Earth Observing System

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In this issue . . . .

EDITOR'S CORNER

Michael King
EOS Senior Project Scientist

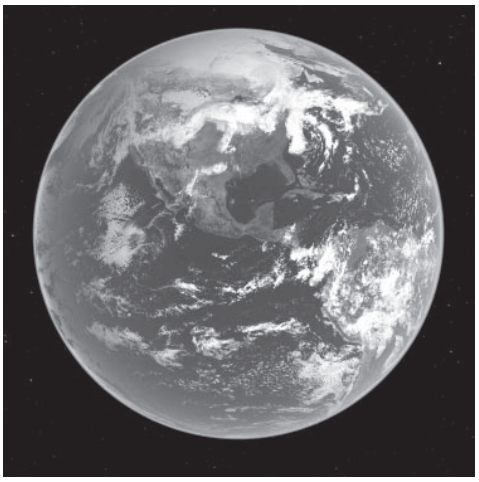
It is with both great regret and congratulations that I must announce the departure of Christopher Scolese as the Deputy Director of Flight Programs and Projects at Goddard. Chris has been named by NASA Administrator Daniel Goldin to replace Dr. Earl K. Huckins III as the Deputy Associate Administrator for the Office of Space Science. During his tenure at Goddard, which began in 1987, Chris served as the EOS Terra Project Manager responsible for the development of the five EOS Terra instruments, the CERES instrument for TRMM, the Terra spacecraft, the interface with the Earth Science Data and Information System, and the integration and launch of these elements. He was also the EOS Systems Manager responsible for the EOS system architecture and the integration of all facets of the project, and has been responsible for the adoption of common data system architecture on EOS and some other Earth orbiting spacecraft. His dedication, commitment, and tremendous contributions to the EOS program will be sorely missed.

Science Team members from the Ozone Monitoring Instrument (OMI) on the Aura spacecraft will participate in an EOS Algorithm Theoretical Basis Document (ATBD) review over the next few months. The ATBD peer review process is intended to ensure that each EOS algorithm is well-conceived, computer efficient, and state-of-the-art, prior to launch. The Dutch-led OMI Science Team will submit four documents for review describing the instrument and Level 1B data processing, ozone products, clouds, aerosol and radiation products, and trace gas products. Following the preparation of these ATBDs, written reviews will be conducted by experts in each field of study prior to an oral review at Goddard Space Flight Center on November 5, chaired by Dr. John Burrows from the University of Bremen, Germany. A panel report will be produced for the authors with recommendations for improvements to the algorithms, if necessary.

(Continued on page 2)

Aura is currently scheduled to launch in July 2003, carrying OMI and three other atmospheric chemistry instruments. The High-Resolution Dynamics Limb Sounder (HIRDLS), Microwave Limb Sounder (MLS), and Tropospheric Emission Spectrometer (TES) have already participated in the ATBD review process with very favorable results.

The next EOS Investigators Working Group Meeting will be held October 30 - November 1 at the Adams Mark Hotel in San Antonio, TX. The agenda is being formulated at this time, but the primary focus of the meeting will be to learn of new EOS program developments, mission capabilities, and scientific discoveries. The science portion of the meeting will be formatted around the ESE science research strategy, which is based on questions (variability, forcing, response, consequence, and prediction) rather than topical science themes (e.g., atmosphere, ocean, land, and cryosphere). This sequential logic should stimulate a more comprehensive awareness of how various EOS research studies fit together. Registration and hotel information have been posted to the EOS Project Science Office web site at eospso.gsfc.nasa.gov. I hope you will plan to participate in this valuable opportunity to share the latest EOS science and program activities.



Reto Stockli of Science Systems and Applications, Inc. has produced a new global image mosaic of atmospheric, oceanographic and land processes derived largely from the MODIS instrument, where the narrow gaps in orbital coverage in the tropics was filled in using geosynchronous data (GOES in this case). This new 'blue marble' is an eye-catching MODIS multi-parameter global image, and demonstrates the tremendous capability of this instrument for interdisciplinary Earth science studies. It was produced by compositing a number of MODIS science products, including cloud data, sea ice, snow cover, and surface reflectance. The USGS GTOPO 30 topography dataset was overlaid to show terrain relief. In electronic form, the image can be rotated in any orientation, and will be used for a variety of scientific, educational and promotional purposes.

Kudos

The Earth Observer Staff wishes to congratulate these members of the EOS community for their outstanding contributions to NASA and the Earth Observing System Program.

EXCEPTIONAL SCIENTIFIC ACHIEVEMENT MEDAL

Robert M. Atlas—Goddard Space Flight Center
Steven J. Goodman—Marshall Space Flight Center
Dale A. Quattrochi—Marshall Space Flight Center
David F. Young—Langley Research Center

EXCEPTIONAL SERVICE MEDAL

Carol J. Bruegge—Jet Propulsion Laboratory
Bruce W. Guenther—Goddard Space Flight Center
Arlin J. Krueger—Goddard Space Flight Center
Claire L. Parkinson—Goddard Space Flight Center
James D. Spinhirne—Goddard Space Flight Center

EXCEPTIONAL ACHIEVEMENT MEDAL

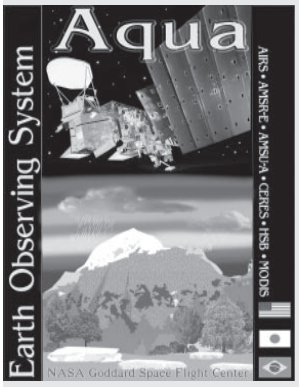
John Barker—Goddard Space Flight Center
Graham W. Bothwell—Jet Propulsion Laboratory
David J. Diner—Jet Propulsion Laboratory
Brent N. Holben—Goddard Space Flight Center

OUTSTANDING LEADERSHIP MEDAL

Michael D. King—Goddard Space Flight Center
Robert A. Schiffer—NASA Headquarters
Dorothy C. Perkins—Goddard Space Flight Center
Christopher J. Scolese—Goddard Space Flight Center

DISTINGUISHED PUBLIC SERVICE MEDAL

Steven C. Wofsy—Harvard University



Minutes of the Aqua Science Working Group Meeting

— Steve Graham, (steven.graham@sesda.com), Aqua Outreach Coordinator,
— Claire Parkinson, (claire.parkinson@gsfc.nasa.gov), Aqua Project Scientist

Introduction and Status of Aqua

The Aqua Science Working Group met for a day-long meeting on August 2, 2001 at Goddard Space Flight Center (GSFC). The meeting was chaired by Aqua Project Scientist Claire Parkinson, who opened the proceedings by showing a preliminary animation of the anticipated A-train sequence of afternoon satellites, with Aqua flying over the Americas followed by ESSP 3 (formerly PICASSO-CENA), CloudSat, Parasol, and Aura, all due to be launched within the next several years. The animation was produced by Jesse Allen of Science Systems and Applications Incorporated and will be enhanced over the next several months. Parkinson then showed the newly published AIRS brochure and praised the AIRS Science Team and especially Mike Gunson and AIRS Team Leader Mous Chahine for its quality and successful completion. Copies of the brochure were made available to the meeting participants later in the day. Parkinson also described an Aqua lithograph that is currently in press and went over the status of the negotiations and timing of an anticipated Aqua special issue of the IEEE Transactions on Geoscience and Remote Sensing. It is hoped that the deadline for papers for the Aqua special issue will be in early 2002 and that the issue will be published by the end of 2002.

