few research groups, but has not yet been picked up at operational centers. Different models require different formats and resolutions (the OC group provides regridding/averaging tools rather than special products).
- *Outreach*. Newsworthy events are captured in ocean imagery; early notification of publications and newsworthy scientific funding are on the website; and articles are published in popular magazines. The team also publishes an annual report.

Chris Justice, the MODIS Land Group Leader, reported that the group is actively contributing to the emerging ESE land focus areas. The group is emphasizing six areas (as is reflected in the presentations), including stewardship of data, community outreach, land data systems development, transitioning capabilities to the operational domain (NOAA and Direct Broadcast [DB] groups), CDRs, and international observation coordination. In addition, the Land Group is tracking a number of instrument issues, including reflective bands calibration accuracy and stability, noise in the Terra longwave bands; striping in SWIR (esp. Band 7), and polarization corrections. Four breakout sessions focused on MODIS Normalized Difference Vegetation Index (NDVI) – Enhanced Vegetation Index (EVI) comparisons, community outreach, catering to modelers, and evolving toward CDRs. The CDRs were a particularly hot topic — the group recognized the need to develop long-term data records of critical variables from multiple sensors of sufficient quality to study global change. The session members stressed that to be able to generate CDRs, it is essential

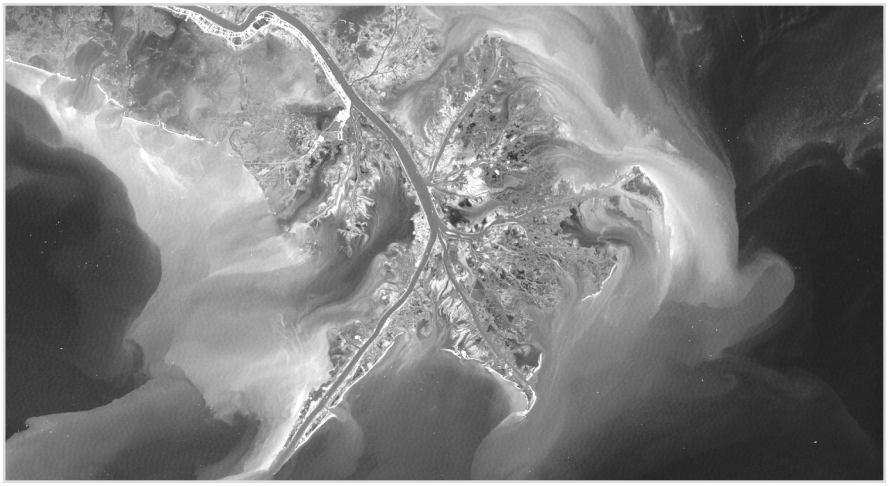
to preserve the data, instrument, and calibration information. Accuracy and stability documentation are essential for individual instruments, so the community must decide which ground-based instruments are needed to support the accuracy and stability of the data. Validation needs to be part of the CDR process, and there needs to be an appropriate level of funding commitment. The CDRs will need science stewardship, keeping the CDR generation close to scientists that are using the product, and the CDRs need to evolve with an understanding of data and science needs.

Michael King, the MODIS Atmospheres Group Leader, reported that the group covered a number of topics, with special focus paid to increasing interaction between all of the discipline groups. Software updates were a large portion of the topics discussed, with a recommendation made to incorporate destriping detectors into calibration, characterization, and Level 1B data production. Updates to a number of the products were discussed, especially the Cloud Mask and Cloud Product. Data use, assimilation, and interdisciplinary science move forward with the Polar Winds product, while modeling activities continue, including a Global Ozone Chemistry Aerosol Radiation Transport (GOCART) model of anthropogenic aerosol radiative forcing; and a new clear sky radiance dataset being developed for ingest at European Centre for Medium-range Weather Forecasts (ECMWF). King noted that the group will put new emphasis on updating ATBDs and other documentation.

Vince Salomonson thanked everyone for attending the meeting and contributing to MODIS. He stressed the importance of keeping access to products simple and fast for users at any level. Collaboration across disciplines and agencies is also important, particularly concerning DB, real-time, and bent-pipe data efforts at NOAA/NESDIS. We have to answer questions on how to further such efforts. We need to define what the term "climate-quality" in climate-quality data sets means in order to move forward. Our efforts to assimilate MODIS data into the big GCM climate and weather modeling groups; e.g., ECMWF, Global Modeling and Assimilation Office (GMAO), National Centers for Environmental Protection (NCEP), etc., must continue.

Hal Maring, the NASA Atmospheres Program Manager, said that he was very impressed with the wide application and utilization of MODIS data. It's obvious how carefully the people in this program worry about calibration/validation, because it is so obviously applied to a wide range of applications that are not only global in scope, but in utilization as well. He noted that during the recompetition, there was a shift in programmatic emphasis away from cal/val, and more toward actually using the science data. There is a new emphasis on cross-disciplinary and cross-sensor work; Maring was particularly impressed by the efforts of the Atmospheres Group in this area. The team needs to knock down barriers between traditional disciplines, and it was nice to observe Ocean Color members actively participating in the Atmospheres breakout session. Finally, the third emphasis is on data models—MODIS needs to be involved in more of these.

Paula Bontempi, the new NASA MODIS Program Scientist, noted the diversity of applications and hard work of the MODIS team. Tremendous progress has been made over the past decade. She also noted that interdisciplinary products are increasingly important, and the team needs to break down the barriers between disciplines. No matter what NASA Headquarters reorganization brings, the focus will still be on the Earth science/model as a whole.



The image above of the Mississippi River delta was acquired on November 27, 1999, by the Enhanced Thematic Mapper plus (ETM+) aboard NASA's Landsat 7 satellite. NASA image by Robert Simmon, based on Landsat data provided by the UMD Global Land Cover Facility.

Joint Advanced Microwave Scanning Radiometer for EOS (AMSR-E) Meeting

— Elena Lobl, Elena.lobl@msfc.nasa.gov, AMSR-E Science Team Manager

The Joint AMSR Science Team meeting took place this year at Colorado State University in Fort Collins, Colorado. The U.S. AMSR-E Science Team, the Japanese AMSR-E Science Team, and both processing teams attended. The meeting was, as always, beneficial: we exchange information about the research, processing, and validation done with the AMSR-E data. This year, we also had attendance by some of the new team members selected in the last Aqua NASA Research Announcement (NRA). All presentations made at the meeting are available at the NASA AMSR-E home page (*www.ghcc.msfc.nasa.gov/AMSR*).

Ramesh Kakar, the Aqua Program Scientist, opened the meeting with the new NASA organization chart. Some discussions followed.

There were two Japanese Aerospace Exploration Agency (JAXA) presentations the first day. **Masato Yamanashi** (JAXA/AMSR-E Project Coordinator) presented a JAXA AMSR-E project update. The Earth Observation Center (EOC) is the organization tasked with the production of the AMSR-E Level 1A data. They are working on an updated calibration, and the new Level 1A data will be available for distribution at the end of January 2005. Yamanshi then presented the ongoing field campaigns: soil moisture in Mongolia, Tibet, and Thailand; snow in Siberia; sea ice around Antarctica; and precipitation on Minamidaito and Hegurajima islands. The 'ground truth' data from these campaigns will be posted on the web at *sharaku.eorc.jp/AMSR/data_val*. Because of the early failure of the ADEOS II spacecraft (which carried an AMSR), JAXA has decided to develop a direct-broadcast capability and have the immediate use of the data from Terra and Aqua around Japan. The main use of these data (MODIS and AMSR-E) is for monitoring the weather around Japan. The two main contributors to severe weather in Japan are typhoons and the Kuroshio current (which has high sea-surface temperature) flowing on the south side of Japan. Finally, Yamanashi talked about the third Research Announcement that will be coming out at the end of October, with the funding decisions to be announced in March 2005. The Principal Investigators (PIs) selected will be able to obtain AMSR and AMSR-E data and products free of charge.

Makoto Imanaka (JAXA, EOC, Processing Manager) presented the AMSR/AMSR-E data-processing status at JAXA/EOC. The processing at EOC is going well. Imanaka presented the schedules for the public release of the AMSR/AMSR-E Level 1A version 2, as well as the Level 2 products. The public release will start at the end of January, processing forward, with the processing of the data prior to January being done in parallel. All of the archived Level 1A data should be processed by August 2005.

Dawn Conway, Lead Software Engineer at the Team Lead Science Computing Facility (TLSCF), and **Kathryn Regner**, system engineer at the Science-led Investigator Processing System (SIPS-GHCC) presented on the status of the U.S. data processing. Conway presented an estimated schedule for the delivery of the next changes to the Team Leader Science Computing Facility (TLSCF) by all the algorithm developers. This schedule was based on a September delivery of the new version of the Level 1A from EOC in Japan. At the meeting our EOC colleagues announced that this new version of the Level 1A data will be delivered in January 2005, with reprocessed data delivered in February 2005. Also included in the schedule was a proposed reprocessing of all data no earlier than March 2005. This reprocessing would follow JAZA's delivery of the reprocessed version 2 L1A data. The algorithm updates and reprocessing schedule will be revised to reflect the January 2005 version L1A delivery. Conway's schedule will have to be revised to take into account the new date. She also discussed the browse images for all the AMSR-E products. These images will be archived at National Snow and Ice Data Center (NSIDC), and a '.png' version of these images (called 'Quick-look') will also be available on our website. Along with these browse images, a Quality Assurance (QA) summary that is generated during processing, will also be archived at NSIDC,

as well as listed on the AMSR website. Conway also noted that the TLSCF is reviewing the Heirarchical Data Format (HDF) version 4.2 and will begin integrating algorithm software utilizing this version in the near future. Conway also initiated a discussion of when validated algorithms can be expected from the algorithm team. Finally, Conway and **Elena Lobl** suggested an AMSR/AMSR-E workshop to be held in the summer of 2005 for all interested users.

Regner reviewed the data flow from the spacecraft to the EOS Data and Operations System (EDOS) at Goddard Space Flight Center (GSFC), EOC Japan, the Physical Oceanography Distributed Active Archive Center (PO.DAAC)/Jet Propulsion Laboratory (JPL) and finally Science Investigation-led Processing System (SIPS)-RSS and the Global Hydrology and Climate Center (GHCC) where the higher level products are generated. She also reviewed the status of reprocessing of all data with the second version algorithm. The reprocessing of the entire data set (from June 18, 2002) will be completed by the end of October 2004. A follow-on reprocessing with the latest algorithms is planned for early next year. The browse images, also discussed by Conway, are produced only forward in time. Browse images for the entire dataset will be produced as part of the reprocessing scheduled to start next year. A few other topics were discussed, including late file processing, secure FTP implementation, and a new point-of-contact (POC) while M. Goodman, SIPS Manager is at NASA/HQ. Regner will serve as the new POC for the coming year; she can be reached at (256) 961-7791 or *Kathryn.regner@msfc.nasa.gov*.

The status of the AMSR-E data archive at NSIDC was presented by **Melinda Marquis** (NSIDC/AMSR-E Product Team Lead) for the processed space data, and by **Michele Holm** (NSIDC/AMSR-E Validation Data Coordinator) for the Validation data sets. Marquis presented the NSIDC AMSR-E operations, data ordering methods, available tools for AMSR-E data users, and distribution statistics. Her talk concluded with the NSIDC's outreach plans. NSIDC is ingesting and distributing the following: Level 1A (counts), Level 2A (spatially re-sampled brightness temperatures), Level 2B and Level 3 products (rainfall, ocean sea-surface temperature (SST), wind, columnar liquid water and columnar water vapor, soil moisture, snow and sea ice). The four methods for ordering the AMSR-E standard products are:

- *Data Pool*. All AMSR-E products are retained for 160 days (at the present).
- *EOS Data Gateway (EDG)*. This interface provides access to the entire archive of data, and provides access to the HDF-EOS Web-based (HEW) subsetter.
- *Search 'N Order Interface (SNOWI)*. This tool provides a quick and simple way to search and order limited products from NSIDC and other Distributed Active Archive Centers (DAACs).
- *Subscription*. This option is convenient if you require new data for a specific region as they are ingested into NSIDC's data archive, but you do not want to actively search and order data files each time. Website: *nsidc.org/daac/subscriptions.html*

In addition, NSIDC hosts a 7-day, rolling archive of preliminary AMSR-E data, for users who need data closer to near-real-time than final, standard data AMSR-E products can be produced. These products are made accessible from the (EOSDIS Core System) ECS at NSIDC (via the four methods above). Interested users can register at (*nsidc.org/data/amsr/prelim.html*) to access these preliminary data.

The website for ordering the final, standard AMSR-E data products is: *nsidc.org/data/amsr/order.html*. The tools available for AMSR-E data users are found at: *nsidc.org/data/amsr/tools.html*.

Tools include:

- AMSR-E Swath to Grid Toolkit (AS2GT, *nsidc.org/data/tools/pmsdt/as2gt.html*)
- HEW (a subsetting tool accessible via the EDG at *nsidc.org/~imswww/pub/imswelcome/index.html*)
- Land masks (at *ftp://sidads.colorado.edu/pub/DATASETS/PASSIVE_MICROWAVE/POLAR_STEREO/TOOLS/MASKS/HDF/)*
- HDF-EOS information and tools (*nsidc.org/data/hdfeos/*).

Michelle Holm described the process that the validation data undergo, from 'Ingest to Public Release.' Once the data are ingested at NSIDC, high-level metadata are generated, and, after the PI reviews the data, they are made available to the public. At this point 16 out of the 23 cryospheric validation data sets, 9 out of 11 rainfall data sets and 35 out of the 42 Soil Moisture Experiment 2002 (SMEX02) data sets are available to the public. The website to access these data is: *nsidc.org/data/amsr_validation/*. In the near future, Holm plans to overhaul the website where these data are available, and make the access to the data through the EOS Data Gateway.

Carlos Gomez (EOS Data and Operations Systems [EDOS] Operations

Manager) joined our meeting with a proposal for improving the data latency. The data latency is a parameter that we are trying to shorten (improve) so that the users have the data available in a more timely fashion. Gomez' proposal is to simply replace the current process—whereby JAXA/EOC is notified that data are vailable, JAXA/EOC then 'gets' the data and sends out a confirmation notice—with simply having EDOS 'push' the data and provide notification of completion of transfer. JAXA at the moment is studying this proposal.

The second day of the meeting was reserved for all the science-related presentations. The day started off with presentations from each U.S. AMSR-E Science Team member as well as some of the Japanese members. In the afternoon, the newly accepted team members spoke. There were three special topic presentations: calibration update from JAXA, geolocation issue from Remote Sensing System (RSS) and water-vapor profile from (Atmospheric Infrared Sounder) AIRS presented by **Bjorn Lambrigsten**.

Roy Spencer (US AMSR-E Science Team Leader) has looked at the AMSR-E rainfall data and showed that the tropical oceanic data depart from *single rain rate* theory in a manner that appears to be only explainable by the footprint-filling effect. Spencer concluded that the magnitude of the departure from theory can be considered as a quantitative signature of the degree of footprint-filling.

Chris Kummerow (AMSR-E Science Team member/rain over ocean) presented the rainfall algorithm status and future plans. The algorithm is running with no issues at the moment, and minor modifications in the coastal part of the algorithm continue to be made. The next version (version 7) will use the Tropical Rainfall Measuring Mission (TRMM) Precipitation Radar (PR) to construct a much more robust *a-priori* database (that reflects observed distribution of clouds). This solution will benefit the AMSR-E algorithm over oceans warmer than 15° C.

Jeff McCollum (AMSR-E Science Team member/rain over land) presented first results from validation analysis using the Iowa rain-gauge network. Overall AMSR-E retrievals were about 20% higher than the gauge data in 2003. The algorithm will eventually take this and any other validation results into consideration. A second topic discussed by McCollum was the treatment of coasts in the retrieval algorithm. For the last submission of the algorithm, the initial criterion of the coastal rain/no-rain decision tree is changed to a no-rain condition.

Tom Wilheit (AMSR-E Science Team member/monthly rain) developed the algorithm for retrieving monthly rainfall. In accumulating monthly rainfall totals, given that a month is around 700 hours, even small offsets in the retrievals can amount to a great deal of rain. Instrument calibration and modeling uncertainties mean that it is unrealistic to expect a bias much less than 0.1 mm/h, i.e., 70 mm/month. We can solve for the offset by accumulating histograms of rain rate with negative rain rates allowed whenever the brightness temperatures call for negative values. The figures show histograms for several channels of AMSR-E and, for comparison, TRMM Microwave Imager (TMI). Since, even in very rainy areas, the most probable rain rate is zero, the peak of the histogram indicates any bias or offset in the retrievals. The data are collected separately for odd and even days of the month to permit uncertainty estimates for the bias determinations. Even though the biases are smaller for the AMSR-E than for the TMI for the particular 5x5 box shown, the AMSR-E biases are slightly more variable than those for TMI. Using the odd/even day partitioning, the uncertainties in the offset for the 37V GHz channel (the most important for this purpose) can be shown to be about 16 mm/month for AMSR-E and about 14 mm/month for TMI. Examination of the data in the space of two brightness temperatures shows slightly less self consistency in the AMSR-E data than in the TMI data, which is consistent with this slightly higher bias uncertainty in the AMSR-E. Presumably, the source of this increased uncertainty is variability in the warm-load calibration.