Parkinson then introduced Phil Sabelhaus, the Aqua Project Manager, to give an update on the current status of Aqua. Sabelhaus began by showing several photographs of the Aqua spacecraft, the Aqua solar array, and the thermal vacuum chamber into which Aqua was carefully being lowered on the day of the Working Group meeting. All photos were taken at TRW in Redondo Beach, California.

Sabelhaus explained that vibration, acoustics, shock, electromagnetic interference, and fault management testing have all been completed, as have 108 hours of ground system interface testing. Earlier problems with transponders, transponder interface electronics, and the solid state recorder in the formatter multiplexer unit have been solved, and each of these units was repaired and reinstalled on the spacecraft prior to the baseline System Comprehensive Performance Test (SCPT), which was successfully completed on July 23. In contrast to the initial SCPT conducted back in February 2001, this SCPT included on the flight hardware. The successful completion of the baseline SCPT now means that the spacecraft is ready for the thermal vacuum test, scheduled to begin on August 18. If the thermal vacuum testing goes well, with no major problems identified, Aqua could be ready for shipment to Vandenberg Air Force Base in early December and possibly ready for launch by late January 2002. The launch manifest for Vandenberg is somewhat crowded over the next 12 months, however, so the actual launch date for Aqua will depend on launch slot availability as well as Aqua readiness. *[Editor's note: as of September 2001, the Aqua launch will be no earlier than March 2002.]*

Sabelhaus saved his most contentious issue for last; he stated that he opposes a deep-space maneuver for Aqua citing the risks involved. The AIRS Science Team is similarly opposed, but many scientists from the CERES, MODIS, and AMSR-E teams support the proposed maneuver for calibration purposes. An agreement has been reached to undertake this maneuver on day 60 of the mission. Sabelhaus recognized this agreement and understands that the spacecraft is designed to handle this deep-space maneuver but is still opposed to the plan because he believes the maneuver is unnecessary. Bruce Wielicki from the CERES Team noted that other missions have done such maneuvers successfully and that the risk involved is small and is far outweighed by the potential science benefits. Wielicki agreed with Sabelhaus that the maneuver should be attempted only if the spacecraft is performing well. Sabelhaus concluded by reiterating that the maneuver is in the official timeline and that we can expect it to occur on day 60 (or thereabouts).

Update from NASA Headquarters

The next speaker was Ramesh Kakar from NASA Headquarters. Kakar explained that there is no closure yet on the issue of recompeting the EOS science teams but that Headquarters soon wants to issue a

Request for Proposals (RFP) for maintenance of the approved algorithms, plus a NASA Research Announcement (NRA) for data analysis that can be done using either the approved algorithms or alternative algorithms. Instrument Principal Investigators and Science Team Leaders should submit proposals in response to the RFP. In these proposals, the budget should show a decrease in algorithm-maintenance money with time, to allow more money for data analysis in later years. If necessary, the Instrument Principal Investigators can propose to change the composition of their teams at this time.

Kakar emphasized the need for the Aqua science teams to integrate into their programs the new validation activities that have recently been funded through last year's Validation NRA. Kakar also warned the group that the Senate Appropriations' Committee recently recommended removing $15 million from the EOS algorithm budget for FY2002, although the House of Representatives has not done so and it is not clear at the present time how this issue will work itself out.

CERES Early Results and TRMM/ Terra Experience

Bruce Wielicki from the CERES Science Team followed Kakar and offered an update on the CERES program. The CERES instrument on Terra is performing well with no major anomalies. The only minor issue is that the solar diffusers have experienced degradation of coatings and are not useable. The team will rely on calibration lamps, inter-instrument calibration, and convective cloud stability checks.

Earth Radiation Budget Experiment (ERBE)-like Top Of the Atmosphere (TOA) flux data products continue to be produced as validated products, and there are now 16 Terra months available.

There was a press release on the first year of Terra CERES data. Wielicki views the release as a huge success and praised the Earth Observatory, Goddard Scientific Visualization Studio, and public affairs teams for their considerable work. The release can be found at: earthobservatory.nasa.gov/Newsroom/NasaNews/2001/200106204895.html.

Next, Wielicki commented on the status of CERES data products from the Tropical Rainfall Measuring Mission (TRMM), noting that the TRMM beta Angular Distribution Models (ADMs) are encouraging and there has been a factor of 4 to 8 improvement in clear ocean fluxes. The remaining ADM challenge is viewing zenith angle dependence of cloud fraction and optical depth.

Regarding Terra data products, the ERBE-like TOA fluxes have been validated and processed to the present. However, the MODIS cloud analysis has been slowed by data calibration/noise delays, MODIS data delivery and delays in getting Atmospheric Radiation Measurement (ARM) data used for validation analyzed for overpasses.

Wielicki noted that comparison testing is underway between the Goddard Earth Observing System (GEOS) 3.3.x and the European Centre for Medium-Range Weather Forecasts (ECMWF). This had been planned for the March/April 2001 timeframe, but there was a schedule slip of a month or two by GEOS, which then caused an overlap with TRMM and complications with conflicting personnel responsibilities. This delayed part of the GEOS/ECMWF comparison until late June. Temperature and water vapor profiles obtained by CERES longwave and window channel tests taken in April/May compare well with data from ECMWF data from the same period. The team hopes to wrap up testing in August 2001, pending the renewal of the ECMWF data contract (which ran out on July 31).

The Chesapeake Lighthouse and Aircraft Measurements for Satellites (CLAMS) Field Experiment was run from July 10 to August 2, 2001 over the Chesapeake Lighthouse, located 25 km off the Virginia Beach coast. The goals of the experiment were to develop a better understanding of how the ocean surface reflects sunlight and to validate and improve satellite-based estimates of atmospheric aerosol properties and surface and atmospheric heat budget estimates.

Next, Wielicki commented on the status of the ARM/ Baseline Surface Radiation Network (BSRN) validation data source. ARM is starting to produce routine daily processing near Terra overpasses, and all but the Tropical Western Pacific sites are processed to within three months of current observations. The BSRN archive has been unavailable for the last year and there is still no official word on when it will become available (it was expected to be available in June). A short-term workaround is to contact individual BSRN sites directly.

The CERES team is still waiting for the Terra deep space calibration maneuver. This maneuver would let overlapping instruments intercalibrate to better than 0.1% (95% confidence) in window and longwave radiance using six weeks of overlapping orbit crossing data. Without the deep space look, each scan position has variations up to 0.5% and the CERES team requires 100 scan positions to be determined instead of 1 gain value. With the maneuver, they could approach solar constant level stability of 0.2 W/m^2 in longwave flux. To avoid this concern, the

CERES team supports conducting the Aqua deep-space maneuver early in the mission.

Recent science results from CERES include evaluation of the Iris hypothesis that thin cirrus clouds in the tropics exert a large negative feedback in the climate system. The evaluation was done using CERES/Visible Infrared Scanner (VIRS) TRMM data and the discovery of dramatic changes in the ratio of shortwave cloud radiative forcing (CRF)/longwave CRF during the 1998 El Niño (confirmed by Stratospheric Aerosol and Gas Experiment II measurements).

Data archive issues now being worked include a NOAA/NASA agreement and the transition of NASA data to NOAA's long-term archive. In addition, CERES and other teams are continuing to evaluate data processing hardware requirements.

Science Requirements Flow Down

Following Wielicki, Chi Wu of the Aqua Project gave an overview of the Aqua top-level science requirements flow down. Wu noted that the flow down needs to be completed by early September and most of the work is already done for the instruments, spacecraft, and ground requirements. However, the project needs the Aqua science community's help regarding the top-level science requirements flow down. The top level science requirements consist of the Aqua minimum success criteria (which can be found at aqua.nasa.gov/science.html) and the instrument science requirements, including data collection and data product requirements. The latter are complicated, involving instruments, algorithms, and calibration. Ken Anderson, the Aqua Instrument Systems Manager, will be contacting team members soon for their help and input.

Parkinson added that recent calculations based on the original Aqua minimum success criteria yielded only a 42% probability of mission success. As a result, the requirements and the various interpretations of them are being reevaluated.

Results from the Terra MODIS and MODIS Team Plans for Aqua

Following Wu, Vince Salomonson, the MODIS Science Team Leader, introduced a series of MODIS presenters, beginning with Michael King, the MODIS Atmosphere Group Leader and EOS Senior Project Scientist, who gave a status update on MODIS atmosphere science.

King noted that MODIS atmosphere products are produced on 5-minute granules covering an area of 2330 km x 2000 km. Level 2 atmosphere products include a cloud mask for distinguishing clear sky from clouds, cloud radiative and microphysical properties, aerosol optical properties, atmospheric moisture and temperature gradients, and columnar water vapor content. Level 3 gridded time-averaged atmosphere products include daily, 8-day, and monthly products on a 1° x 1° equal angle grid, and contain mean, standard deviation, marginal probability density function, and joint probability density functions of most atmosphere Level 2 parameters. The algorithms used for these products are comprehensive and efficient as compared to similar products.

King noted that the cloud mask product uses 17 of the 36 MODIS bands and then presented a cloud mask image of Namibian stratus as an example of the product. Additional examples can be found on the MODIS Atmosphere website at modis-atmos.gsfc.nasa.gov.

King then highlighted the MOD12 land cover type classification scheme, noting that the International Geosphere Biosphere Program classification product is being applied to MODIS data.

Next, King quickly moved through examples of cloud top pressure, cloud top temperature, cloud optical thickness, cloud effective particle radius, atmospheric water vapor, and precipitable water over land and sunglint.

King then highlighted the aerosol products from MODIS, which use 7 MODIS bands to derive aerosol properties over the land and ocean. Examples included a Gobi dust outbreak over China and Korea and global aerosol optical thickness and effective radius images for September 2000.

To finish, King offered the near-term plans for MODIS data processing. The updated algorithms were submitted in May and have been integrated into production. Plans are moving forward to test both forward production and parallel reprocessing to fill in a full year of production and should be completed near the time of the Aqua launch. Thirty-five MODIS products have been released to the public thus far, and all users are encouraged to order data from the Distributed Active Archive Centers (DAACs). The availability of MODIS data is published on the MODIS Atmosphere website at modis-atmos.gsfc.nasa.gov/products_calendar.html and is updated on a daily basis.

Following King, Wayne Esaias, the MODIS Oceans Group Leader, gave an overview of MODIS ocean products, including Terra performance and plans for Aqua. The MODIS ocean product suite includes 47 parameters in 9 product groupings (sea surface temperature, water-leaving radiance/atmospheric correction, chlorophyll case 1 and 2, fluorescence, sediments and optical attenuation, coccoliths and

calcite, phycobilipigments, bio-optical properties, and ocean net primary production).

Esaias presented a series of examples highlighting MODIS capabilities, including MODIS-SeaWiFS chlorophyll comparisons, MODIS-SeaWiFS ocean backscatter coefficient product comparisons, chlorophyll motion, aerosol optical depth, water-leaving radiance, coccolith concentration, instantaneous photosynthetically active radiation, fluorescence and productivity, and thermal sea surface temperature (SST). The provisional products, which are in production now, appear superior in many respects to precursor missions. The chlorophyll fluorescence observations and 4 µm nighttime SST observations are very exciting and offer tremendous research potential, although data system performance is a major concern and limitation.

Esaias next reported on MODIS SST coefficient determination. He noted that the coefficients were determined by the SST group through regression of nighttime MODIS brightness temperatures with Advanced Very High Resolution Radiometer (AVHRR) pathfinder SST to avoid diurnal heating contamination. For a satellite-satellite comparison, MODIS SST retrievals were compared with AVHRR pathfinder data and validated using MODIS side A for April and August 2000, and MODIS side B for December 2000. For a satellite-*in situ* comparison, MODIS SST retrievals were compared with Marine-Atmosphere Emitted Radiance Interferometer measurements over the Mediterranean Sea for April 2000 and over the Pacific Ocean for April 2001. The early results look very promising.

Regarding response versus scan angle (RVS) on SST, the radiative transfer approach for SST correction did not meet expectations, but a regressive approach gives promise of useful performance. It is not clear that better RVS from the deep space maneuver will improve the SST product. Thus the need for the Terra deep space maneuver has decreased, but this still leaves open the reasons why the forward physical approach failed. The SST group has concluded that further evaluation is needed, and the current approach requires a global satellite field to regress against. Esaias stressed that the radiative transfer approach for SST will be a priority for Aqua since it will have better characterization in bands 31 and 32. This reemphasizes the need for an Aqua deep space maneuver, to be done early in the mission.

Lastly, Esaias stressed that the Aqua MODIS is a different instrument than the Terra MODIS. The team expects that the initialization process may be more rapid for Aqua than it was for Terra, assuming that both instruments are stable, but that it will likely take longer than 3 months. The ocean group has already planned for the first release of combined Terra-Aqua products at one year after the initial release of Aqua products, but will initially focus on stable, validated products for Aqua and improvements in daily coverage and diurnal variability in SST, chlorophyll fluorescence efficiency, ocean current effects, and AMSR-E comparisons and synergy.