Chris O'Dell presented research done by Bennartz and Petty (AMSR-E Validation Team members/rain over oceans). Bennartz and his colleagues looked at global AMSR-E Level 2A (brightness temperatures) and Level 2 ocean products (sea surface temperature, wind speed, and water vapor column amount) and compared them with forecasts of NCEP's Global Forecasting System (GFS). AMSR-E Brightness Temperatures (T_b's) compare well with simulated T_b's; global biases are generally smaller than 1 K for cloud-free cases and less than 2 K for cloudy situations.

At lower frequencies (especially at 6 and 10 GHz), near the specular reflection angle of the sun (sunglint angle), a significant warming—sometimes more than 10 K—is observed due to direct reflection of sunlight into the sensor. To avoid any deterioration due to

sunglint, the use of AMSR-E data over oceans should be restricted to sunglint angles larger than 20°. This results in an about 4 % reduction in global coverage.

The standard AMSR-E Level 2 ocean products compare favorably to the GFS data. Biases (model-satellite) and root mean square deviations for these products are: SST (K): -0.06/1.45; surface wind speed (m/s): +0.05/1.75; water vapor column (kg/m^2): +0.59/2.52.

Frank Wentz (Remote Sensing Systems, AMSR-E Science Team member/ocean products) gave an update on the AMSR-E calibration algorithm and on the validation of the AMSR-E ocean products. A revised calibration algorithm is being tested that does not rely on coincident Special Sensor Microwave Imager (SSM/I) and TMI observations. The basis for the new method is the assumption that the vertical-polarization (V-pol) and horizontal-polarization (H-pol) effective temperatures of the hot load are the same. Under this assumption, the effective temperature can be expressed in terms of a linear combination of V-pol and H-pol antenna temperatures that is insensitive to atmospheric water vapor and cloud water. This insensitivity allows the U.S. to use monthly climate values for vapor and cloud rather than the SSM/I and TMI values and still maintain the required accuracy. Other pending improvements in the Level-2A algorithm were also presented, including: (1) a correction for the AMSR-E pitch error that occurred in August-September 2003; and (2) a flag for radio frequency interference (RFI) contamination reflecting off the ocean surface. The second part of the talk was a validation study that compared AMSR wind speeds with scatterometer wind speeds. The passive and active wind retrievals are in close agreement. The root mean square (rms) difference on a footprint-by-footprint basis is 0.8 m/s, and for monthly averages, the difference is about 0.3 m/s. Preliminary WindSat results were also presented with the focus on how WindSat can be used to assist in the calibration of AMSR.

Don Cavalieri (AMSR-E Science team member/sea ice) presented a brief overview of the validation data sets collected during the March 2003 Aqua AMSR-E Arctic Sea Ice Validation Field Campaign. The validation data sets including satellite, aircraft, and surface-based measurements are being used to validate the three standard AMSR-E sea-ice products: sea ice-concentration, sea-ice temperature, and snow depth on sea ice. He then proceeded to show validation results from a comparison of AMSR-E and Landsat 7 ETM+ Bering Sea ice concentrations for March 13 and 15, 2003. The ETM+ imagery provides high-resolution (15 meter) sea-ice concentrations with which to validate the AMSR-E ice concentrations mapped to a resolution of 12.5 kilometers. For March 13, the mean ice concentration difference (AMSR minus Landsat) was -1.5% and the standard deviation of the difference was 6.4%. The rms difference was 6.6%. For March 15, the mean difference was -1.9%, whereas the standard deviation was 6.0% and the rms difference was 6.3%. An analysis by sea-ice type showed that the largest source of error was the presence of new ice types both at the Bering Sea ice edge and in coastal polynyas. Over ice-free water and in areas of young and first-year sea ice, the rms error was on the order of 1%. These results will be used to improve the Arctic-ice-concentration algorithm accuracy particularly in areas of new ice such as coastal polynyas where strong air-sea-ice interactions take place in winter.

Joey Comiso's (AMSR-E Science Team member/sea ice) AMSR-E Bootstrap Algorithm (ABA) for sea ice has been enhanced to improve the accuracy of both ice concentration and surface ice temperature products. The 3-channel technique that has been used for the Arctic region is now being used for the Antarctic region. The 2-channel technique has worked very well in the 1980s for Scanning Multifrequency Microwave Radiometer (SMMR) and SSM/I, but with lots of icebergs calving in the 1990s and 2000s, the emissivity of the surface has changed quite a bit. Icebergs have relatively low emissivities because of volume scattering, and the effect is similar to that of multiyear ice in the Arctic in terms of ice-concentration retrieval. The use of the 3-channel technique minimizes the errors associated with ice surfaces with low emissivities. Examination of surface ice temperature products also revealed that abnormally cold temperatures are retrieved near the marginal ice zones and in low-concentration regions. In low-concentration regions, typically near the ice edges, the ice cover consists mainly of new ice, small pancakes, or brash ice (or broken floes), the temperature of which is similar to that of the freezing or melt temperature. To overcome this problem, a threshold in ice concentration of about 30% was set such that whenever the ice concentration is less than this value, the ice temperature was set to 271 K. The procedure provided more-consistent spatial maps of surface-ice temperature. A 6-km-resolution ice-concentration algorithm was also developed (using the 89 GHz channels), and the results show promise for using the data to identify surface features such as leads

and large floes. More work, however, is required for this research product since the algorithm tends to overestimate ice concentration in cloudy areas and underestimate the ice concentration in some snow-covered areas. Results from an upcoming Antarctic campaign will be used to resolve some of the validation issues.

Richard Kelly (AMSR-E Science Team Member/snow water equivalent [SWE]) took over the algorithm development for SWE from Al Chang. He was helping Chang with the validation program even before Al's passing. Validation of the AMSR-E snow-depth and water-equivalent product is an important aspect of the product development, and two studies are under investigation as part of this AMSR-E snow-product validation effort. First, AMSR-E data are used to analyze the evolution of the snow pack in the Ob River basin during the snow season of 2002-03. The Ob River is the biggest Russian river with respect to its watershed area (2,975,000 km^2). The majority of snow cover is contained in the lowlands rather than in mountainous regions and persists for six months or more. During the snow season, surface air temperatures are very cold. The combination of cold dry snow and large areas of uniform topography is ideal for making snowpack extent and water equivalent retrievals from passive microwave observations. A comparison between the AMSR-E ground measurements is performed and the differences are analyzed. Initial results show that there is good agreement between the baseline AMSR-E snow depth retrieval algorithm and interpolated ground measurements. We are currently looking at comparisons with SSM/I estimates for 2002-2003 and extending the study to the 2003-2004 winter season.

In the second study, snow-depth retrievals from AMSR-E are being tested with Global Energy and Water Experiment (GEWEX), Asian Monsoon Experiment (GAME), and Coordinated Enhanced Observing Period (CEOP) *in situ* data. Level 1A AMSR-E brightness temperatures are used in the study. Seven acoustic snow gauges located within a 100x100 km domain near Yakutsk in Siberia were used to record snow depth. These point-snow-depth measurements span a period between October 2002 and February 2003 and are used to test AMSR-E ascending and descending retrievals from an adjusted baseline algorithm. Results from the AMSR-E estimates are generally in agreement with the ground measurements. They also show that snow-depth data from the nearby World Meteorological Organization/Global Telecommunication System meteorological station at Yakutsk compare well with the GAME/CEOP site snow-depth data and AMSR-E estimates suggesting that this is a good validation site.

Further AMSR-E validation efforts are ongoing for the Cold Land Processes Experiment site data for the 2002-2003 winter season and over Canadian Prairies.

Mary Jo Brodzik presented the work of her collaborators: Richard Armstrong (AMSR-E Validation Team member/snow), M. Savoie, K. Knowles (Cooperate Institute for Research in Environmental Science [CIRES]/University of Colorado). Armstrong's team provided to the algorithm team the historical (1987-2003) monthly SSM/I-derived snow-water equivalent (SWE), to be used for time series analysis. The goal is to replace the ancillary data that are being used in the algorithm, with a static climatology data set.

The Tibetan Plateau is the only large region where the microwave-derived snow-covered area is consistently greater than the snow-covered area derived from visible sensors. An investigation continues aimed at exploring this phenomenon. It was easily confirmed that the higher resolution from AMSR-E improves the ability to distinguish SWE patterns on the plateau. Ongoing questions in this study include investigating how SWE retrievals are influenced by frozen ground/soil type, water (solid/liquid) extent within the scene, the reduced atmospheric layer and validation using non-representative station data. The significant general problems of dense vegetation and wet snow are conveniently absent on the plateau. A metric was developed to quantify the threshold at which AMSR-E snow is detected as a function of the higher resolution MODIS snow-covered-area products. As expected from similar work with SSM/I, the threshold improves as the winter season progresses. Examples of the prototype *blended snow* product (MODIS snow-covered area blended with AMSR-E-derived SWE) were shown.

The time series of 36/37 GHz brightness temperatures at Dome C (Antarctica) from SSM/I and AMSR-E has been extended. The plan is to create a time series for the other frequencies shared by these two sensors. Collaboration is ongoing with Njoku (JPL) on using the historical passive microwave archive to evaluate homogeneous-location candidates for stable calibration targets.

Eni Njoku (AMSR-E Science Team member/soil moisture) reported on his work with Steven Chan at JPL on the AMSR-E soil-moisture products. He began by showing a sequence of monthly-averaged global maps of retrieved soil

moisture, generated from the available archived AMSR-E soil-moisture product. The maps cover global land areas except for regions of dense vegetation and permanent ice. Njoku also showed an associated sequence of maps of a combined vegetation and roughness parameter derived as a correction factor in the soil-moisture-retrieval algorithm. The maps indicate the seasonal cycles of global surface moisture and vegetation at a monthly mean temporal scale. The short time-scale soil-moisture dynamics were then illustrated on a regional basis by a sequence of daily (interpolated) AMSR-E-derived soil-moisture maps over the central U.S. following widespread thunderstorms in the region. The temporal variability in the spatial extent and intensity of surface wetness, followed by drying, are clearly observed in these maps. Njoku followed this discussion with a review of the effects of RFI on the 6.9-GHz and 10.7-GHz T_b data observed over land, and he described a simple 2-D thresholding algorithm, developed in collaboration with Li Li and Peter Ashcroft, to identify strong occurrences of land-based RFI. The RFI at 6.9 GHz is particularly intense and widespread over the U.S., Middle-East, and Japan, hence the current global soil moisture algorithm does not use the 6.9 GHz channels. The use of 6.9 GHz is still viable, however, for regional studies in Africa, South America, and most parts of Canada and Eurasia where RFI is less evident. Published maps of the AMSR-E-observed RFI have been useful in reviewing the design of the Conical-Scanning Microwave Imager Sounder (CMIS) on the future NPOESS satellites, and in increasing the importance given to RFI mitigation efforts for passive microwave sensing, including new digital radiometer technologies. Njoku concluded his presentation with a discussion of AMSR-E T_b monitoring over tropical forests, as quasi-blackbody targets, to investigate the long-term calibration stability of the AMSR-E instrument.

Eric Wood's (Princeton University, Princeton, NJ/AMSR-E Validation team member/soil moisture) project goal is to provide modeling support to the AMSR-E validation activities through a combination of soil-moisture retrievals and process-based hydrological modeling. Wood presented results from his most recent analysis: SMEX02 (Iowa 2002). In Iowa, the soil-moisture products seem to have a more realistic variability after rain events when compared to Theta-probe *in situ* measurements. Quantitatively, AMSR-E retrievals underestimate both the Theta-probe data, as well as the aircraft Polarimetric Scanning Radiometer (PSR) data. Future work, in conjunction with University of Melbourne, will be looking at data sets from Goulburn River catchment in Australia.

The winners of the last Aqua NRA who will be using the AMSR-E data in their research automatically became members of the AMSR-E Science Team. Some of these new members came to the meeting and presented the research they proposed to study.

Anthony Del Genio's (Goddard Institute of Space Studies) presentation was entitled "Why Can't Global Climate Models (GCMs) Simulate El Niño/Southern Oscillation (ENSO)?" Del Genio proceeded to show the possible sources of GCM errors. The list includes precipitation anomalies, latent and radiative heating profile anomalies, clear-sky water vapor problems, marine stratocumulus anomalies and the circulation response to heating. Besides AMSR-E data, Del Genio plans to use TRMM, Atmospheric Infrared Sounder (AIRS) and MODIS data to help validate physical processes in GCMs.

John Kimball (Flathead Lake Biological Station, University of Montana), **Steve Running** (University of Montana, NTSG), **Kyle McDonald** and **Eni Njoku** (JPL), and **Walt Oechel** (San Diego State University, Global Change Research Group) collaborated on the proposal entitled "Regional Assessment of Arctic Vegetation Productivity and Soil Respiration Environmental Controls Using MODIS and AMSR-E: A New Approach for Satellite Monitoring of Pan-Arctic Terrestrial Net CO_2 Exchange."

Keith Brewster (Center for Analysis and Prediction of Storms (CAPS), University of Oklahoma) presented his ongoing research in prediction of storms when the model is initialized with Next Generation Radar (NEXRAD), Geostationary Operational Environmental Satellite (GOES), and surface data. He conducted experiments from April 12 to June 4, 2004, and showed the results. He feels that his model is able to initialize and maintain individual storm cells, and that these positive results last for several hours. The next step in improving his results is to use AMSR-E data to complement the NEXRAD radar data used for initializing the model. The AMSR-E data would also provide information about the cloud fields and latent heating, as well as updates to the sea-surface temperatures and cloud-liquid-water constraint. This work will be in collaboration with the Short-term Prediction Research and Transition Center (SPoRT) facility at the National Space Science and Technology Center (NSSTC) in Huntsville, Alabama.

Chris Grassotti (Atmospheric and Environmental Research (AER), Inc, Lexinton, MA) collaborates with Jean-Luc Moncet (AER), the PI on the proposal submitted to the Aqua NRA. Grassotti presented the goal of their project as well as a plan of how to accomplish it. The goal is to derive a highly accurate, high-temporal-resolution emissivity database, enabling retrieval of accurate land-surface temperature (LST), cloud liquid water and water vapor over land. The land-surface-emissivity database is needed mostly during transitional events, regions of large inter-annual variability, e.g., mid-latitude winter, and instances of precipitation events, e.g., floods. Optimal results are obtained with a dynamically updated local emissivity database. The data used will be from AMSR-E, AIRS/Advanced Microwave Sounding Unit (AMSU), and MODIS. Grassotti showed the details in the emissivity estimation scheme that uses an existing non-linear (maximum-likelihood based) physical retrieval algorithm. The main assumptions are: specular reflection and constant penetration depth. Validation of surface emissivity is notoriously difficult. Indirect validation will be investigated. Direct observations from the Atmospheric Radiation Measurement Climate and Radiation Testbed (ARM CART) site, Oklahoma Mesonet and SMEX03 PSR data will also be used.

Rolf Reichle (GEST, University of Maryland, Baltimore County/Global Modeling and Assimilation Office, NASA-GSFC) leads a group of four scientists in studying the assimilation of AMSR-E data and application to the initialization of soil-moisture reservoirs in a seasonal forecasting system. Reichle presented the rational for assimilating the AMSR-E data at this point, and showed a work plan for achieving the goal of the project.

- TASK I – Preparation of input data sets
- TASK II – Assimilation and analysis of soil moisture data
  - Prepare four different soil moisture datasets: Integrate land model with GCM-produced precip./radiation (GCM forced with observed SST), observed precip./radiation, GCM-produced precip./radiation + assimilation of AMSR-E soil moisture, observed precip./radiation + assimilation of AMSR-E soil moisture
  - Assess impact of AMSR-E data on soil-moisture estimation.
- TASK III – Experimental prediction
  - Ensemble seasonal forecast experiments with initial conditions from TASK II.
  - Assess impact of observed precip./radiation and AMSR-E assimilation on seasonal forecasts.
  - Establish routine AMSR-E land assimilation in operational GMAO seasonal forecasting system.