Following Esaias, Steve Running from the University of Montana described the anticipated MODIS-derived Surface Evaporation Index, a new product for the Aqua mission. This product was proposed in 1988, and since that time the algorithm for it has been developed and is awaiting the Aqua MODIS launch. The index uses a scale from 0 to 1, with values determined from the MODIS satellite data. It is felt that the afternoon data provided by the Aqua MODIS will be much more appropriate for this index than the morning data provided by the Terra mission, and hence there are no plans to implement the algorithm until the Aqua data are available. This index is expected to have immediate applications in drought monitoring for agriculture, water management, and fire danger management. It will also be useful in carbon cycle models and in climate models. Several hundred sites around the world will be used for validation.

Vince Salomonson reiterated the fact that the MODIS land, ocean, and atmosphere products are coming along well, as illustrated by the preceding MODIS speakers. He then proceeded to describe the status of the Terra MODIS instrument. There was an instrument shutdown from June 15 to July 2 that was apparently caused by a high-energy particle hit. The MODIS team is greatly relieved that the anomaly has been worked through and that the instrument is again operating, although using the A side electronics rather than the B side, which had earlier been found to be preferable. The shutdown will require a "noise check" and other performance evaluations associated with the change back to the A side.

Overall, the Terra MODIS is providing generally good spatial, spectral, radiometric, geometric, and quantization performance. Instrument noise and a host of other factors have been identified and reduced, leading to a satisfactory state for scientific use. Also, studies are continuing to optimize Level 1b products

Solomonson next reported that approximately 40 science products are in development and nearly all were released for production in Fall 2000. Many of the products are now considered by the MODIS team to be provisionally useful scientifically, but most will be undergoing

further checking and be even more appropriate for scientific use by Fall 2001. Use of the data is being encouraged, both for its inherent value and to get feedback and hasten validation.

Salomonson then presented selected results of the MODIS user survey conducted at the most recent meeting of the American Geophysical Union. While there are many exciting products for the community to use, those surveyed noted that the user interface is cumbersome. Salomonson mentioned that there are now improved data access capabilities and support initiatives. In addition, many user survey respondents noted that they would find the data more manageable if subsets of selected parameters for specific geographic regions were available. Progress is being made in this area, and there should be geographic, temporal, and parametric subsetting capabilities via the initial Data Pools release and FTP Pull distribution by December 2001. Also, some users expressed concern about the data only being available in Hierarchical Data Format (HDF)-EOS format. The team is studying the ability to convert MODIS HDF-EOS data to geographical information system format, based on the success realized from similar TRMM data conversions and on the ability to convert MODIS data to flat binary file format.

Status of the GES DAAC in handling Terra Data

Following the MODIS presentations, Steve Kempler, the GSFC Earth Sciences (GES) DAAC Manager, gave an update on the status of the GES DAAC and Terra data handling.

Kempler started by noting that there are three DAACs responsible for MODIS data ingest, archive, distribution, management, user support, and Level 1 production. These DAACs are the GES DAAC in Greenbelt, Maryland, the National Snow and Ice Data Center (NSIDC) in Boulder, Colorado, and the Earth Resources Observation System (EROS) Data Center (EDC) in Sioux Falls, South Dakota.

Kempler then commented on the status of GES DAAC MODIS Level 1 processing. Over 240 consecutive full days of Level 1 data have been processed, and during the last 8 months, Level 1 production was upgraded to process at 3x (i.e., at three times the rate of raw data collection), in preparation for the first MODIS reprocessing campaign. The EOSDIS Core System (ECS) has been producing Level 1 data in a timely fashion since September 2000, and has proven its processing capability. New ECS functionality is still being developed and delivered, and major new releases could introduce unexpected data handling risks. In meeting processing requirements, input/output is now the processing bottleneck.

Over the last 3 months, there has been an average of 18.3 terabytes of MODIS data archived at the GES DAAC per month, and 20.6 terabytes of data at all the MODIS DAACs. But average daily distribution has been considerably lower than expected, and the demand has not reached the theoretical capacity of approximately 446 gigabytes per day.

Kempler noted that over the last several months of study, survey, and solicitation, several reasons have been identified for the less-than-expected data distribution totals. These include system availability, data maturity, difficulties in ordering data, a confusing interface, very large data files, and the data only being available in HDF-EOS format. The DAAC understands these issues and is focused on resolving them. For example, data access, subsetting, and format tools are now available and ECS implementation of data pools is due in December 2001, which will allow for more flexible in-process data volume reduction software and a wider distribution. In addition, EOS Data Gateway (EDG) and GES DAAC user interfaces will continue to be supported with additional information and instruction, while a resurfacing of web pages will eventually offer additional information on data options. Finally, ECS implementation of the Product Distribution System will greatly enhance the variety of media in which data can be distributed.

Kempler then addressed the fact that there are many ways to obtain MODIS data, which can be confusing. The DAAC user services group is encouraging people to call on them for assistance.

There have been recent growing pains within the DAACs as well. Higher sustained volume increases due to reprocessing at the DAAC concurrent with data returned from the MODIS Team's processing has impacted data ingest into the system. Consequently, automated ingest throttling is being implemented and debugged. Also, approximately 40% of the MODIS Level 0 files are arriving truncated due to network issues, which are causing significant gaps in the data flow. The primary problem appears to be an EOS Data and Operations System (EDOS) network issue. Data gaps are being filled via tape transfer, which takes significantly longer to stage. *[editor's note: "The ESDIS Project notes that this problem has now been solved and reprocessing and retransmission requests to EDOS are virtually reduced to zero."]*

Kempler feels the DAACs will be ready for the Aqua data by the time of the Aqua launch. They anticipate delivery of additional storage space by September 2001, and spares are already on site. They

anticipate that only commercial-off-the-shelf product upgrades will be needed to maintain system support. Finally, operations agreements and operations documentation should be completed without problems.

Public Affairs Office (PAO) Plans for Aqua

The next speakers were Lynn Chandler of the Goddard Public Affairs Office (PAO). Parkinson congratulated Chandler on her recent appointment as the new head of EOS for the Goddard PAO. This position makes Chandler the key PAO representative for Aqua as well as the other EOS programs at Goddard.

Chandler presented an overview of the PAO outreach efforts for Aqua, the goals of which are to increase public awareness of the Aqua Program and its place in NASA's broader EOS program, and to increase scientific literacy regarding the mission. The tools are television, traditional print media, the World Wide Web, and radio, with television emphasized as the tool producing the largest payoff. Television coverage for Aqua will include pre-launch animations and interviews with scientists, a press conference at NASA Headquarters 14 days prior to launch, a press conference at Vandenberg Air Force Base one day prior to launch, and live launch coverage on NASA TV. Post-launch television coverage will emphasize science results as they are developed, including science visualizations. Chandler emphasized the need for scientists to focus the message they want to convey and to make it understandable to an average 12-year-old. PAO will also assemble a pre-launch press kit consisting of fact sheets, lithographs, and press releases. After launch, PAO will provide Aqua's first images and science results. PAO will additionally arrange for media training for Aqua scientists, and produce an Aqua Science Writers Guide for journalists.

PAO is in charge of registering guests for the launch viewing and coordinating bus service to and from the launch viewing site. Chandler mentioned that in light of the delays in the launch, additions can still be made to the launch-invitation list. Anyone connected with the Aqua mission who would like to be invited to the launch should contact Steve Graham at steven.graham@sesda.com and ask to be added to the list. The invitation allows entrance to Vandenberg Air Force Base on the day of the launch; no travel or other funds are included.

Although Goddard Space Flight Center is the lead NASA center for planning, implementation, and coordination of public affairs activities in support of Aqua, other centers have major related responsibilities as well. Kennedy Space Center is responsible for the PAO launch preparations and coverage, including television coverage from Vandenberg Air Force Base. Vandenberg will provide support to the entire PAO team throughout the launch activities. Langley Research Center is responsible for public affairs related to CERES; the Jet Propulsion Laboratory is responsible for public affairs related to AIRS; NASDA is responsible for public affairs related to AMSR-E; and Brazil is responsible for public affairs related to the Humidity Sounder for Brazil (HSB).

Rob Gutro followed Chandler, and explained the role of the EOS Project Science Office Science News and Information Team. Created in July 1998, the News Team's goal is to help identify and promote newsworthy science results and projects sponsored by NASA's EOS Program. The team, led by Gutro, is centered at Goddard but works with EOS researchers around the world, collaborating with the public information offices at the researchers' home institutions. The team has developed press materials with over 40 universities, research institutions and scientific organizations, resulting in media coverage from major television, radio, on-line, and print media outlets. The team also facilitates press coverage at major Earth science conferences and works with NASA TV to create broadcast quality video and graphics.

Gutro described the Aqua Science Writers' Guide that he will be working on over the next several months with the assistance of Aqua scientists. Gutro showed a preliminary list of topics to be covered in the guide and several of the scientists whom he expects to contact about these topics. Gutro also described some recent successes in getting news of EOS science out to the public through television and print media, including widespread coverage in late May and early June of new results on distributions of carbon monoxide from the Measurements of Pollution in the Troposphere (MOPITT) instrument on Terra.

Interagency Issues and the EOS Budget

Following Chandler and Gutro, Jack Kaye of NASA Headquarters was on hand to answer questions concerning interagency issues and the EOS budget. Kaye noted that the Earth Science Enterprise (ESE) is a major contributor to the United States Global Change Research Program (USGCRP). Progress is being made on a draft of the USGCRP ten-year plan, which contains six science themes: the carbon cycle, water cycle, ecosystem resources, climate, land cover/land use change, and atmospheric composition and aerosols. The ten-year plan also addresses cross-cutting issues such as observations, modeling, regional impacts, human

dimensions, and management. The plan is based on a conceptual framework of "change, vulnerability, and resilience" and, if fully implemented, should provide increased ties between traditional providers of global change information and those who need to make policy and management decisions based in part on environmental information.

President Bush has stated that he would like to increase the nation's investment in climate change research and has designated the Secretary of Commerce to coordinate a five-year plan among the relevant agencies. NASA is vigorously engaged in the interagency process and in defining a potential budget initiative for FY03. This new initiative builds on the carbon cycle initiative that has been under development for some time and includes focused components in the areas of modeling and computing.

The results of the House and Senate budget markups were also discussed, most notably the potential $15M reduction for EOS algorithms included in the Senate appropriations' language. If this provision is included in the final budget, it could have significant impacts on the production of products derived from the EOS data.

AIRS Science Team Update

After a lunch break, George Aumann, the AIRS Project Scientist, gave an AIRS/AMSU/HSB Science Team update. Hardware for AIRS, AMSU and HSB have been subjected to warm system testing without any complications; the System Comprehensive Performance Test (SCPT) has also been completed. The pre-thermal vacuum (TVAC) AIRS scan mirror inspection was completed on February 18, 2001, and cleaning was completed on May 20, 2001.

Concerning software status, Product Generation Software (PGS) version 2.1.5 has been delivered to the GES DAAC, and the final interfaces have been frozen. This is the last pre-launch PGS delivery. The next delivery will be a Level 1b post-launch update at launch +7 months.

Level 1b and Level 2 data processing software development contiues at JPL. Level 1b software has been revised based on Lockheed Martin/TVAC data and has been documented in the Level 1b Algorithm Theoretical Basis Document (ATBD) Rev. 2.2i. Level 2 software is based on simulated data derived from a general circulation model (GCM) and has been documented in the Level 2 ATBD.

Aumann noted that the global simulated data, which have been key for software development, have included realistic instrument noise and spectral characteristics. The global data field was based on a National Centers for Environmental Prediction (NCEP) aviation forecast, including multi-layer clouds, liquid water, surface emissivity and surface temperature, realistic gradients over land from AVHRR Normalized Difference Vegetation Index, and emissivity over the ocean from the Masuda model. For software development, the data are also available without clouds/without noise, and without clouds/with noise.

Aumann then stressed that the "golden day" concept is key to pre-launch software development and initial on-orbit verification. Team exercises using a December 15, 2000 simulation were conducted in January, May, and July 2001. These exercises tested data flow, display, retrieval and analysis software, and identified issues with the simulation and retrieval system. The analysis is continuing.

For AIRS/AMSU/HSB validation, the team is working towards the original schedule of DAAC delivery of validated PGS by launch +12 months. The "golden analysis" has been used to test the validation tools. The selections of the NASA Research Announcement (NRA) for the validation support teams were announced in May 2001 with funding to start October 2001. The AIRS Team is working with Bob Atlas of the GSFC Data Assimilation Office to integrate the newly selected personnel into the validation plan.

Next, Aumann reviewed the AIRS/AMSU/HSB verification and validation phase. Instrument operation will begin at launch +1 month and initial verification will be at launch +2 months. Initial validation using SST, internal update of Level 1b software, and data flow to direct assimilation teams will all be at launch +3 months. At launch +4 months, instrument and Level 1b software is expected to be stable, and the ARM/Cloud and Radiation Testbed validation program using dedicated radiosonde launches coinciding with Aqua overpasses will commence. Also, there will be an update of Level 1b software at the DAAC at launch +7 months, and an update of Level 2 software at the DAAC and routine production and distribution from the DAAC at launch +12 months.

Aumann reiterated the challenge set forth by James Baker of NOAA and Dan Goldin of NASA to demonstrate AIRS data assimilation impact by Launch + 12 months. To that effect, a second data assimilation workshop was held on May 16, 2001 (the first was held on December 6, 2000) and was attended by representatives of NCEP, the ECMWF, the UK Met Office, the Canadian Meteorological Center, and the GSFC Data Assimilation Office. The operational data link via NOAA's National Environmental Satellite Data and Information Service is in place and is currently

producing daily AIRS/AMSU-A/HSB "data" using the NCEP Aviation Forecast Model. The current data assimilation uses only Level 1b, cloud-free data. The AIRS science team will assist with cloud-free identification, cloud-cleared radiance utilization, and the forward and tangent model. The next workshop is scheduled for September 2001.