The JAXA AMSR-E team was represented by A. Shibata, K. Aonashi, F. Nishio, M. Nakayama, and K. Imaoka.

Akira Shibata (JAXA/Earth Observation Research and Application Center [EORC] AMSR-E Science Team lead) showed the effects of RFI and land contamination on the retrieval of the Kuroshio current sea-surface temperatures (SSTs) (the warm current that flows on the Southern coast of Japan). He showed numerous examples at different times of the year, where the RFI contaminated the coast data and the retrievals of the SSTs near the coast were impossible to do with the 6-GHz data. Shibata suggested replacing the 6-GHz with the 10-GHz in the SST retrieval, for SST larger than 10° C, and set them to 'missing', for SSTs lower that 10° C. The existing geolocation error makes the land-contamination issue difficult to estimate. That issue will be looked at again once the geolocation is corrected.

Kazumasa Aonashi (Meterological Research Institute [MRI]/JAXA AMSR-E Science team member/rain) reviewed the Wakasa2003 Precipitation campaign and the validation data obtained by the JAXA validation team. This team consisted of Core Research for Evolutional Science and Technology [CREST] (surface sondes, Gulfstream II) and the AMSR validation team (radars, surface observations, ground-based microwave radiometers, sondes). Three types of weather systems were observed and analyzed: an extra-tropical low, an upper cold low, and the winter monsoon. The data sets obtained in this campaign can be found at *sharaku.eorc.jaxa.jp/AMSR/index_e.htm*. Preliminary results show that the three types of systems studied are very different in terms of the precipitation profile, ice-particle density, and cloud liquid water. Aonashi then presented results from the comparison of the Radiative Transfer Model (RTM) and the AMSR-E data. The best agreement between the models and the space data were when the model used a cloud liquid water of 0 to 0.1 kg/m^2 and a density of 0.01.

Fumihiko Nishio (Chiba University, Tokyo, Japan/JAXA AMSR-E Science Team member/sea ice) presented the validation plan for the sea ice around the Antarctic. He collaborated with Comiso on this plan. Nishio then pre-

sented the hypothesis that wind can be a large factor affecting the extent of the ice cover, and that new ice is a key source of the ice-extent uncertainty, because new ice has unpredictable emissivity. An interesting analysis was presented on the effects of the Drake passage Oscillation Index (DPOI) on ice extent. The DPOI represents the difference in pressure between Rio Gallegos, Argentina, and Esperanza Station at the tip of the Antarctic Peninsula. In the Weddell Sea the correlation coefficient is -0.55 (for the winter months only), whereas the correlation coefficient is +0.38 for the Bellingshausen/Amunsdon seas.

Masashige Nakayama (Chiba University/Validation/sea ice) has been involved in all the *in situ* sea ice validation campaigns. His presentation focused on the Sea of Okhotsk data taken concurrently with the PSR on the NASA P3 aircraft and the *in situ* sea-ice thickness taken off of the Japanese Coast Guard's P/V SOYA. The preliminary results of the relationship of the brightness temperature and sea-ice thickness were shown.

One aspect of **Keiji Imaoka's** (JAXA/AMSR-E Science team member) work is his involvement with the instrument calibration. JAXA is completing an update to the calibration coefficients to version-2, and Imaoka gave some insight on how the calibration coefficients were obtained. The version-2 warm-calibration-load effective temperature will be offset from the previous coefficients. The warm-end calibration will be determined by using TMI match-up data. A non-linearity correction will be included in these new coefficients; this correction is largest for the 6.9 GHz data.

Peter Ashcroft's (Remote Sensing Systems, AMSR-E Science Team member/Level 2A T_b's) special topic was geolocation: understanding the current way of allocating a location to a footprint, the source of the error, and a proposal for correcting this error. Currently, Level 2A data use the JAXA-provided geolocation for the 89-GHz channel; for the low-frequency channels' location a JAXA-provided distance from this 89-GHz channel location is used. A major error occurs in the accuracy of the 89-GHz location, and the inconsistency in this accuracy. (In other words the error in the 89-GHz location is random!) Also, the distances provided for finding the low-frequency channels location are incorrect. JAXA will provide a new, *empirically adjusted* 89-GHz geolocation for the next version of Level 1A data. Resampling (the process between Level 1A and 2A) will shift the geolocations of the channels, and Ashcroft will provide the new resampled locations. The resampled channel locations will not match the original channel locations. Imanaka presented the details behind the new geolocation scheme that JAXA is planning to use for the second version of Level 1A data.)See the presentation at *wwwghcc.msfc.nasa.gov/AMSR* for the details.)

Bjorn Lambrigtsen (JPL, AIRS Science Team member) joined our team meeting to show the comparison of AIRS and AMSR-E SST and total water. Lambrigtsen concluded that AMSR-E and AIRS total water are highly correlated. AIRS is wetter than AMSR-E by ~0.4 mm of precipitable water at night; there is no bias during daytime. The SST comparison showed the two retrievals to be within 1% of each other. The AIRS Validation Scientist is Eric Fetzer; he can be reached at *Eric.Fetzer@jpl.nasa.gov* or (818) 354-0649.

Kudos

SORCE Mission Team Receives Awards

The SORCE Mission Team recently received the "NASA Group Achievement Award" in recognition of its outstanding accomplishments. **Gary Rottman**, SORCE Principal Investigator, accepted the award on behalf of the Team at the NASA Honor Awards Ceremony at Goddard Space Flight Center on Tuesday, August 24. SORCE Program Manager, **Tom Sparn**, received NASA's Public Service Award in recognition of his outstanding leadership and distinguished contributions to the SORCE Mission. *The Earth Observer* staff and the scientific community congratulate the SORCE Mission Team on their outstanding accomplishments.

Atmospherically Corrected Landsat ETM+ Imagery for the EOS Land Validation Core Sites

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The *EOS Land Validation Core Sites* serve as focal points for global land product validation (Morisette, Justice, Privette, 2002) within the MODIS Land (MODLAND) Team. This focus allows for collaboration within and among science teams and reduces the duplication of effort that would result from validation efforts at disparate sites. Although the MODLAND Team has led the development of these sites, they are intended for use by any satellite sensor (Justice *et al*, 2000), and most of the data that have been compiled for the Core Sites are freely available for use by other scientific investigations and the remote-sensing and Earth-science communities (see *landval.gsfc.nasa.gov/MODIS*).

Current work at NASA's Goddard Space Flight Center, in conjunction with the University of Maryland, has utilized the data on sky aerosol optical properties (available through the Aerosol Robotic Network [AERONET], Holben *et al*, 1998) and the Second Simulation of the Satellite Signal in the Solar Spectrum (6S) atmospheric model to atmospherically correct 43 Landsat Enhanced Thematic Mapper Plus (ETM+) scenes over 14 of the 26 EOS Land Validation Core Sites. The sites are listed in **Table 1**.

This article describes the method used to create the atmospherically corrected data sets and information for the on-line access to the resulting data and information used to parameterize the 6S correction.

6S Atmospheric Correction

Atmospheric correction attempts to correct for the difference between the actual upwelling radiance and the radiance remotely measured from the satellite sensor. This difference is due to the offsetting effects of atmospheric scattering and absorption by molecules, water vapor, and aerosols in the atmosphere. The atmospheric correction for the ETM+ scenes was performed using the 6S radiative transfer code (Vermote *et al*, 1997). The 6S code determines the atmospheric path radiance, the portion of the total radiance due to the atmosphere rather than the target, for each band by calculating gaseous absorption, atmospheric scattering, and approximating the interaction between the absorption and scattering. It integrates both the solar spectrum and the atmospheric absorption and scattering across the relative-spectral-response functions for each of the ETM+ bands, and returns the coefficients x_a, x_b, and x_c that are used to convert the measured at-sensor radiance to atmospherically corrected surface reflectance (ACSR) via the following equations:

$$y = x_a * \text{radiance} - x_b$$
$$\text{ACSR} = y \ / \ (1 + x_c * y)$$

The input parameters required for the 6S modeling include, water vapor, aerosol optical thickness (AOT) at 550 nm and total ozone (Vermote, 1997). The water vapor and AOT measurements were available through the AERONET (Holben, 1998, *aeronet.gsfc.nasa.gov*). The ETM+ scenes were subset to an area approximately 60 x 60 km, centered on the location of the AERONET instrument. AERONET data for all of the sites and dates used here were derived from Cimel sun photometers (Cimel Electronique, Paris, France), which measure the AOT at several wavelengths and water-vapor column density, approximately every 15 minutes. AERONET quality-assured (Level 2.0) AOT measurements at 500 nm and 670 nm taken from the two periods closest in time before and after the ETM+ acquisition were linearly interpolated, in wavelength and time, to estimate the AOT at 550 nm at overpass time. We obtained total-column ozone using the NASA Total Ozone Mapping Spectrometer aboard the Earth Probe satellite (*toms.gsfc.nasa.gov/teacher/ozone_overhead.html*, McPeters *et al*, 1998). Finally, we created a cloud mask, using visual inspection, to provide a binary mask of cloud and cloud shadow. The cloud-mask data are provided as separate files.

On-line Data Access

The atmospherically corrected ETM+ and cloud-mask images, as well the 6S-

parameter files, are all posted on-line and can be found by following the links from the MODLAND Validation page (*landval.gsfc.nasa.gov/MODIS*) under the core site of interest. The individual core-site pages list the available data sets for each core site. Look for the link to 'Atmospherically Corrected ETM+' data under the 'Satellite Imagery' section (see **Figure 1**).

The prefix naming of the files has the following structure: pNNNrNNN_YYYYMMDD, where p and r stand for the World Reference System (WRS) path and row for the ETM+ scene, and the NNN that follow each are the numbers for the path and row, respectively. YYYYMMDD corresponds to the date of the image acquisition as year, month, and day. The different files available for each acquisition are :

Image files

ETM subset and header (*_sub_sin_ac, .gz and .hdr)

Cloud mask and header (*_mask_sub_sin, .gz and .hdr)

Parameter files

IDL processing parameter file (SITE-NAME_YYYYMMDD_parameters.txt)

6S input parameter file (*_sixs_in-

Table 1 List of available atmospherically corrected ETM+ scenes, the DAAC code listed here was used as the directory name for each site.

Full Site Name	EDC Name (DAAC code)	AERONET Site Name	State, Country	Date
Barrow	barrow	Barrow	Alaska, USA	14-Jul-2000
Bondville	bondvill	Bondville	Illinois, USA	25-Mar-2000 15-Jul-2000 26-Apr-2000 29-Jun-2000 1-Sep-2000 17-Sep-2000 16-Jun-2001 4-Sep-2001 15-May-2001
Cascades/H.J. Andrews LTER	cascades	HJ Andrews, Blue River	Oregon, USA	18-Sep-2000
Harvard Forest LTER	harvard	Harvard Forest	Massachusetts, USA	5-Sep-2001 28-Jul-2001
Ji-Paraná (LBA: Jaru Tower)	jiparana	Abracos Hill	Rondonia, Brazil	11-Aug-2001
Konza Prairie LTER	konza	Konza Prairie Biological Station	Kansas, USA	9-May-2001 13-Aug-2001 11-Sep-2000
Mongu	mongu	Mongu	Western Province, Zambia	30-Aug-1999 10-Apr-2000 31-Jul-2000 16-Aug-2000 1-Sep-2000 4-Nov-2000
Wisc: Cheq.-Nicolet NF-Park Falls	parkfall	Chequamegon	Wisconsin, USA	25-Sep-2001
Sevilleta LETER	sevillet	Sevilleta	New Mexico, USA	9-May-2000 28-Jul-2000
Skukuza, Kruger NP	skukuza	Skukuza	Northern Province, RSA	12-Jun-2000 31-Aug-2000 18-Oct-2000 28-Apr-2001 18-Aug-2001 3-Sep-2001
Tapajos (LBA: Santarém)	tapajos	Melterra	Para, Brazil	30-Jul-2001
BARC, USDA ARS	usdaars	GSFC, Greenbelt	Maryland, USA	11-May-2000 2-Oct-2000 3-Nov-2000 22-Jan-2001 7-Feb-2001 23-Feb-2001 28-Apr-2001 2-Aug-2001
Virginia Coast Reserve	vcr	Oyster	Virginia, USA	26-May-2002
Walker Beach	walkerbr	Walker Branch	Tennessee, USA	1-Oct-2001

put_NUM)
6S output parameter file (*_sixs_output_NUM)

"SITENAME" corresponds to the DAAC code of the site (see **Table 1**) and "NUM" refers to the ETM+ bands (1-5,7). See the online 6S manual (*ftp://kratmos.gsfc.nasa.gov/pub/6S/*) for an explanation of the input and output parameter files.

Conclusion

The Core Sites were established to provide the general community with some of the best and simplest opportunities for multi-EOS sensor-data comparisons and synergistic science. In addition to the *in situ* data and EOS imagery available, there are now 43 atmospherically corrected ETM+ subsets available on-line for 14 Core Sites. The EOS Core Sites are intended to serve as magnets for ground-based data collection and remote-sensing research. The availability of atmospherically corrected ETM+ data will help to meet this objective.

Acknowledgement

The Landsat ETM+ data were purchased through funds provided by Martha Maiden, NASA Headquarters, and the MODLAND validation infrastructure is supported by Diane Wickland's Terrestrial Ecology program. We thank both of them for their support. Thanks to Brent Holben and the AERONET program for aerosol and water vapor data.

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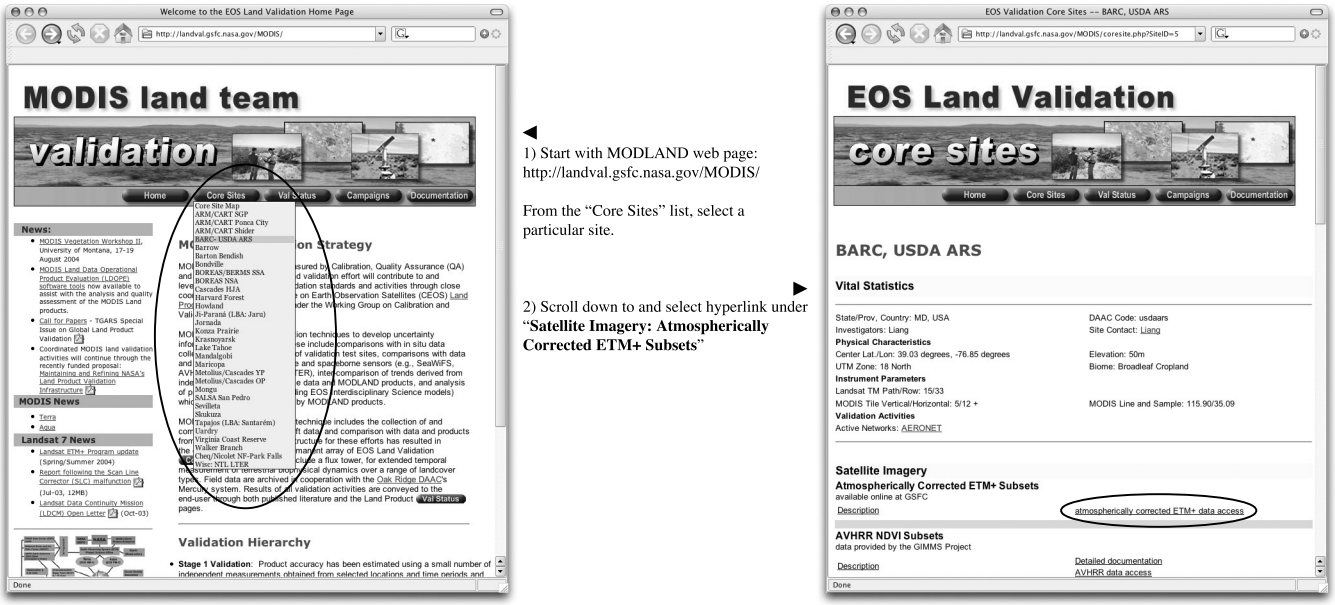


Figure 1. Diagram to show web-based access to the atmospherically corrected ETM+ data.

Report on the Physical Ocenography Distributed Active Archive Center (PO.DAAC) User Working Group Meeting

— Jorge Vazquez, jv@pacific.jpl.nasa.gov, Jet Propulsion Laboratory

The regular meeting of the Jet Propulsion Laboratory Physical Oceanography Distributed Active Center (PO.DAAC) User-Working Group (UWG) was held June 2 and 3, at the Raytheon/ITSS facility in Pasadena, CA. Those in attendance included UWG members R. Evans (chair), David Glover, John Lillibridge, C.K. Shum, Victor Zlotnicki (ex-officio), and Yi Chao. Kenneth Casey at NOAA was also present via a telecon. Tim Liu, member of the UWG, was absent due to business travel. The meeting was chaired by Robert Benada, acting manager, and Jorge Vazquez, Task Scientist. The incoming new manager of the PO.DAAC, Patricia Liggett, was present at the meeting.

The meeting began with an overview of the PO.DAAC. A large focus of the meeting was the future direction and priorities of the PO.DAAC.

Introduction

The primary goal for the PO.DAAC is to continue as the lead center for distribution of satellite-derived sea-surface topography and ocean-vector-wind products. The PO.DAAC will continue to support oceanographic missions measuring these parameters.

PO.DAAC management and lead engineers gave overview presentations of strategic functions of the PO.DAAC. These included presentations on the collection of statistics, near-real-time operational distribution and browsing capability (OCEANIDS, Near Real-Time Image Distribution Server [NEREIDS]), mission updates, and web interface capabilities through the PO.DAAC Ocean Earth Science Information Partnership (ESIP) Tool (POET).

Statistics

During the previous year, the PO.DAAC had 12,000 unique users access the FTP interface. Such interfaces as POET will be fully integrated into these statistics. This is especially critical because of the increased popularity of regional subsets among the research community. Other system enhancements are planned to enable more complete reporting of user statistics.

Overview

POET

The POET interface can be accessed from any web browser; users do not need to install a local client to use the interface on their computer. POET can handle a variety of data formats—GIF is the most popular. A new capability was added to POET in the past year that allows the extraction of minimum quality values for data sets. This capability is an extremely useful addition, especially for data sets like the Pathfinder Sea-Surface Temperature data, where each pixel has an assigned quality flag between 0 and 7. POET can also handle non-net CDF data and can produce different data outputs. The ability to output data in different formats is very useful for PO.DAAC, as it allows them access to a wider market for their products.

OCEANIDS/NEREIDS

OCEANIDS/NEREIDS is a new PO.DAAC near-real-time data distribution and browsing system. The system is currently being used to handle 30 live data streams in a near-real-time environment. Several advantages include an increase in reliability by having backups both at the PO.DAAC and the site where data is being pushed to, and automatic communication with both data archiving and system operations such that operators are immediately notified if anything goes wrong. The system is very reliable, has the ability to serve multiple data streams and interfaces, and can use several file transfer protocols such as FastCopy, SFTP, and SCP. Additionally, the system is scalable, including the ability to add a new data stream within a few hours. Errors are reported to the operators in a database where everything is listed for operators. Thus operators can see what is going on and can contact data providers quickly. This system will be used as the primary distribution point

for the Global Ocean Data Assimilation Experiment High Resolution Sea Surface Temperature Pilot Project (GHRSST-PP), described below.

RightNOW and New Web Site

The PO.DAAC has integrated a new commercially available software technology, RightNOW, which allows for significant improvement in managing data and user interactions and frequently asked questions (FAQs). All user e-mails will go through the RightNOW technology. The new PO.DAAC web site, which also uses RightNOW, consolidated all sea-surface-height, sea-surface-wind, and sea-surface-temperature information into easily searchable databases for data ordering, documentation, and accessibility. Using the RightNOW interface, PO.DAAC hopes to consolidate all the user activities in one location.

GHRSST-PP

An overview was given of the GHRSST-PP project. This project seeks to develop a high quality sea surface temperature data set that can be used operationally in climate modeling. After the GHRSST meeting in Townsville, Australia the PO.DAAC has been designated as the Global Data Assembly Center (GDAC) for the project.

IAS-International Altimetry Service

The PO.DAAC will examine how best to support the International Altimetry Service. Global Ocean Observing System. The organization is currently in the planning stage. No funding has been designated for the project. The mission is to provide a comprehensive altimetry service where each member organization contributes a specific part. The current objective is to spin up funding agencies and get data flowing.

Altimetry Pathfinder

The PO.DAAC is distributing reprocessed sea-surface-height-anomaly (SSA) data from the Altimeter Ocean Pathfinder project. Current data include SSA from the Geostationary Satellite (GEOSAT), Earth Resources Satellite (ERS) 1-2 Exact Repeat Mission (ERM), and the GEOSAT Follow On (GFO) missions. Future data will include TOPEX/Poseidon SSA, TOPEX/Poseidon Tandem Mission SSA, and the Jason SSA.

Missions

The PO.DAAC will be involved in future missions such as the Ocean Vector Wind Mission (OVWM), the Ocean Surface Topography Mission (OSTM), and the Aquarius Mission. Plans are being discussed for the cooperation of the PO.DAAC with other agencies such as NOAA. Plans for the support of these flight projects will be built on the experience gained through work on The Ocean Topography Experiment (TOPEX)/Poseidon, NASA Scatterometer (NSCAT), QuikScat, and Jason-1.

The Jason follow-on mission, known as the Ocean Surface Topography Mission (OSTM) will have the swath data distributed through the PO.DAAC. NOAA will distribute the geophysical data records (GDRs).

Other missions currently supported through the PO.DAAC include the Gravity Recovery and Climate Experiment (GRACE), Jason-1, QuikScat, the Advanced Microwave Scanning Radiometer-EOS (AMSR-E), and Windsat. Support of these projects includes both public data distribution and pushing data operationally to different agencies such as AMSR-E data being sent to Remote Sensing Systems (RSS) for further processing. This data is also sent to SeaPAC and NOAA. Windsat products being distributed include both a sensor data record (SDR) and environmental data record (EDR)

AMSR-E data are received from Japan and distributed to Remote Sensing Systems at the rate of 28 granules/day. It is also sent to SeaPAC and NOAA.

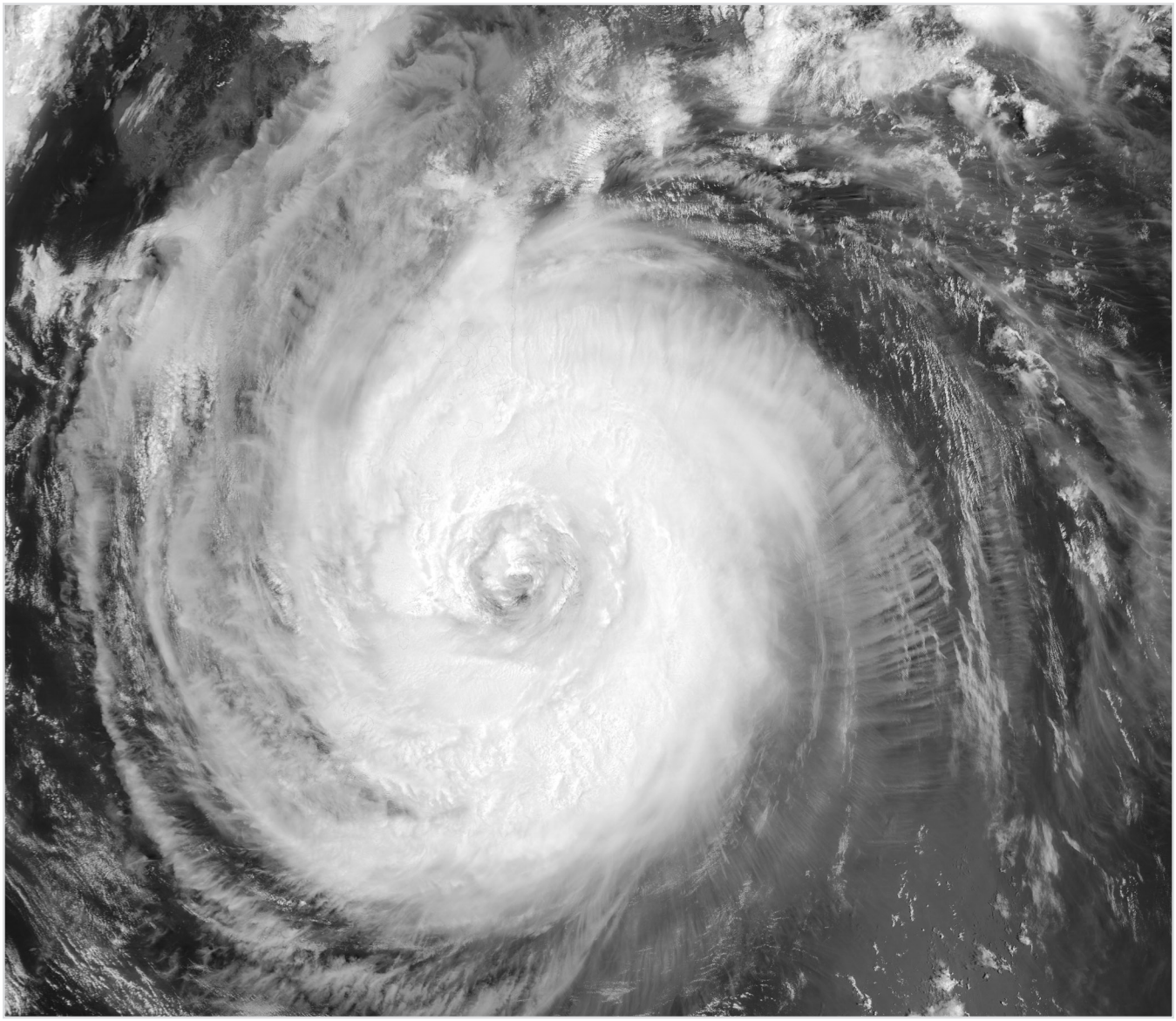
SST

The PO.DAAC currently supports several SST data sets. These include both historical data and near-real-time products. Near-real-time products include SST data from the Moderate-resolution Imaging Spectroradiometer (MODIS), the multi-channel sea-surface temperature (MCSST) from the Naval Oceanographic Office (NAVOCEANO), a 2.2-km regional SST product from NAVOCEANO, and SST data from the Geostationary Operational Environmental Satellites (GOES) distributed in collaboration with NOAA. With the release of version 5.0, the PO.DAAC reprocessed the historical data working in collaboration with NOAA's National Ocean Data Center (NODC) and the Rosenstiel School of Marine and Atmospheric Sciences (RSMAS) at the University of Miami. The PO.DAAC also distributes the Reynolds Optimally Interpolated Analysis, along with several months of test data from the Along-Track Scanning Radiometer.

Conclusions

The PO.DAAC will continue to support missions and data sets dealing with the description of the physical state

of the world's oceans. Collaborative efforts, that have been initiated with such agencies as NOAA and NAVOCEANO, will continue. Missions will include OSTM, GRACE, Aquarius, Windsat, and QuikScat. Additionally, collaboration with such projects as the International Altimetry Service will be examined. Data reprocessing efforts in support of climate data records (CDRs) such as the Altimeter Ocean Pathfinder Project will be supported as well as distribution of SST products that are part of the GHRSST-PP effort.



NASA's Terra satellite captured this image of Typhoon Chaba on August 29, 2004, at 1:45 UTC. At the time Chaba was located approximately 537 km (334 miles) south-southeast of Sasebo, Japan, and was moving towards the west-northwest at 15 km/hr (9 mph). Maximum sustained winds were near 194 km/hr (121 mph) with higher gusts to 241 km/hr (150 mph). Chaba means 'hibiscus' in Thai, and the storm does have an awesome beauty as it swirls in the Pacific south of Japan.

Chaba was the third powerful tropical storm to hit Japan in two weeks, as first Typhoon Megi, then Typhoon Aere, and finally Chaba churned through the region. At least five people were killed in Japan when Chaba came ashore, and tens of thousands evacuated their homes in Kyushu and Shikoku as the heavy rain from the storm posed a risk for flooding and landslides. Hundreds of thousands of people were without power, and trains and other transportation were severely disrupted.

Image courtesy Jacques Descloitres, MODIS Land Rapid Response Team at NASA GSFC

Summary of the ESIP Federation's Summer 2004 Meeting: Advancing Science Through Collaboration

— *Carol Meyer, carol.meyer@earthsciencefoundation.org, Earth Science Foundation*

The Federation of Earth Science Information Partners (ESIP) held its thirteenth meeting August 16-18, 2004. The meeting was hosted by NOAA's National Climatic Data Center in Asheville, North Carolina. The meeting agenda was carefully crafted to capture the attention of members and non-members alike, with increased emphasis on reaching our science and research constituents. The focus of the meeting was *Advancing Science Through Collaboration*.

In addition to the traditional sessions, the summer 2004 meeting provided new opportunities for members to interact, explore collaborations, and learn how GIS and other technologies support science data and research. Highlights of the conference included:

- Opening Day Opportunity Fair to encourage new collaborations between members.
- Technical Workshops and a Technology Exhibition.
- Keynote address by Jack Dangermond, President of Environmental Systems Research Institute (ESRI).
- GIS panels focusing on science and applications.
- Opportunities to Impact the Federation's Future Through Strategic Plan Discussions.
- Election of Federation Officers.
- And much more…

Keynote Address and Other Meeting Highlights

In addition to the networking and collaboration opportunities, the Federation meeting sponsored GIS-day. **Jack Dangermond**, President of ESRI, keynoted the day's events. He challenged the science community to work more closely with the geospatial community to bring more information to bear to the broadest of user communities. In addition, the day featured three GIS panels devoted to Applications, Education, and Science, respectively.

In addition to GIS-day, the Federation meeting served as a meeting ground for NOAA and NASA to share information on data management. NOAA has launched its own long-term data-archiving system known as the Comprehensive Large Array-data Stewardship System (CLASS) and it consulted with NASA data management counterparts who together comprise the Federation's Type I members. A CLASS overview was presented and culminated with a working session between the NASA Distributed Active Archive Centers (DAACs) and NOAA. This sharing of ideas and lessons-learned has strengthened the bond between the two agencies and has demonstrated the Federation's value in facilitating this interagency dialogue. In the future, more discussions of this nature will occur at Federation meetings.

This Federation meeting culminated with the organization's annual election. The Assembly, the Federation's governing body, elected **Thomas P. Yunck** of the Jet Propulsion Lab as President and **Tamara S. Ledley** of the Technology Education Research Center (TERC) as Vice President. The new officers will serve one-year terms, commencing with the end of the meeting. The Federation's new officers and committee leadership will be working to implement activities that are consistent with the Federation's first strategic plan (also adopted in Asheville).

Opportunity Fair

On August 16, an Opportunity Fair was held. This replaced the traditional poster session featured at previous Federation meetings. The purpose of this session was to promote inter-ESIP collaborations with an eye toward developing new projects for our members. Loosely modeled after Personal Advertisements, members submitted in advance any connections they are trying to make. More than 55 ads were published in the Federation's version of the *Nothing Personals* and enabled attendees to seek out their *match* during the fair and beyond. Members could submit any number of ads at no charge. In addition, a listing of Federal Grant Opportunities that are currently out for solicitation was made available.

Awards were given for the most creative ad and for the most promising

collaboration resulting from the Fair. Collaborative projects resulting from the Opportunity Fair (and the meeting in general) will be active in the coming months. The next Federation meeting, scheduled for January 5-7, 2005, will focus on addressing some of the community-wide technical issues identified at the August meeting.

Technical Workshops

The Technical Workshops, sponsored by the Information Technology and Interoperability Committee, ran concurrently with the Federation meeting. Beginning with technical tutorials on the morning of August 16, the Workshops included technical presentations and a technical poster session throughout the duration of the meeting. The Technical Workshops also included a Technology Vendor Exhibition on August 18, where hardware, software, and service providers showcased their products and services. Vendors also had the opportunity to present a 30-minute workshop on the functional specifications of their products.

About the ESIP Federation

The Federation of Earth Science Information Partners is a broad-based consortium of Earth-science-data interests involved in the chain of data processing and impact analyses activities that prepare data for use in the broader Earth-science community. As part of this continuum, data from Federation partners are captured, researched, analyzed, and then applied to such fields as public health, climate variation and change, water and disaster management. Founded in Year 1998 with support from NASA, the consortium includes more than 75 member organizations that use data for research, technology development, education, and commercial purposes. As such, the Federation provides an ideal forum for generating collaborations that will lead to the discovery of new applications and improved public policy decision making relating to our environment. The work of the Federation is facilitated by the Foundation for Earth Science, a *501(c)(3)* organization. The Foundation supports the Federation and its committees by providing ongoing professional staff support, strategic planning, fundraising, and grants management. For more information, visit *esipfed.org* or call (877) 870-3747.

Image 1: Attendees at the ESIP meeting.

ASTER Science Team Meeting

—T. Tachikawa, tatikawa@ersdac.or.jp, Earth Remote Sensing Data Analysis Center
—E. Abbott, elsa@aster.jpl.nasa.gov, Jet Propulsion Laboratory

The 25th Joint Japan/U.S. Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Science Team Meeting was held at Aoyama Tepia in Tokyo, Japan, from June 14 to June 17, 2004. The meeting was attended by about 80 people including science team members from Japan and the U.S., as well as participants from other affiliated organizations.