Lastly, Aumann commented on the pre-launch EOS Aqua IEEE special issue, noting that his team has commitments for 16 AIRS/AMSU/HSB related papers. A complete set of abstracts was received by June 20, 2001.

U.S. AMSR-E Science Team Update

Following Aumann, Roy Spencer, the U.S. AMSR-E Science Team Leader presented a status update on the AMSR-E instrument. On the hardware side, there is an issue with the design of the warm load. Thermal conductivity of the warm load is 0.13 $Wm^{-1}K^{-1}$ (compared with SSM/I's 1.37 $Wm^{-1}K^{-1}$). Temperature gradients exist along pyramids on the black body surface and across the entire load. The Mitsubishi Electric Company (MELCO) has implemented a fix that consists of moving two platinum resistance thermometers from the inside to the outside surface of the pyramids (this will help reduce uncertainty). NASDA/MELCO is performing an analysis to characterize the load and obtain calibration coefficients. Frank Wentz plans to do a post-launch analysis and verify the calibration coefficients.

After Spencer, Elena Lobl discussed the scheduling of AMSR-E validation activities, assuming an early 2002 Aqua launch. The soil moisture experiment (SMEX02) is the first AMSR-E campaign scheduled post-launch and is planned to take place in Oklahoma, Iowa, and Georgia. Shortly after the completion of SMEX02, there is a sea ice validation campaign scheduled in Antarctica with a short flight over Brazil on the return ferry (from Antarctica) for soil moisture validation. In 2003 the plan is to do a precipitation validation campaign in Wakasa Bay in collaboration with NASDA, a sea ice campaign in Alaska, and a snow water equivalent campaign in Colorado.

Other validation activities include monitoring a rainfall validation site (radar and rain gauges) in Eureka, California, and a soil moisture validation site in an area around Alabama A&M University (near Huntsville, AL).

Lastly, Lobl presented a list of new AMSR-E validation investigators, all of whom were selected from the scientists that responded to the Aqua Validation NRA.

Japanese Field Experiments for AMSR/AMSR-E Validations

Complementing the U.S. AMSR-E Science Team update, Keiji Imaoka of the Earth Observation Research Center (EORC) of the National Space Development Agency of Japan (NASDA) presented the Japanese AMSR-E Science Team update, focusing on validation strategy and validation sites. Japanese validation activities will cover jointly the AMSR instrument on ADEOS-II and the AMSR-E instrument on Aqua.

Operational activities are ongoing at NASDA/EORC, an *in situ* archive and match-up data generation are in place and continuing. Upper air sounding, precipitation, snow depth, sea-surface temperature, and wind velocity data are operationally collected and available in near real time. Soil moisture and snow data are also routinely observed, although not available in real time.

There are also experimental activities ongoing. An *in situ* archive and match-up data generation continues, a collaborative effort between the AMSR Principal Investigators, and the Global Energy and Water Cycle Experiment Hydrometeorology Panel. Automatic stations are collecting water vapor, cloud water, cloud height, precipitation, snow and soil moisture.

The following are AMSR validation sites with target parameters in parentheses: the Airborne Microwave Radiometer underflight (brightness temperature; i.e., calibration), Siberia (snow, soil moisture, and precipitation), Tibetan Plateau (snow, soil moisture, and precipitation), Mongolia (soil moisture), Thailand (soil moisture), Wakasa Bay (snowfall), Miyako-Yaeyama (precipitation), Minami-Daito and Hegura-jima (water vapor and cloud liquid water).

Update on the Aqua Mission Timeline

Following a break, Parkinson introduced Carolyn Dent, the Aqua Mission Manager, to give an update on the official Aqua Integrated Mission Timeline (IMT). The IMT document covers Aqua's launch and ascent, beginning at one hour prior to launch, and the spacecraft and instrument activation and checkout activities through the first 120 days after launch. It may take up to 30 days, dependent on launch date, before the spacecraft reaches its final intended orbit, at an altitude of 705 km, and is phased appropriately with respect to the Terra and Landsat spacecrafts.

As explained by Dent, if all goes as scheduled, the solar array will be deployed on day 0 (launch day), as will AMSR-E and the two CERES instruments. The AIRS instrument will be powered up on day 2, CERES on day 3, AMSU on day 8, and HSB on day 9. AMSU and HSB checkout activities will take place on days

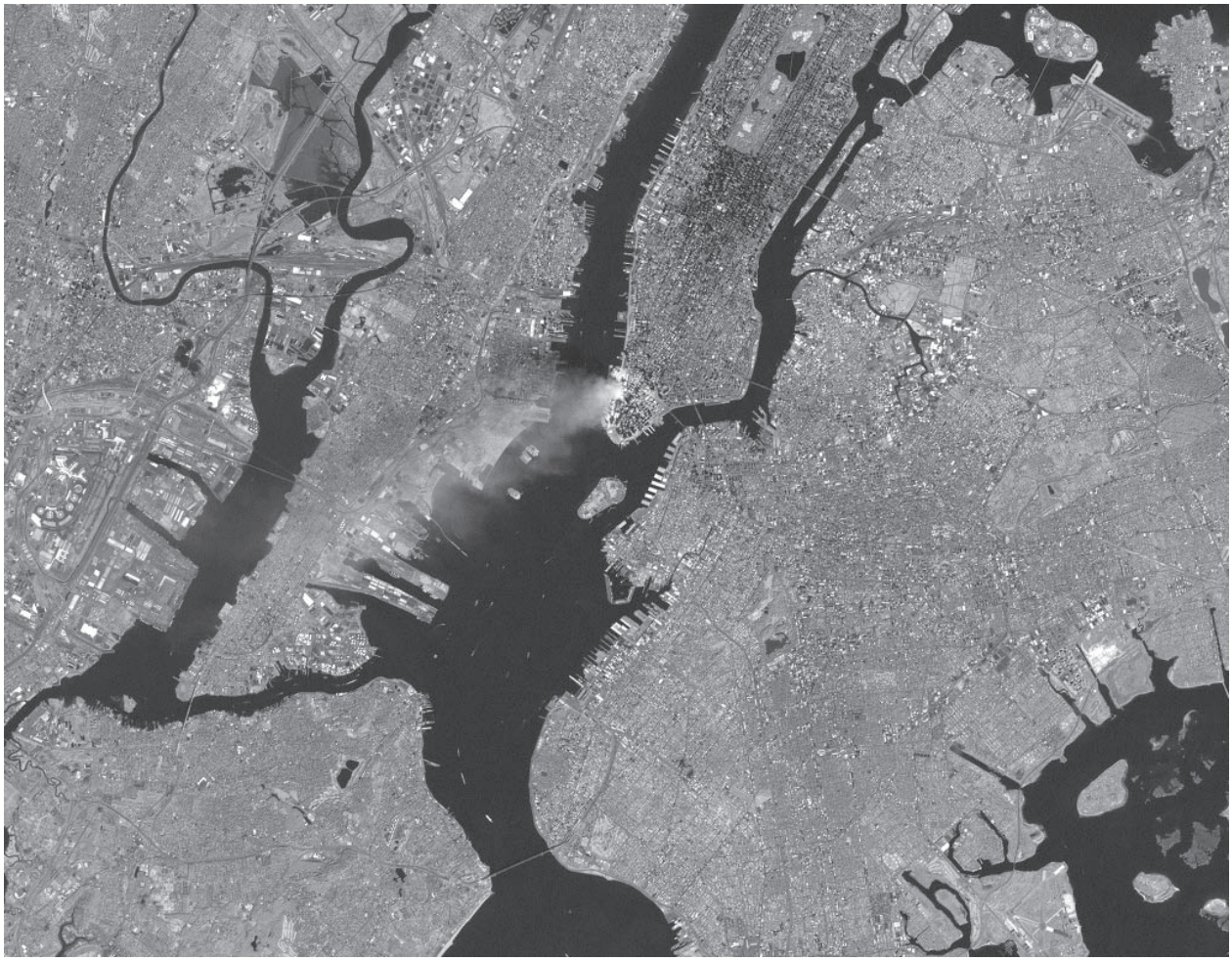
15-21, AIRS checkout activities on days 15-67, and CERES checkout activities on days 18-38. MODIS will be powered up on day 20; the AIRS Earth shield will be deployed on day 29; the AIRS cooler will be turned on 3 days later; and the MODIS space-view door will be opened on day 33. MODIS checkout activities will then take place on days 34-60, with MODIS yaw maneuvers occurring on days 37-38 and 42-43. CERES yaw maneuvers will occur on day 46 and the Aqua deep-space maneuver for CERES, MODIS, and AMSR-E calibrations will occur on day 60 or soon thereafter, depending on the location of the moon. The IMT was baselined on July 18, 2001 and can be found in detail on the Internet at aqua.qssmeds.com/docs.html.