At the opening plenary session, **H. Tsu** (Geological Survey of Japan) and **M. Abrams** (Jet Propulsion Laboratory [JPL]), the Japan and U.S. ASTER Science Team Leaders respectively, opened the meeting with greetings representing Japan and the U.S., followed by the introduction of new members of the U.S. Science Team. **M. Kato** (Earth Remote Sensing Data Analysis Center, ERSDAC), Japan ASTER Science Project Manager, described the schedule of the ASTER Science Team Meeting and other meeting logistics.

The NASA Headquarters representative, **W. Turner**, welcomed **M. Abrams**, the new U.S. Team Leader, and the new team members. He then talked about the structural reorganization taking place in NASA and how the transformation, and the fact that there is no follow-on mission for Landsat, might affect the ASTER project. He then described the Memorandum of Understanding (MOU) between the U.S. and Japan which will be in place when the current Diplomatic Note expires in October. The MOU will extend for 10 years. It will only change slightly, one change being that there will be an allowance of 10% usage time for a *general use* category, which is essentially for commercial users. It will be administered by the Japanese and will have lowest priority.

N. Ohgi (Japan Resources Observation System Organization [JAROS]) discussed the status of the ASTER instrument, reporting that it is generally in good health. There has been a gradual degradation of the radiometric response for the Very Near Infrared (VNIR) (10% per year) and Thermal Infrared (TIR) (7% per year) and a stabilization of the Shortwave Infrared (SWIR) following several adjustments. There is no indication that ASTER will not be working well for the proposed extension of the mission to 6 to 8 years. Extending the mission, however, raises the question of how to extend the life of the pointing capability. This discussion was deferred to later in this meeting. There is no indication that electrical or other mechanical parts are at risk at this time.

K. Okada (Japex Geoscience Institute) and **L. Maldonado** (JPL) reported on the land-surface-coverage status and the number of acquired scenes. The total global-coverage map consists of 801,239 scenes of which 0% to 20% cloud-cover-data amount to 331,323. However, some areas are better covered than others. For example Western Australia is poorly covered, an issue which is being investigated. The impact of a new science team aquisition request (STAR), the TIR nighttime mapping STAR, is being investigated with simulation using two trial areas, and it seems there is no appreciable impact. The STAR Committee plans to review 74 STARs for possible change of status with the nominal mission lifetime approaching.

Y. Kannari and **H. Watanabe** (both from the Earth Remote-Sensing Data Analysis Center [ERSDAC]) reported on the Ground Data System (GDS). Approximately 798,000 scenes have been collected and categorized, by requestors and data types, etc. The daily acquisition of scenes has been reduced from an average of 500 to 400 as a result of the decision to reduce the pointings from 9 to 4 times daily to conserve pointing capability. Details of this decision were put off to the Operations and Mission Planning (OMP) session later in this meeting. An ongoing problem with damage to the data tapes sent from Ground Data System (GDS) to the Distributed Active Archive Center (DAAC) was solved with changes in the packing material. A widening of the registration between the SWIR and VNIR telescopes was noted and discussion deferred to the Level 1/Geographic/Digital Elevation Model (DEM) session. GDS has been considering replacement of their Product Generation Subsystem (PGS) processing machines and has various machines under consideration. Kannari

discussed the option of a dedicated network transfer to replace the courier now used to transport the Level 1B data, which may shorten the data transfer time by 4-5 days.

Y. Maruyama (ERSDAC) discussed the current status of the Japanese post-ASTER plan, which is to develop a small lightweight satellite instrument which will be similar to ASTER with some changes which will be developed jointly with countries from Asia and Oceana. The plan will favor industry, focusing on data applications for land and forest management, while addressing such issues as illegal deforestation and desertification. The first phase is planned for about 2010, second phase 2010-2015, and third phase 2015-2020, but this instrument is still in early phases of planning. Among the questions raised following this presentation was whether U.S. cooperation was excluded, to which the answer was "no."

B. Bailey of the Earth Resources Observation Systems (EROS) Data Center began his presentation by thanking all the people who supported the proposal for a Landsat follow-on mission. He then gave an overview of the Landsat situation, the atmosphere at NASA Headquarters, and the status of the proposal and motivation for how the proposal was written. He explained that there is a mandate to have continual coverage of the Earth's surface with a Landsat-type instrument, and Landsat-7's degradation has caused considerable concern by NASA and the user community that there is nothing ready to fill that slot. It was proposed to replace both Landsat and ASTER in three years with an instrument jointly operated by the US, Japan, and nations that have ground receiving stations. At the same time, Japan has been considering options for an ASTER follow-on mission. Given these common goals, a joint mission seems to make a lot of sense, but this was only one of four U.S. options which also included a solely U.S. mission and the more international mission with the collaboration of many nations, namely Japan and countries that have ground receiving stations. This latter configuration was how the recent proposal was worded, and it was ready for presentation discussion at the Earth Observation Summit meeting, the GEO meeting, and the Ministry of Economy, Trade and Industry (METI) (Japan)/NASA/U.S. Geological Survey (USGS) meeting, all in Tokyo. The proposal failed to be addressed at the METI/NASA/USGS meeting, and it doesn't seem to be a favored approach by U.S. funders. This subject is still very much unsettled and under discussion.

Bailey then reported that Land Processes DAAC distribution of ASTER data is operating without any problem. The Landsat-7 Enhanced Thematic Mapper Plus (ETM+) data are now being distributed through the USGS Earth Explorer at a discount price. The DAAC has started processing ASTER L1B products to provide for what was not being produced at GDS and, so far, 250,000 scenes have been processed. The DAAC plans to coordinate with Japan for Level 1B production in the future (GDS would promote reprocessing on demand from the U.S. side). Traditionally, sales of Landsat products surpassed that of ASTER products; now, however, the trend has reversed. An increased number of orders for DEMs has generated a backlog of work equal to 900 scenes, a majority of which came from science users. Because of this heavy load, a system upgrade is being considered.

Abrams and Watanabe reported on recent conference presentations and other outreach events as well as on progress in data processing and on the status of emergency observations. Watanabe reported a steady increase in user registration and use of data and strongly supported a follow-on mission.

Y. Yamaguchi (Nagoya University) raised three issues for working-group leaders to discuss in each splinter session. They were to: (1) review the existing data acquisition plan in view of the extended mission lifetime; (2) discuss planned publications for the journals *Remote Sensing of Environment* and *Transactions on Geoscience and Remote Sensing*; and (3) summarize the group's thoughts on post-ASTER.

Working Group Reports

Calibration Working Group

Reports were made on the VNIR, SWIR and TIR onboard-calibration trends by NT Space MELCO and Fujitsu, respectively. **S. Tsuchida** (Geological Survey of Japan [GSJ]) and **F. Sakuma** (National Research Lab of Meterology) did a study of contamination and radiation effects on the VNIR by applying two degradation curves, a single and a double exponential function to address different models, the single exponential for single layer of contamination and double exponential for multiple layers of contamination and radiation damage. These results were compared with JERS1/OPS degradation cases. They concluded that radiation contamination is not the main reason for sensor degradation. A smooth function (exponential or second-order polynomial) was recommended for the radiometric calibration coefficient for both the VNIR and the TIR.

It has been determined that there is a

scratch on the filter of the SWIR system and ERSDAC commissioned Mitsubishi to investigate it and develop a correction method. They performed a statistical analysis using uniform areas of desert scenes and did a frequency analysis. They found that after doing a radiometric correction there was still a need to find the location of the scratch by frequency analysis. It was found at slightly different locations and affected a different number of pixels in each band. **K. Arai** (Saga University) has suggested a procedure for correction, which Mitsubishi will implement and test.

Reports on onboard calibration were followed by reports on science, or vicarious calibration. **H. Kieffer** (U.S. Geological Survey) reported on the lunar calibration results. Kieffer discussed the previously known crosstalk in the form of weak images in all of the SWIR bands, but most pronounced in bands 4 and 5. He also stated that there is a small amount of line noise in all bands except band 4, which may be correlated to the other crosstalk. In addition, ther is a wide leak above and below all primary locations from an unknown source. Some of these leaks extend to the edge of the swath. When he investigated the TIR, he found that "ghosts" exist in each band and that they are different for the odd and even detectors.

A. Iwasaki (National Institute of Advanced Industrial Science and Technology) also discussed results of the lunar calibration experiment crosstalk in the SWIR and VNIR zero-offset results. **H. Tonooka** (Ibaraki University) presented a TIR stray light analysis and **S. Biggar** (University of Arizona) did an analysis of the SWIR crosstalk problem.

S. Tsuchida, **K. Thome** (University of Arizona) and **K. Arai** gave reports on field campaigns for vicarious calibration of the VNIR and SWIR bands. They concluded that smooth (first or second order polynomials) functions would work best for the radiometric calibration coefficients (RCC) for the VNIR. The crosstalk problem in the SWIR is an overriding problem. **F. Palluconi** (JPL), **H. Tonooka** and **S. Hook** (JPL) reported on vicarious calibration results for the TIR, and smooth function RCCs are recommended.

STAR Committee Working Group

H. Sekine from Mitsubishi Research Institute (MRI) reported on the progress of revisions to the STAR TOOL reflecting what was discussed during the previous OMP *ad hoc* meeting. Okada said that once the screening of select STAR proposals was over, the renewed STAR TOOL would be in operation within a week.

Kato introduced new STARs proposed in connection to business operations at ERSDAC and received approval. K. Okada clarified that all the candidate status proposals subjected to screening by the STAR TOOL were approved except for Thermal Global Map (TGM). H. Muraoka from Geotechnos proposed suspending some of the STARs targeting areas over Japan to ensure observations of west Australia (which is undercovered) by separately submitting a local STAR over the area. The proposal was approved. OMP WG in Japan will decide when to carry out the observation.

T. Matsunaga (National Institute for Environmental Studies) reported on the discussions to do nighttime coverage of the Earth in the TIR. A sub-working group called the temperature-emissivity separation (TES) working group was created to work out details and submit a priority map to the Operations Working Group (OWG).

It was unanimously agreed to submit a STAR review plan to OMP by September 15.

Geology Working Group

It had been decided that existing STARs under the Geology Working Group be reviewed and perhaps removed, and the consensus was that each responsible requestor make that decision.

Several science members gave presentations as follows:

• **F. Kruse** (Horizon GeoImaging) presented *Mineral Mapping Using ASTER and HIS Data*. ASTER discriminates mineral groups but can't discriminate individual minerals.

• **T. Gubbels** (Science Systems and Applications, Inc.) presented *Examples of ASTER Rapid Response*. The EDS were very useful for monitoring disasters such as volcanic, seismic, and floods.

• **M. Ramsey** (University of Pittsburgh) presented *Kamchatkan Volcanology Results and Upcoming Field Campaigns*. ASTER data were found useful in volcanic observations, but it is necessary to develop a new emissivity-temperature-separation algorithm to observe very hot surfaces.

• **M. Urai** presented *ASTER Image Database for Volcanoes*. A web-based ASTER volcanic image database has been operational since March 2004.

• **B. Bailey** presented *Effects of the New 'Gap-Filled' Landsat ETM+ Data for Geo-*

logic Mapping in Semiarid Terrains. New ETM+ SLC off images might be used for geologic applications.

• **H. Kieffer** presented *Update on the GLIMS Science*. 100,000 ASTER Level 1A scenes have been acquired over glaciers.

Deadline dates for submission to ASTER special issues of *Remote Sensing of Environment and Trans. Geosci. and Remote Sensing* were confirmed.

Level 1/Geometric/DEM Working Group

• **Fujitsu** reported on the renewal of ASTER Level 1 data-processing parameters.

• **MSS** reported on the evaluation of parallax correction processing.

• **Hitachi** reported on registration between telescopes.

• **H. Fujisada** (Sensor Information Laboratory Corp., SILC) remarked that the inconsistency between V and S was attributable to SWIR.

• **SILC** reported on the accuracy of Level 1 geometry.

• **Abrams** introduced an ASTER geometric correction tool that will allow users to have geometric correction done to their data at JPL by request through the ASTER web site.

• **CCS** reported on the validation result of product accuracy. Fujisada hinted at the possibility that the accuracy of the information on Terra's degraded orbit was causing the degradation of geolocation accuracy.

• **Bailey** reported on the provisional validation results of the DEM product at LPDAAC, which was being tested using two sites.

• **Abrams** asked to carry out a comparison between DEMs produced at NED-USGS and U.S.-ASTER.

• **Kieffer** reported on SWIR crosstalk at lunar calibration and said that higher gain setting for SWIR would be desirable if there was a chance for a second lunar calibration.

• **Fujisada** explained how to use the DEM/Ortho software developed by SILC.

The Working Group has assigned members to review the STARs under the group's name.

Science Scheduling Support Group/ Operations and Missions Planning (SSSG/ OMP) Working Group

A review of the action items from the last meeting was conducted by **Y. Yamaguchi** followed by reports on some high priority items by **L. Maldonado**. The experiment conducted April through June to lower the number of pointings showed a significant impact on data acquisition. Two important observations in the U.S.: 26 observations in April, mostly field campaigns, and 10 of 36 observations in May were missed. This was judged to be unacceptable, and it was agreed to return to the original pointing function. Furthermore, pointing control may not be the only limiting factor for the life of ASTER. At this time, there is no indication of degradation of the hardware. It is possible that there may be a problem with the simulator. On the U.S. side, the mission simulator is being reactivated to examine the problem in greater detail and study the long-term effects. The current scheduling simulator did not show the effects of reduced pointing.

The second round of global mapping was evaluated and it was found that western Australia remained undercovered due to priority observations in Japan and southeast Asia. It was agreed that some STARs in Japan would be suspended and a new STAR proposed for intensive observation of western Australia.

Matsunaga described an experiment done in February through March to do nighttime TIR global mapping. There was some impact to daytime observations but it was felt to be overridden by the advantage of having a nighttime global map, particularly if a priority map is developed. Advantages to nighttime observations include better emissivity values due to less temperature contrast and more useful information for such applications as heat-island analysis.

The SSSG report was given by **Okada**, who showed by use of maps the total observed scenes and scenes with less than 20% cloud cover, globally and by local area (Japan and U.S.). He addressed the status of the Global Mapping STAR round two (GM2) and TIR Nighttime Global Map (TGM). He suggested for the TGM that two large areas be used to test the impact. The GM2 STAR suspends the GM1 high-priority STARs and submits high-priority STARs with modified parameters such as permitted wider scan angles. This STAR started August 20, 2003, and many may have already been satisfied. The OMP WG agreed in an *ad hoc* meeting February 2004 on a plan to analyze 74 STARs whose *lifetime end* is set around 2006 to be reevaluated by the relevant working group by the next team meeting.

Temperature Emissivity Separation (TES) Working Group

S. Rokugawa (Tokyo University) reviewed the status of the existing STARs for this group. A presentation was then given by **H. Tonooka** on Level 1B and the atmospheric-correction product reprocessing for temperature-emissivity separation. **T. Matsunaga** then led a discussion on the nighttime TIR STAR proposal. **D. Sabol** (University of Washington) reported on the status and future plans for the U.S. TES Product. **M. Ramsey** then gave a report on the "hot target" study. Discussions followed on post-ASTER scenarios, ASTER operations beyond 2005, publication plans, and the four TES STARs. It was decided to maintain the STARs as they are.

Ecosystems/Oceans Working Group

The new members of the working group were introduced by Matsunaga followed by a review of the status of the STARs. Then six scientific presentations followed:

• **A. French** (Goddard Space Flight Center), *Optimal Land Surface Temperature Estimation and Assimilation for Global Hydrological Applications*

• **T. Miura** (University of Hawaii), *A Continuity/Compatibility Investigation of EOS Reflectance and Vegetation Index Products*

• **M. Kishino** (retired, Institute of Physical and Chemical Research), *Retrieval of Chlorophyll A, Suspended Solids, and Colored Dissolved Organic Matter in Tokyo Bay Using ASTER Data*

• **S. Tsuchida**, *Phenological Eyes Network-Ground-based Measurement for ASTER Data*

• **Y. Sakuno** (Hiroshima University), *Study for Monitoring Water Quality, SST, and Coral Reef Using ASTER Data-Our Activities, 1995-2004*

• **M. Netzband** (University of Arizona), *Urban Land Cover and Spatial Variation Observation Using ASTER and MODIS Satellite Image Data*

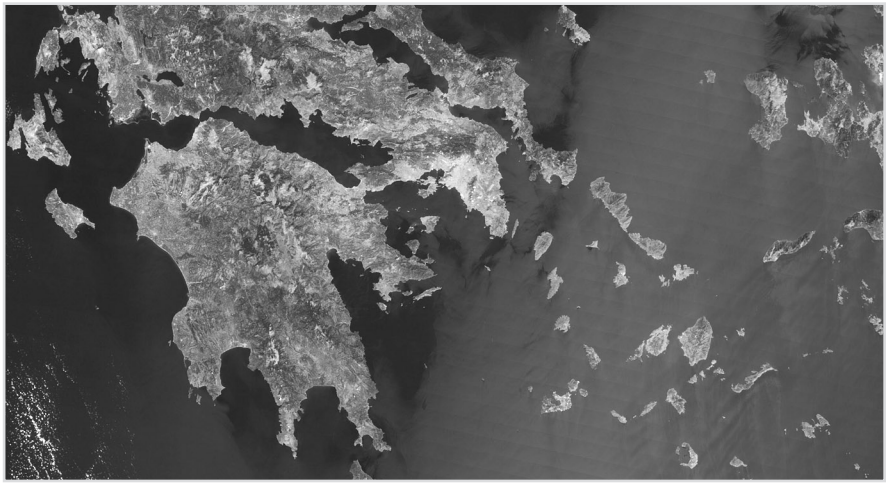
Discussions followed on the operational scenario beyond 2005 and the pointing-control issue, whose negative impact on field-campaign observations is especially disturbing. Five papers are expected to be submitted by members of the group to Remote Sensing of Environment.

Atmospheric Correction Working Group

The action items were reviewed and the STARS. **B. Eng** (JPL) gave a presentation on the current status of atmospheric-correction software. **K. Thome** then discussed the current status of the VNIR/SWIR correction and proposed that exclusive dependence on MODIS will lead to instability of the ASTER data. He then described the validation results on the playas. On the subject of validation of atmospheric correction for the TIR, **H. Tonooka** explained that the validation results for water-surface emissivity were greatly affected by water vapor. He introduced a new algorithm called Water Vapor Scaling for the purpose of removing the major effect. **S. Tsuchida** then reported on the difference of Thuillier irradiance from World Radiation Center (WRC) irradiance for ASTER bands.

The action items will remain open, and no new action items were generated.

The second plenary session was brought to a close with remarks by **H. Tsu**, **Y. Yamaguchi**, and **M. Abrams** with a promise to meet next in the U.S. in late 2004 or early 2005.



Forming the southern tip of the Balkan Peninsula, Greece is made up of a series of mountains that run into the sea, extending into scattered islands through the Aegean Sea in the east. The texture of mountain and valley makes the country appear marbled in this image, captured by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite on August 19, 2004. NASA image courtesy of Jeff Schmaltz, MODIS Land Rapid Response Team at NASA GSFC

Summary of the Third International Workshop on LAI Product Validation

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— Jeffrey L. Privette, jeff.privette@nasa.gov, Goddard Space Flight Center

In a continuing series of international validation workshops, more than 20 scientists—representing seven countries and 71 globally distributed field sites—met in Missoula, Montana on August 16, 2004. The meeting was organized under the auspices of the Committee on Earth Observing Satellites' (CEOS) Land Product Validation (LPV) subgroup, and served as a preamble to the MODIS Vegetation Products II workshop (Aug. 17-19). The LPV subgroup was established in 2000 to define standard guidelines and protocols and to foster data and information exchange relevant to validation of high-level satellite products (see **Figure 1**). The primary methods for LPV to meet its mission and objective are via these topical meetings and through product and method intercomparisons. The Missoula meeting was the third such meeting for Leaf Area Index products (LAI); for reports on the first two meetings, see Privette et al, 1998 and Privette et al., 2001).

In the past five years, multiple LAI and Fraction of Photosynthetically Active Radiation (FPAR) products have become available to the science community. The Moderate Resolution Imaging Spectroradiometer (MODIS) LAI and FPAR Products (Principal Investigator: R. Myneni, Boston U.) are operationally produced every 8-days at global scale. The MODIS record began in March 2000 and continues to present (Yang et al., 2004). The French Space Agency (Centre d'Etudes Spatiales de la Biosphére/Centre national d'Etudes Spatiales, CESBIO/CNES) is currently producing an LAI product from the Polarization and Directionality of the Earth's Reflectances 2 (POLDER-2) instrument (preliminary results are posted at *smsc.cnes.fr/POLDER*). Further, the Global Vegetation Monitoring (GVM) unit of the European Commission's Joint Research Centre (JRC) has developed an algorithm to derive FPAR from Medium Resolution Imaging Spectrometer (MERIS) data, although presently this is not a global product. Finally, the Carbon Cycle and Change in Land Observational Products from an Ensemble of Satellites (CYCLOPS) program has developed preliminary biophysical variables (including LAI and fAPAR) using multiple sensors, i.e. the Advanced Very High Resolution Radiometer (AVHRR), VEGETATION, POLDER, and the European Medium Resolution Imaging Spectrometer (MERIS).

As CEOS members produce more global products, selecting which product, or combination of products, best serves a user's needs will require characterizing each product's uncertainty, i.e., validation. Recent studies (e.g., Baret et al., 2004) suggest that the most rigorous validation results arise from the simultaneous characterization of multiple (~5- to 10) product pixels at a site against an LAI map derived from field measurements and fine-resolution (~30 m) remote sensing imagery. The fine resolution maps should have known accuracy and be obtained over a set of globally distributed sites. It is this requirement that has prompted LPV to coordinate various LAI validation activities. The Missoula meeting brought together 8 groups that, collectively, will ultimately provide high-resolution LAI maps at up to 71 sites (see **Table 1**).

The objective of this workshop was for each of the groups to discuss:

LPV Mission
To foster quantitative validation of higher-level global land products derived from remote sensing data, and to relay results so they are relevant to users.

LPV Objectives
- To work with users to define uncertainty objectives
- To identify and support global test sites for both systematic and episodic measurements
- To identify opportunities for coordination and collaboration
- To develop consensus "best practice" protocols for data collection and description.
- To develop procedures for validation, data exchange, and management.

landval.gsfc.nasa.gov/LPVS/

Figure 1

1) detailed information on their field data collection techniques (instruments and sampling schemes);
2) the approach used for integrating field data with high-resolution imagery (10-30m spatial resolution);
3) recent results comparing high resolution LAI data with moderate-resolution LAI products; and
4) plans for sharing field data and/or high-resolution LAI products.

The agenda and presentations from the meeting are posted at: *landval.gsfc.nasa.gov/LPVS/LPV_LAI_meeting04.html*. The reader is directed there for more details. Here we report on the general findings from the workshop.

Presentations and discussion at the meeting showed significant progress since the previous meeting (Privette et al., 2001). High-resolution LAI maps are available for many sites, some of which have also been compared to one or more of the moderate-resolution products.

General approach for integrating field points with high-resolution imagery (10-30m spatial resolution) to create a high-resolution LAI map

Figure 2 is adapted from both the Boston University and VALERI presentations and shows the general strategy for LAI validation. None of the workshop participants advocated direct comparisons between field-measured LAI and 1km LAI products due to the scale mismatch and the excessive effort that is required for statistically-significant field sampling. Rather, in all cases, participants integrated field-measured LAI values with high-resolution data to form transfer functions relating the radiance (or reflectance) values from the imagery to the field-measured LAI. The transfer function was then applied to the high-resolution data for an area covered by the ground measurements to create the high-resolution LAI maps. Each group developed their own method to create the transfer functions, but all used empirically-based relationships for the estimation. It became clear at the meeting that while the specific sampling designs varied, each group felt it necessary for the sample design to capture the variability at 30m scale over the whole study site, which was generally around 4 to 25 km in size.

Current status of the actual validation exercise

Most validation results were focused on MODIS products because of its early release and open availability. **Table 2** shows a bibliography of published results for the MODIS LAI product. Other results are given in the presentations available online. The limited number, of comparisons between the high-resolution LAI data and moderate-resolution LAI products showed mixed results. Many participants suggested that this was due in large part to the different analysis approaches employed (e.g., filtering of product values to compare based on QA flags, inclusion/exclusion of understory LAI). To encourage further evaluation and intercomparison, participants agreed to apply a consistent metadata set to their field data, and to share the field data in a timely manner. During the meeting, and through subsequent discussions, lists of metadata requirements were established.

Metadata for optical LAI field measurements include:

- Instrument(s) used (make, model)

Table 1 - Workshop participants and the number of sites where field data and high-resolution LAI maps ar or will be available.

Group	# of Sites
BigFoot	9
Boston University	5
Canadian Center for Remote Sensing	20
Penn State University	2
U.S. Environmental Protection Agency	6
University of Helsinki, Finland	2
University of Milan-Bicocca	2
VALERI	25
Total number of sites	71

- Instrument configuration (masks, rings, etc.)
- Height of instrument during measurements
- Time of day (specify whether local or GMT time reported)
- Sampling strategy
- Species (leaf-types, broadleaf or needle-leaf)
- Description of understory component and if/how it been included in the LAI calculation
- Phenological state of vegetation
- Stem area considerations (i.e. note any adjustments for LAI vs. PAI)
- Significance of terrain/slope and if there has been any accounting for such
- Sky conditions
- Post-processing of data
- Error budget and uncertainty estimate
- Software used

Metadata for the high-resolution LAI surface maps:

- Description of the high-resolution data used as input for the map
- Description of, or reference for, any of the ground measurements

used
- Description of transfer function connecting the map to the field data
- Error budget and uncertainty estimate
- Vegetation community description (leaf-types)
- Description of understory component and if/how it has been included in the LAI calculation
- Significance of terrain/slope and if there has been any accounting for such

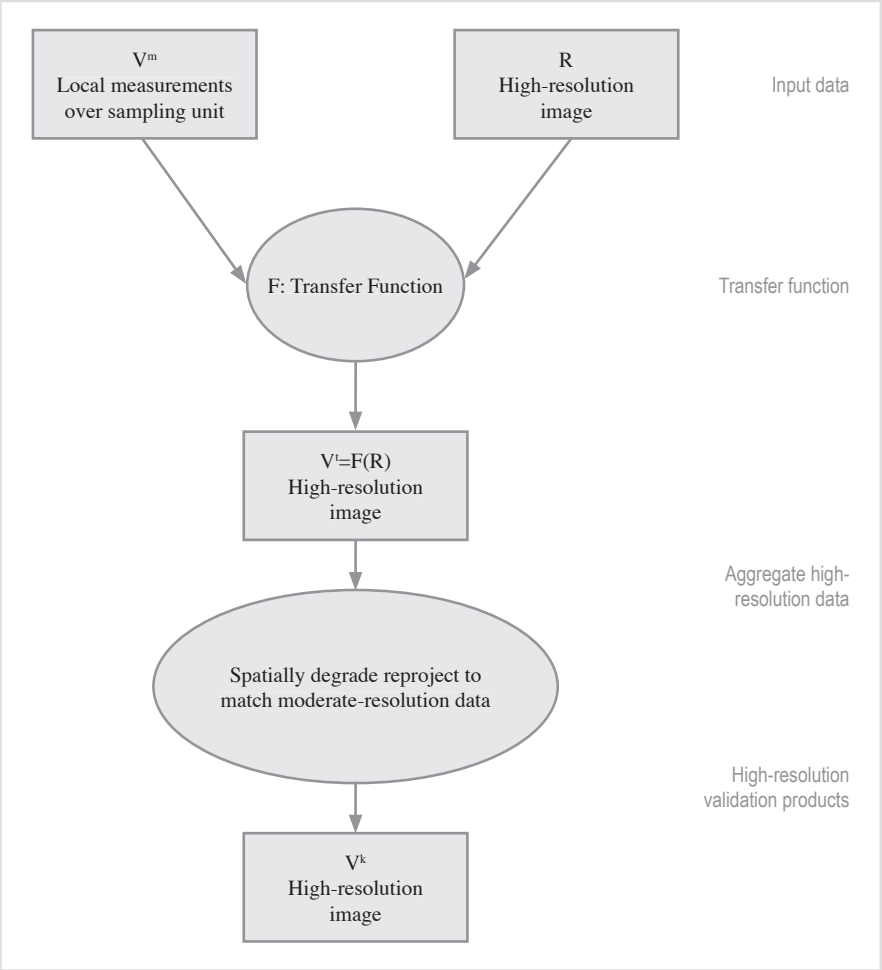
Metadata for destructive LAI measurements

Due to the diverse approaches for destructive/allometric LAI estimation, there are no specific metadata requirements, but we request that the data providers thoroughly detail their sampling and measurement techniques to allow full replication/understanding of the methods. Further, an error budget and resultant uncertainty estimate should be included.

Outstanding issues and future plans

One obvious challenge in developing a summary uncertainty estimate is due to the variety of methods (field sampling/instruments, error budgeting, transfer functions, product characterization) employed by different research groups. Therefore, near-term research will be directed toward harmonizing the methods and converging results through definition and consistent application of "best practice" protocols over all sites, as well as consistent reanalysis of previous data collections.

Figure 2: General LAI validation procedure



A special issue of the *Institute of Electrical & Electronics Engineers-Transactions on Geoscience and Remote Sensing* (IEEE-TGARSS) is being developed on the topic of land product validation, which should be published in early 2006. This issue will contribute to the dissemination of the validation methods that have been developed. Readers interested in participating should contact the authors of this article. The LAI intercomparison workshop participants agreed to develop and submit a "best practices" article based on the current CEOS global intercomparison effort.

There was consensus at the meeting that individual validation activities at most sites, where only one global product has been considered, are now sufficiently complete to support a multi-site comparison; where LAI products from MODIS as well as other sensors can be considered. Future research will be directed toward this goal. A necessary first step for this global multi-sensor LAI intercomparison is the compilation of high-resolution LAI products and initial validation results that will be made available as a result of this and preceding workshops.

Acknowledgements

Funding for the workshop came from grant EOS/03-0408-0637 through NASA's Terrestrial Ecology program (Diane Wickland, Program Manager). We thank Wickland for the continued support of the MODIS validation infrastructure. The meeting was hosted

by the Numerical Thermal Dynamics Group at University of Montana – special thanks to Steve Running and Youngee Cho for their help with meeting arrangements.

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Table 2: Summary of Publications on MODIS LAI and FPAR Validation

Publication	Site	Vegetation Type	Results
Privette et al., RSE, 83, 232-243, 2002	IGBP Kalahari Transect	Semiarid woodlands & savannas	C1 MODIS LAI algorithm correctly accommodates structural and phenological variability in semiarid woodlands and savannas, and is accurate to within the uncertainty of the validation approach used
Huemmrich et al., IJRS, 2004	IGBP Kalahari transect, Mongu, Bolivia	Woodlands	C3 MODIS and ground-measured LAI time series (2000-2002) corresponded well, while there was a significant bias between MODIS and ground-measured FPAR
Scholes et al, CCB, 10, 292-302, 2004	IGBP Kalahari transect	Six savanna sites on deep, sandy soils, along a gradient of increasing aridity	There was good agreement between LAI observed in the field using a line ceptometer, and the C3 LAI inferred by the MODIS sensor on the Terra satellite platform; 2 months later in the same season
Wang et al., RSE, 91, 114-127, 2004	Ruokolahti, Finland	Needle leaf forest mixed with large and small lakes	C4 MODIS LAI is accurate to within 0.5 LAI, precision: 48%
Tan et al., JGR, 2004 (submitted)	Alpilles, France	Agricultural area	C4 MODIS LAI is accurate to within 0.3 LAI; precision: 20%, uncertainty: 25%. Biome misclassification deteriorates the accuracy by factor of 2
Cohen et al., RSE, 88, 233-255, 2003	BOREAS NSA, Harvard Forests, MA; Konza, KS, Bondville, IL	Cropland; prairie grassland; boreal needle leaf & temperate mixed forests	C3 MODIS-based LAI estimates were considerably higher than those based on ETM+ LAI. Samples of C4 LAI products were examined and found to consist of significantly improved LAI predictions for KONZ, and to some extent for ARGO
Fensholt et al., RSE, 91, 490-507, 2004	Senegal, Western Sudano-Sahelian zone	Grass savanna	Seasonal dynamics of both in situ LAI and FPAR were captured well by MODIS LAI and FPAR. MODIS LAI is overestimated by approximately 2-15% and the overall level of FPAR is overestimated by 8-20%.
Kang et al., RSE, 86(2): 232-242	Korea	Temperate mixed forests	Minimal cross-validation errors between the predicted and MODIS-based timings of onset were found at a mean absolute error (MAE = 3.0 days) and bias (+ 1.6 days). This study demonstrates the utility of MODIS land products as tools for detecting spatial variability in phenology across climate gradients.
Pandya et al., Current Science, India, 85 (12): 1777-1782	Madhya Pradesh, India	Agricultural areas	The results indicated significant positive correlation between LAI derived from LISS-III data and MODIS data, with an overestimation in the MODIS product, root mean square error of 0.92 to 1.26 for the Bhopal site and 0.20 to 0.33 for the Indore site.
Fernandes et al., IGARSS 2002	BOREAS	Needle leaf forests	C3 MODIS LAI overestimates LANDSAT derived LAI by 33%

Report from JCG-2004, Potsdam

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The First Joint CHAMP-GRACE (JCG) Science Team Meeting was held July 6-8, 2004, at the GeoForschungsZentrum (GFZ) Potsdam. It was the second GRACE Science Team meeting and the third CHAMP Science Team meeting since their respective launches. This First Joint Meeting unified the Earth gravity, magnetics and atmospheric sensing payloads on board the near-polar, low Earth orbiting Gravity Recovery And Climate Experiment (GRACE) (*www.csr.utexas.edu/grace*) and CHAllenging Mini-satellite Payload (CHAMP) (*op.gfz-potsdam.de/champ/index_CHAMP.html*) missions, into collective application areas of Solid Earth (SE), Oceans/Ice/Hydrology (OIH) and Atmosphere/Ionosphere (AI). The SE and OIH session are described in greater detail below.