Update on the A-Train (Aqua, ESSP-3, CloudSat, Parasol, and Aura)

The last presentation of the day was on the status of the A-Train and was given by Bruce Wielicki. PICASSO-CENA is now being called Earth System Science Pathfinder 3 (ESSP-3), but will soon be renamed, pending approval from NASA Headquarters. ESSP-3 and CloudSat are back on track for a joint Delta launch in Spring 2004, while Parasol is currently scheduled for a late 2004 launch.

The current formation plan for the A-Train includes CloudSat and ESSP-3 flying near nadir behind Aqua for the first two years. Beginning at the start of the third year, ESSP-3 precesses across the forward-scatter side of the MODIS swath over a one-year time frame, stopping at the edge of the MODIS scan. Parasol stays near nadir but sees a complete angle range.

Parkinson closed the meeting by thanking all the speakers and other participants and explaining that she will hold off on scheduling the next meeting until after Aqua's thermal vacuum testing is completed, at which time we might have a better sense of launch date possibilities.



Aftermath of World Trade Center Attack — This image was taken by the Enhanced Thematic Mapper Plus (ETM+) aboard the Landsat 7 satellite on September 12, 2001, at roughly 11:30 a.m. Eastern Daylight Savings Time. Visit the USGS Landsat 7 Websit for additional Landsat imagery. (Image courtesy USGS Landsat 7 team, at the EROS Data Center.)

Terra Cloud Mask Workshop held in Madison, WI. May 8-9, 2001

— Paul Menzel, (paul.menzel@ssec.wisc.edu), National Oceanographic and Atmospheric Administration (NOAA), and Steve Ackerman, CIMSS, University of Wisconsin-Madison

A workshop to exchange information regarding cloud detection with Terra instruments was held at the Cooperative Institute for Meteorological Satellite Studies (CIMSS), University of Wisconsin-Madison on May 8-9, 2001. An international group of 55 scientists gathered to discuss the status of the cloud detection schemes for the MODIS, CERES, MOPITT, ASTER, MISR, and AIRS instruments and to plan comparison studies. The goals of this workshop were to: 1) exchange information on the current status of the different cloud masking approaches; 2) identify problem areas that have significant impact on users of the MODIS cloud mask and propose a strategy to address these issues; and 3) discuss comparison and validation studies.

Exchange of Information

The workshop started with a session of invited presentations from a representative of each Terra instrument on their cloud mask activities. Post launch modifications to the cloud detection algorithms were summarized for each of the Terra instruments.

Rich Frey gave an overview of the current status of the MODIS cloud mask. He noted that the 1.38 µm thin cirrus test is handicapped for high elevation scenes (too little water vapor) and thus had been turned off when elevations exceed 2000 m. False cloud occurrences continue in the African Sahel, but an updated ecosystem map is expected to help; daytime vegetated land has been causing problems but these have been mostly fixed. Nighttime and 250 m cloud masks have not been checked out to date; evaluation will begin in the fall of 2001.

Larry Di Girolamo from the MISR Science Team explained three MISR cloud masks. The Radiometric Camera-by-camera Cloud Mask (RCCM) uses 865 nm reflectance R865 (1.1 km) and 670 nm spatial variability S670 (275 m) to identify cloud high, cloud low, clear low, and clear high scenes. The RCCM has been implemented over ocean, and later, over land. The locations of 1580 surface types are updated every 16 days. The Angular Signature Cloud Mask (ASCM) is being developed for future implementation. It is based on the premise that forward scattering by clouds is greater than for smooth or rough sea ice; the angular shape of the 670 nm reflectance is used to identify clouds. The Stereo Derived Cloud Mask (SDCM) separates clouds from background by combining MISR's multi-angle camera images in a MISR "movie." Di Giorolamo showed an example, which demonstrated the SDCM technique; it showed good skill over polar regions. The SDCM is improved over other techniques because the result produced is not dependent on surface type.

Juying Xie Warner from the MOPITT Science Team spoke about the derivation of cloud-top pressure (CTP) using CH_4 above cloud tops; clouds are detected by comparing MOPITT offline radiances with a forward model. The CTP is then based on MOPITT's estimate of above cloud tropospheric methane. The algorithm is most suitable for overcast conditions.

Pat Minnis from the CERES Science Team summarized the CERES cloud mask. A 16 x 32 km tile of pixels is processed at one time using multispectral thresholding. Several classes in cloudy and clear skies are estimated. There are 6 multispectral tests which include 0.65 and 1.6 µm (A tests), 11 µm, 0.63 µm, and 3.7-11 µm (B tests), and a cloud shadow test over land, low cloud tests, etc. (C tests). The addition of an 8.4 µm test is being considered.

Todd Berendes from the ASTER Science Team presented the ASTER cloud mask which uses a supervised neural network based classifier. The 30 m cloud mask uses all 14 ASTER channels and calculates NDVI and NDSI.

Identify Problem Areas

The Terra Cloud Mask reviews were followed by an afternoon of presentations from different applications groups on their use of cloud masks. These presentations focused primarily on the impact of the MODIS cloud detection algorithm on science products, identifying cloud mask problem areas in the process. The first day ended with a summary of cloud mask issues. The following issues were given high priority for investigation: high elevations, arid and semi-arid regions, thin cirrus screening, shadows on ground

and clouds, heavy aerosol discrimination.