Introduction

The meeting host **Christoph Reigber** (Director, Division-1) of GFZ-Potsdam welcomed the attendees, and pointed out that the keyword geopotential at this meeting encompassed both gravity and magnetics. After an introduction to historic Potsdam and GFZ, he presented a meeting overview, asking the attendees to work towards synergizing the gravity and magnetic observations from the two missions.

Prior to the meeting, the science community had in hand approximately 3 years of CHAMP gravity, magnetic and ancillary data products; as well as one month of GRACE Level-1 (inter-satellite ranging) data products, and fourteen monthly global gravity field estimates from GRACE. The findings in the meeting presentations were based on these products. At this meeting, public release of the complete 2-year GRACE data set from August 2002 to July 2004 was also announced, which has since become available on August 9, 2004.

Solid Earth Sessions

The Solid Earth (SE) theme was subdivided into three main and splinter sessions each, with additional poster sessions. The first SE session on Geopotential Mission Status included the current status, from the respective Principal Investigators, of the CHAMP and GRACE missions; as well as the (future) ESA Earth Explorer gravity field mapping satellite Global Ocean Circulation Experiment (GOCE) (*www.esa.int/export/esaLP/goce.html*), which is integrated and in systems-level testing; and the fifth ESA Earth Explorer magnetic field mapping mission SWARM (*www.esa.int/export/esaLP/swarm.html*), which was recently approved.

The remaining SE sessions took place on Tuesday July 6, and part of Wednesday July 7 and addressed a number of topics. The geophysical applications of the static and time-variable gravity and magnetic fields derived from GRACE and CHAMP data were presented. Some regions of interest in the presentations included the Arctic, the Antarctic, Fennoscandia, Canada, the United States and the Andes. Generally, the presentations attempted to evaluate the changes between the previous generation and the much more accurate GRACE derived gravity models. Improved comparisons with terrestrial gravity or leveling data or a significant reduction of residual data variance were offered as validation of the new gravity field models. In some cases, this was used as the basis for the design of future efforts to merge global GRACE models with high-density terrestrial gravity data for the creation of more accurate local/regional geoid models.

Others addressed the validation of the GRACE-derived low degree gravity field harmonics of degree 2 through 4 based on comparisons with conventional satellite geodetic methods. These included results from Satellite Laser Ranging (SLR) to geodetic satellites, from observations of Earth Orientation Parameters (EOP), and from the load deformational analysis of a network of Global Positioning System (GPS) stations. While all methods gave estimates in the same order of magnitude, there was considerable disagreement in the time history derived from the different methods, and for different harmonics. Discussions during the meeting suggested that these are as likely due to inherent errors of each methodology as due to differences in the models used in data processing by different groups—this topic was marked for further study.

A number of papers and posters addressed new methods for extracting the gravity field from the GRACE and CHAMP data, in contrast to the conventional methods used by the mission data systems, which are derived from standard satellite geodetic practice. In this observer's opinion, the sophistication of these results has steadily improved over the past few years and interesting new results may be expected soon as more flight data becomes available. In addition, there were a few papers on the geophysical application of gravity and magnetic results from GRACE & CHAMP.

Oceans, Ice and Hydrology Sessions

The OIH sessions focused on the application of gravity and magnetics data from GRACE and CHAMP to the oceans, ice and hydrological sub-systems of the Earth, including their mutual interactions. Evidence was presented linking CHAMP-derived magnetic field variability to oceanic variability, including tides. In oceanographic applications, the use of the mean GRACE geoid in deriving dynamic ocean topography (& hence the currents) appears to be most matured. Papers were presented with assessments of both regional and global circulation derived from satellite altimetry, showing heretofore unmatched correlation to hydrographic models. The application of the time-variable gravity models to oceanography presented a more ambiguous picture. While the variability of the global oceans is well observed, good results were obtained regionally either near the high latitudes, or with great smoothing. However, in general, the presenters were concerned about larger than desirable, predominantly north-south aligned artifacts in GRACE derived monthly geoid models. The GRACE Science Data System reported that the removal or reduction of such artifacts is the highest priority for the model and data processing improvements underway.

Papers on hydrological applications generally pronounced that GRACE-derived geoid variability was indeed observing true hydrological variations. High confidence was shown in the GRACE results particularly in regions with major river basins with large signals, such as the Amazon, or Central Africa, or South-East Asia. In comparisons of GRACE results with hydrological models, discussion was also directed towards reconciling the various hydrological models among each other, in light of their agreements or disagreements with GRACE geoid variations.

Presentations on the cryospheric applications of GRACE time-variable gravity field products showed that the variability was of the right magnitude when compared to models. Over regions with large signals, the variability was seen to agree with estimates derived from GPS loading.

Conclusion

Overall, for the GRACE mission, the meeting was the first one to focus predominantly on the science applications and evaluations of the data products, rather than the methodology of GRACE data processing by the project. The sophistication of the applications spanned the wide range from early validation of comparison with so-far known models, to the stage of seeking to correct independent models based on their differences from GRACE observations. The necessity for and the benefits of improving the GRACE data products through re-processing using improved models and methods were clear at the conclusion of the meeting.

The JCG Meeting was followed on Friday, July 9th with a Festkolloqium celebrating the careers of **Chris Reigber** and **Volker Haas**, both of GFZ Potsdam, on the occasion of their retirement. The program included talks from their colleagues in different areas of Earth Sciences, on status and results from various projects and activities where Reigber and Haas had contributions and influence.

The week concluded with a Summer Fest on a sunny Friday afternoon, where a good time was had by all.

The complete meeting program, including abstracts and pictures, are available at *www.gfz-potsdam.de/pb1/JCG/jcg_index.html*.

Earth Science Enterprise Education Program Update

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NASA TO PROVIDE SCHOLARSHIPS AND JOBS TO STUDENTS

NASA has announced the first step towards its new Science and Technology Scholarship Program (STSP), offering up to 225 recipients $20,000 in tuition support plus $10,000 in research internship support annually.

The STSP is a competitive scholarship program intended to guide U.S. undergraduate students toward NASA-related science and engineering careers. STSP is a focused program to attract the "best and brightest" science and engineering students into the NASA work force. In exchange for tuition scholarships and research-stipend support, STSP students must agree to fulfill a service obligation following graduation.

It is anticipated that applications for this program will be open in the winter of 2004 with a due date of early 2005. To receive an e-mail notification as soon as application information is available please visit *www.tsgc.utexas.edu/stsp/*. For information about NASA education programs, visit: *education.nasa.gov*.

GLOBE ONE FIELD CAMPAIGN: PARTNERING STUDENTS, SCIENTISTS AND THE COMMUNITY TO INVESTIGATE THE IMPACTS OF SOIL TILLAGE

Scientists from the NASA-sponsored GLOBE Program are running a field campaign, titled GLOBE ONE, featuring K-12 students working hands-on with scientists and their local communities to perform scientific research. The campaign, which is occurring in Black Hawk County, Iowa, started in the spring of 2004 and is slated to run through the fall of 2005. Students participating in GLOBE ONE are encouraged to ask science questions and develop independent research projects.

GLOBE ONE is looking at how land cover affects the local soil, atmosphere, water and plant growth/development. Observations include such diverse subjects as ruby-throated hummingbirds, contrails, and aerosols. Data are being collected by students, volunteers, and automated weather stations. By addressing a locally relevant research topic, GLOBE ONE is able to engage students in learning about the area around them and help integrate agricultural science into classrooms.

For more information about the campaign, or to view the data, please visit the GLOBE ONE Web site at *www.globe.gov/globeone*.

NEW NASA MISSION NEEDS MIDDLE SCHOOL SCIENTISTS

A new module, *Atmospheric Science Mission*, has been added to the popular Astro-Venture Web site, *astroventure.arc.nasa.gov*. In this new module, students role-play atmospheric scientists as they analyze data from Mars and Venus for human habitability. This interactive, multimedia Web adventure immerses students in the real science of planetary research using scientific inquiry and feedback from actual atmospheric scientists. All activities meet National Science Education Standards and are free of charge; no registration is required.

APPLICATIONS OPEN FOR NASA EXPLORER SCHOOLS PROGRAM
Deadline: Jan. 31, 2005

Schools from across the country are eligible to apply online for an opportunity to partner with the NASA Explorer Schools (NES) Program. NES is designed to bring mathematics, science, technology, and engineering learning to educators, students, and families.

Each spring, a three-year partnership is established between the agency and 50 new NASA Explorer School teams. More than 100 teams of teachers and education administrators from diverse communities in 46 states have participated.

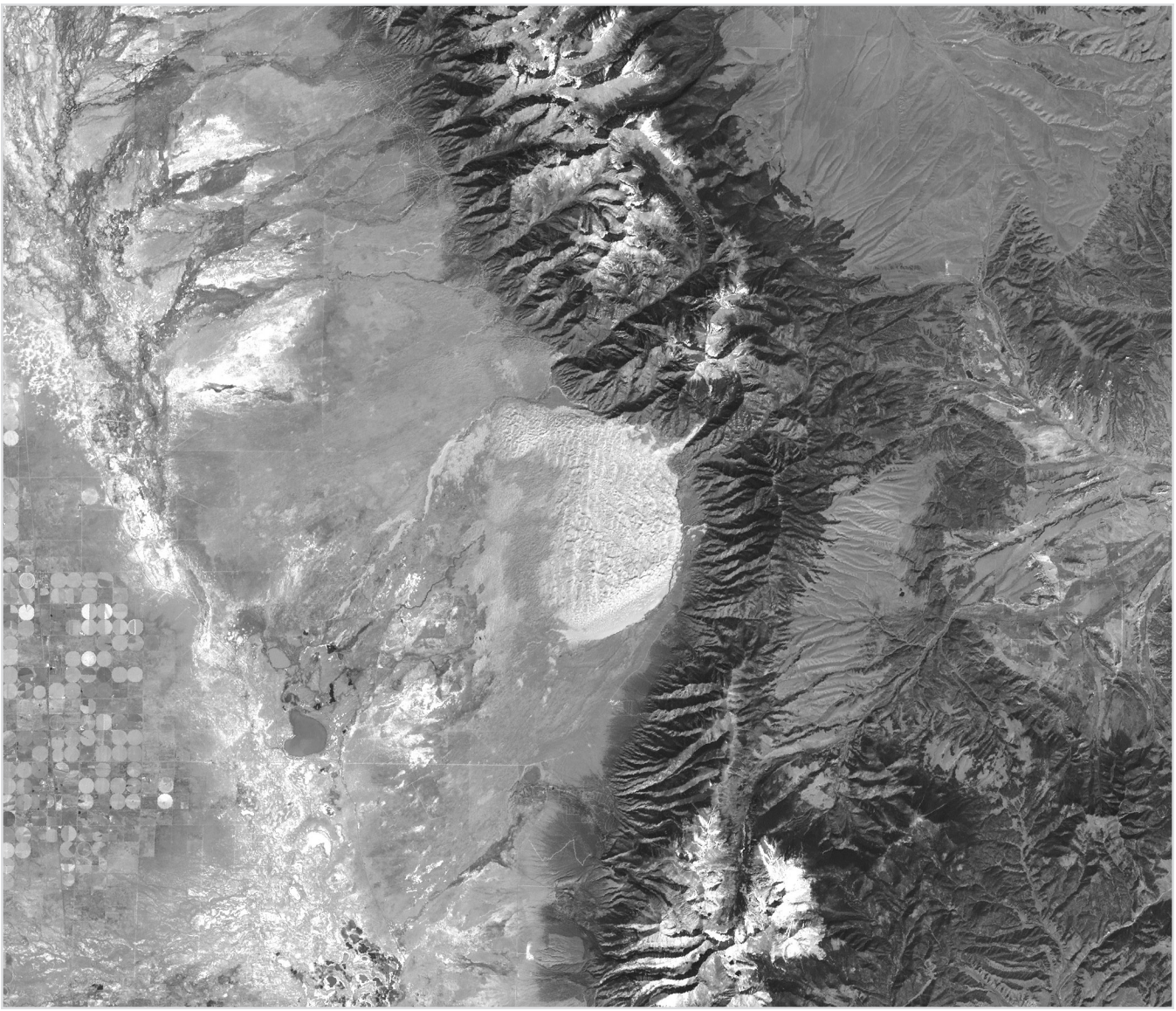
NASA invites the selected teams to work with education specialists from Agency Centers to spark innovative science, mathematics, and technology instruction aimed at students in Grades 4 through 9. NES teams acquire new teaching resources and technology tools using NASA's unique content, experts, and other resources.

To view the 2005 NES application on the Internet, visit *explorerschools.nasa.gov*. The deadline is January 31, 2005.

GRAND OPENING - FUTURE FLIGHT DESIGN!

Middle school students are invited to become NASA researchers designing the air transportation system of tomorrow at *futureflight.arc.nasa.gov*. NASA's latest Web-based, interactive, problem-based learning environment teaches about forces of flight and the engineering of air transportation and aircraft systems of the future. Online biographies highlight careers in aeronautics and aerospace engineering. Two educator guides are available for download that include a student log to help guide students through the activities. All activities meet National Science and Technology Education Standards. No registration fees required.

Mountains of shifting sand swirl around the feet of the rugged Sangre de Cristo Mountains in Southern Colorado. Rising over 750 feet, the dunes are the largest sand dunes in North America. On Monday, September 13, 2004, they became part of the newest national park in the United States. The new Great Sand Dunes National Park contains more than sand—the 84,670-acre park also includes mountain lakes and tundra, high mountain peaks, pine and spruce forests, stands of aspen, grassland, and wetlands. This image, acquired by the Landsat Enhanced Thematic Mapper plus (EMT+) on October 14, 1999, shows the park and its immediate surroundings. NASA image created from data provided by the Global Land Cover Facility, University of Maryland.



Researchers Find Frozen North May Accelerate Climate Change

—Rob Gutro, rgutro@pop900.gsfc.nasa.gov, Goddard Space Flight Center
—Paula Rausch, prausch@ufl.edu, University of Florida

NASA-funded researchers have found that despite their sub-zero temperatures, a warming north may add more carbon to the atmosphere from soil, accelerating climate warming further.

"The 3° to 7° Fahrenheit rise in temperature predicted by global climate computer models could cause the breakdown of the Arctic tundra's vast store of soil carbon," said Michelle Mack, an ecologist at the University of Florida, Gainsville, Fla., and one of the lead researchers on a study published in last week's issue of Nature. It would release more of the greenhouse gas carbon dioxide into the air than plants are capable of taking in.

The study results suggest that climate warming in the Arctic tundra may cause the release of much more carbon dioxide than previously expected. This type of positive feedback will make the Earth's climate change even more rapidly.

The findings were collected in a 20-year experiment of the effects of fertilization on the Arctic tundra at the Arctic Long-Term Ecological Research site near Toolik Lake, Alaska. The National Science Foundation and NASA provided funding for the research.

One-third of the Earth's soil carbon is locked in northern latitudes because low temperatures and water-saturated soil slow the decomposition of organic matter by bacteria, fungi and other organisms.

Scientists from UF, the University of Alaska and the Marine Biological Laboratory at Woods Hole, Mass., added nitrogen and phosphorous fertilizer to the soil to simulate the release of nutrients from decomposing soil organic matter.

The scientists hypothesized the fertilizer would stimulate plant growth, remove carbon from the atmosphere and eventually add it to the soil as plants shed dead leaves and roots over time. Thus, the whole ecosystem was thought to be gaining carbon after fertilization.

Mack and her colleagues found exactly the opposite. Even though plants grew more, and more carbon was stored in plants and in the surface of the soil, the whole ecosystem did not gain carbon. "Instead, it lost a tremendous amount from the deepest soil layers, probably because increased nitrogen accelerated the decomposition of organic matter by soil organisms, thereby releasing carbon dioxide."

The results could have implications for ecosystems in other regions of the world as well, said Edward Schuur, a UF ecologist who co-led the project. Places such as the northeastern U.S. and Europe, where acid rain has increased the amount of nitrogen deposited into the ecosystem from the atmosphere, also could experience an increased loss of soil carbon in response to higher nitrogen inputs.

"It may be that not just Arctic ecosystems, but those in other parts of the world will have a similar decomposition response to increased nitrogen," Schuur speculated. "Increased nitrogen levels are thought to have caused trees to grow more in many places. These places may experience the same kinds of effects below ground that we've noted."

Few previous studies have assessed fertilization effects on soil carbon pools because these effects are difficult to detect over short periods of time. The long-term nature of the experiment makes it unique among studies of Arctic ecosystems, and makes the effects of fertilization large enough to detect.

It has long been thought that global warming would have two opposing effects on arctic soils. First, it would increase the breakdown of soil organic matter, releasing carbon dioxide, the major cause of warming, into the atmosphere. Second, the breakdown of soil organic matter would liberate nutrients that would enhance rates of plant growth, thereby removing carbon dioxide from the atmosphere.

Peter Vitousek, a professor of biological sciences at Stanford University, said

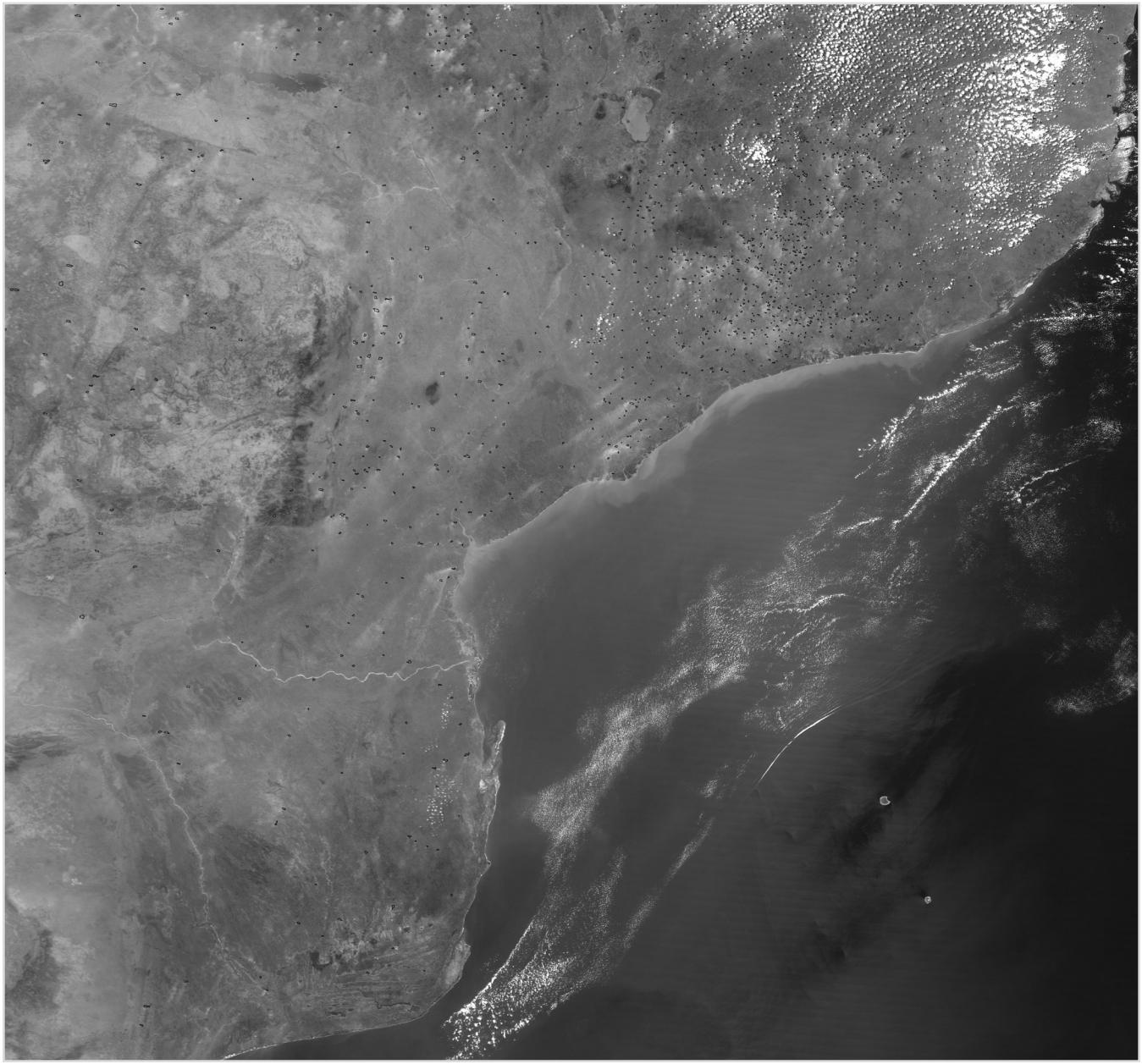
"This work demonstrated beautifully that there is another, even stronger effect, that an increase in nutrients also enhances the breakdown of soil organic matter." The overall effect of warming especially in the Arctic will be to release carbon dioxide to the atmosphere, enhancing the likelihood of further warming.

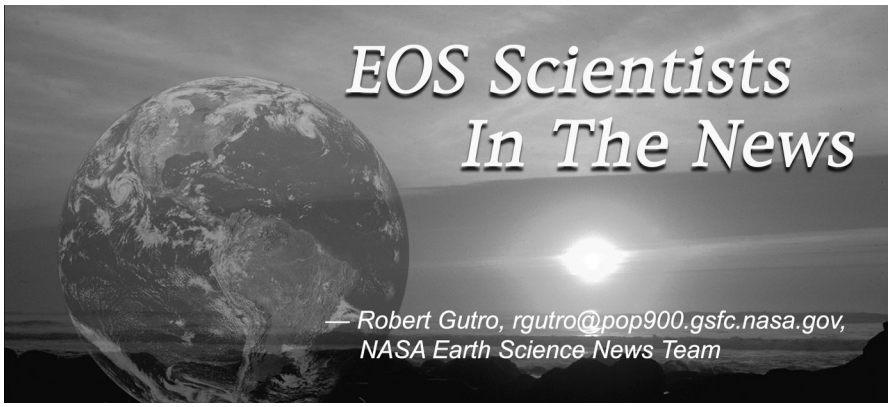
NASA sponsored research projects are selected through peer review and intended to improve the quality of life through the exploration and study of Earth's system, the solar system and the Universe.

For more information and images, please visit on the Internet: *www.nasa.gov/vision/earth/environment/frozen_north.html*

In southeastern Africa, scores of fires were burning on September 25, 2004, in Mozambique south of Lake Malawi, whose southern tip is at the top center of the image. Active fire detections made by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua satellite are marked in black dots. The fires created a layer of smoke that darkened the surface of the land beneath it. At upper left in the image, the body of water is the Cahora Basso Lake, created by a dam on the Zambeze River just inside Mozambique after the river leaves its course along the border of Zambia and Zimbabwe.

NASA image by Jesse Allen, based on data from the MODIS Rapid Response Team, NASA-GSFC





Researchers Find Frozen North May Accelerate Climate Change, October 12; *Science Daily*; Despite their sub-zero temperatures, a warming north may add carbon to the atmosphere from soil, accelerating climate warming according to **Michele Mack** and **Ted Schuur** (University of FL).

NASA Ames Flies Instrument Over Mt. Saint Helens, October 7; *KQED-FM, National Public Radio, San Francisco, CA*; Peter John Schuler of KQED-FM interviewed **Bruce Coffland** (NASA/Ames) about a NASA Ames mission that flew a light plane with an infrared instrument aboard over Mt. St. Helens on September 30, a day before the mountain erupted.

NASA Software Enables Satellite Self-service in Space, October 7; *Computer Week on-line, SpaceRef, Astrobio.net*; The articles highlight NASA Ames' Livingstone software which can find and analyze spacecraft system errors, and is being tested on the EO-1 satellite.

Study Shows Potential for Antarctic Climate Change; October 6; *Habitat.org, UK Weatherworld*; While Antarctica has mostly cooled over the last 30 years, the trend is likely to rapidly reverse, according to NASA's **Drew Shindell** (NASA/GISS).

SAGE's Advice Upbeat For Ozone Layer: Two Decades Of Research By Hampton University And NASA Have Enhanced Understanding For The Future Of The Ozone Layer, October 6; *The Daily Press, Newport News*, VA; Twentieth anniversary celebration of the SAGE II (Stratospheric Aerosol and Gas Experiment) instrument prompts this story on the instrument's contributions to our understanding of the ozone layer. Articles quote **Joe Zawodny** (NASA Langley), atmospheric scientist, and **Jack Kaye**, Earth-Sun System Program Manager for the Science Mission Directorate at NASA Headquarters.

Earthquake Forecast Program Has Amazing Success Rate; October 4; *All India News: KABC-TV, Los Angeles, San Jose Mercury News*; A NASA funded earthquake prediction program predicted the locations of 15 of California's 16 largest earthquakes this decade. John Rundle, director of the Computational Science and Engineering initiative at the U.C. Davis leads the group that developed the forecast scorecard. **Andrea Donnellan**, QuakeSim principal investigator and JPL software engineer **Jay Parker** (both NASA/JPL) were also quoted.

Fall's Blue Skies: Science Explains Why The Heavens Take On A Deeper Hue In Autumn; October 2; *The Virginian-Pilot* (Virginia Beach, VA); On-going series investigating "everyday" science, discussing the physics of the deep blue skies that are common in October Includes quotes from **Chip Trepte** (NASA Langley), atmospheric scientist.

JPL Scientist Predicts This Winter's El Niño Will Be an El Whimpo; September 30; *The Alpenhorn News* (Crestline, CA); **Bill Patzert** (NASA JPL) was interviewed about a weaker El Niño.

Scientists Report Increased Thinning of West Antarctic Glaciers, September 23; *ABC News, Associated Press, BBC News*; Glaciers in West Antarctica are shrinking at a rate substantially higher than observed in the 1990s. **Bob Thomas**, (EG&G Services at NASA Goddard's Wallops) commented.

Glaciers Surge When Ice Shelf Breaks Up, September 21; *Discovery Channel Canada, NPR, USA Today*; Since 2002, when the Larsen B ice shelf broke away from the coast of the Antarctic Peninsula, scientists have witnessed profound increases in the flow of nearby glaciers into the Weddell Sea. Scientists such as **Eric Rignot** (NASA/JPL), **Christopher Shuman** (NASA/GSFC) and **Ted Scambos** (NSIDC) were quoted.

Tactical to Practical; September 20; *The History Channel* featured NASA's ER-2 and interview about Airborne Science mission with NASA pilot **Jim Barrilleaux** (NASA Dryden). Jim explained the physical properties of the aircraft, its science capabilities when carrying a suite of sensors, and his experiences as a U-2/ER-2 pilot.

Spy Planes, Aerial Reconnaissance/Trains/Navigation; September 20; This *History Channel* special featured an interview with NASA Dryden historian

Curtis Peebles. Curtis was interviewed about the historical aspects of the U-2.

NASA Scientist Wins Top Award; September; *The Sun Herald* (Biloxi, Miss.), *Sun Herald Neighbors* (Biloxi, Miss.), *The Times Picayune* (New Orleans, La.); **Carlos Del Castillo**, an aerospace technician with the Applied Sciences Directorate at NASA Stennis Space Center, was one of three NASA-funded scientists who received the Presidential Early Career Awards for Scientists and Engineers. Del Castillo's work consists of using NASA satellites to determine ocean optic conditions, which is used to determine factors such as ocean flow and sedimentation.

NASA's GRACE Gravity Mission Weighs in on Earth's Changing Climate, September 9; *Spacedaily*; Scientists demonstrate how measuring Earth's gravity field can help monitor changes in climate and weather. **Byron Tapley** (University of Texas Center for Space Research, Austin, TX) and **Christoph Reigber** (GeoForschungsZentrum Potsdam in Germany) were quoted.

The Party's Over; September 7; *U.S. Politics Today*; Discussion of global warming and recent findings to support global climate change theories. Includes quotes from **Bruce Wielicki**, Langley senior research scientist and CERES principle investigator.

El Niño Stories and Bill Patzert: New El Niño may or may not be developing in Pacific, August 6; *USA Today, Science Daily, Redding Record-Searchlight* (CA); **Bill Patzert** (NASA/JPL interviews) taped telephone interview with Steve Raleigh, Chief Meteorologist for KRON-TV (Channel 4 in San Francisco). Also aired August 20; The Denver Channel, *San Luis Obispo Tribune*, KTUV (Channel 2 in San Francisco), *Contra Costa Times, Monterey County Herald*.

Dangerous Fire Season Is Forecast, August 9; *LA Times*; Experts say a prolonged drought, tree-killing pests and a century of fire suppression are among the factors that are creating the threat. **Bill Patzert** (NASA/JPL) was interviewed.

EOS Science Calendar

January 5-7

ESIP Federation Workshop. Contact: Carol Mayer, carol.mayer@earthsciencefoundation.com

December 6-10

Joint US/Japan ASTER Science Team Meeting, Las Vegas. Contact: Elsa Abbott, elsa.abbott@jpl.nasa.gov

Global Change Calendar

December 13-17

American Geophysical Union (AGU) Fall Meeting. San Francisco, CA. Tel 1-800-966-2481. E-Mail: meetinginfo@agu.org. URL: *www.agu.org/meetings/fm04/*

2005

January 9-13

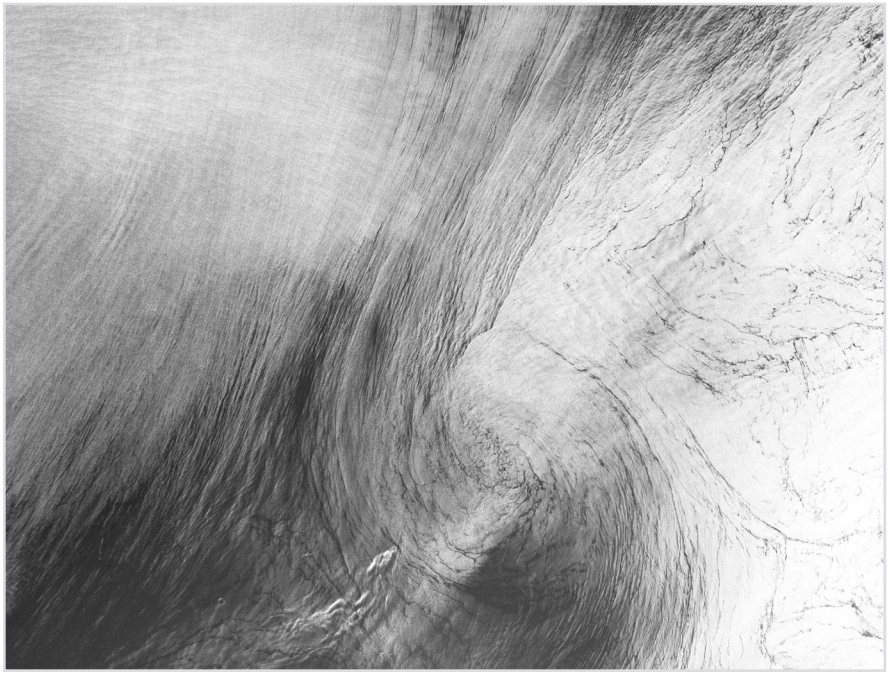
85th AMS Annual Meeting, San Diego. Tel. 617-227-2425, E-Mail amsinfo@ ametsoc.org, URL: *www.ametsoc.org/meet/85annual/*

June 20-24

5th International Scientific conference on the Global Energy & Water Cle, Orange County, CA. URL: *www.gewex.org/5thconf.htm*

June 20-24

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



This image shows a giant whirlpool cloud, coaxed into shape by high-altitude winds, swirling above the sea between Spain and Morocco. The scene was acquired on August 21, 2002, by the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) aboard NASA's Terra satellite. Image provided by the USGS EROS Data Center Satellite Systems Branch as part of the Earth as Art II image series.

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