The second day of the workshop began with an open discussion of the cloud masking issues raised on the previous day. This discussion led to the creation of four focus groups who met during a working lunch, each group addressing one of the major discussion points:

1. *Night-time (IR only) cloud mask:* identify issues, suggest tests, and set goals for improving the night time algorithm,

2. *Instrument performance issues*: review MODIS performance issues and their impact on L1B and cloud masking

3. *Ancillary data*: identify common and necessary data sets, and suggest needed sources if appropriate.

4. *Validation efforts and comparison strategies*: identify goals, near term activities, practical outcomes.

Comparison and Validation Studies

Cloud mask validation campaigns fall into three types: (a) satellite instrument to satellite instrument, (b) satellite instrument to ground-based site instrument, and (c) satellite instrument to field campaign instrument. Satellite comparisons include Terra MISR, MODIS, CERES, ASTER, and MOPITT, the European MOS, and MERIS on ENVISAT. Case studies are being selected and comparisons are beginning in fall 2001. Seven sites were identified for satellite and ground-based comparisons (DOE-ARM SGP, NSA, TWP-Manus, and TWP-Nauru, Utah FARS, RAL CHILBOLTON, KNMI Debilt). A satellite/ground-based cloud observation database has been started and a strategy for automated comparisons is under development.

Summary

The Terra Cloud Mask Workshop included open discussion on the strengths and weaknesses of cloud detection by the Terra instruments. Approaches for solving cloud detection problems that impact downstream science products were discussed and are being pursued during the summer of 2001 with results to be shared at the appropriate instrument science team meetings. Several collaborations were suggested to assist in finding potential solutions to these problems and pursuing validation. A detailed summary of this workshop (including minutes, attendees and action items) can be found at origin.ssec.wisc.edu/~gumley/mask/.

Utah State University professors receive $650,000 NASA grant to research the impact of remote sensing on wheat production

— Rick West, (rickwest1@yahoo.com), Communications Intern, Western Sustainable Agriculture Research and Education

Phil Rasmussen and Bruce Bugbee, both professors in the Utah State University Plants, Soils, and Biometeorology Department, recently received a $650,000 grant from NASA and the USDA Initiative for Future Agriculture and Food Systems Program (IFAFS). The grant will support their research into remote sensing as well as allow them to train county extension agents in this technology.

This grant complements the recent NASA grant that established Rasmussen as the first geospatial extension specialist in the nation. Rasmussen has spent many years researching how remote sensing techniques can help farmers. Remote sensing (or geospatial sensing) is the use of aerial and satellite images to survey an area, such as a farmer's field. It can be used in farming to detect a lack of nitrogen or water, weed infestations, or other areas of poor yield.

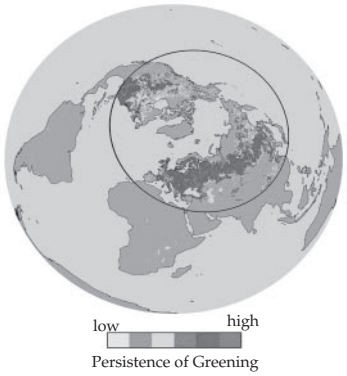
Rasmussen and Bugbee have titled their research "Validation and Application of Geospatial Information For Early Identification of Stress in Wheat." Their research will be a three-step process that will look at using remote sensing to determine if a wheat field is suffering from a lack of nitrogen (fertilizer) or water. They will then try to fix these problems and optimize the quality and quantity of the wheat harvest.

"Clearly, if a simple method can be refined to simultaneously detect nitrogen and moisture stress, farmers would readily adopt this new technology," Rasmussen said. "Environmental benefits would include less groundwater pollution or offsite contamination, as well as decreased energy, nutrient, and irrigation inputs."

Currently, farmers try to find areas of their field that need fertilizer or moisture by simply observing the field. This is not very effective nor accurate. Sometimes farmers may try to avoid the problem by overfertilizing or overwatering, but this can be dangerous to the environment.

Earth's Becoming A Greener Greenhouse

— *David E. Steitz (dsteitz@mail.hq.nasa.gov), Headquarters, Washington D.C.*
— *Lynn Chandler (Lynn.Chandler.1@gsfc.nasa.gov), Goddard Space Flight Center, Greenbelt, MD.*
— *Harvey Leifert, American Geophysical Union, Washington, D.C.*
— *Colin Riley, Boston University, Boston, Mass. (Phone: 617/353-5386)*
— *Rob Gutro(rgutro@pop900.gsfc.nasa.gov), EOS Project Science Office, NASA Goddard Space Flight Center, SSAI*



This view of the top of the world shows enhanced plant growth over the last 20 years, from the north pole, stretching southward to the 30 degree North latitude line (the circle).

NASA satellite data suggest that for more than two decades there's been a gradual greening of the northern latitudes of Earth.

Researchers confirm that plant life seen above 40 degrees north latitude, which represents a line stretching from New York to Madrid to Beijing, has been growing more vigorously since 1981. One suspected cause is rising temperatures possibly linked to the buildup of greenhouse gases in our atmosphere.

Over this same time period, parts of the Northern Hemisphere have become much greener and the growing season has increased by several days. Further, Eurasia appears to be greening more than North America, with more lush vegetation for longer periods of time.

The results of this NASA-funded research will appear in the September 16 issue of the Journal of Geophysical Research - Atmospheres.

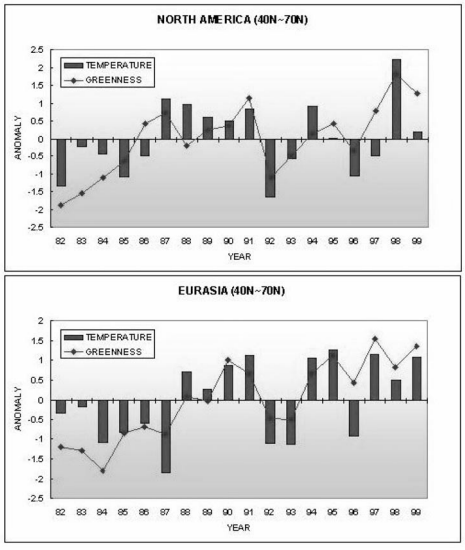
"When we looked at temperature and satellite vegetation data, we saw that year-to-year changes in growth and duration of the growing season of northern vegetation are tightly linked to year-to-year changes in temperature," Liming Zhou of Boston University said. The area of vegetation has not extended, but the existing vegetation has increased in density.

The authors also looked at the differences in vegetation growth between North America and Eurasia, since the patterns and magnitudes of warming are different on the two continents.

The greenness data from satellites were strongly correlated with temperature data from thousands of meteorological stations on both continents. The Eurasian greening was especially persistent over a broad area from central Europe through Siberia to far-east Russia, where most of the vegetation is forests and woodlands. North America, in comparison, shows a fragmented pattern of change notable only in the forests of the East and grasslands of the upper Midwest.

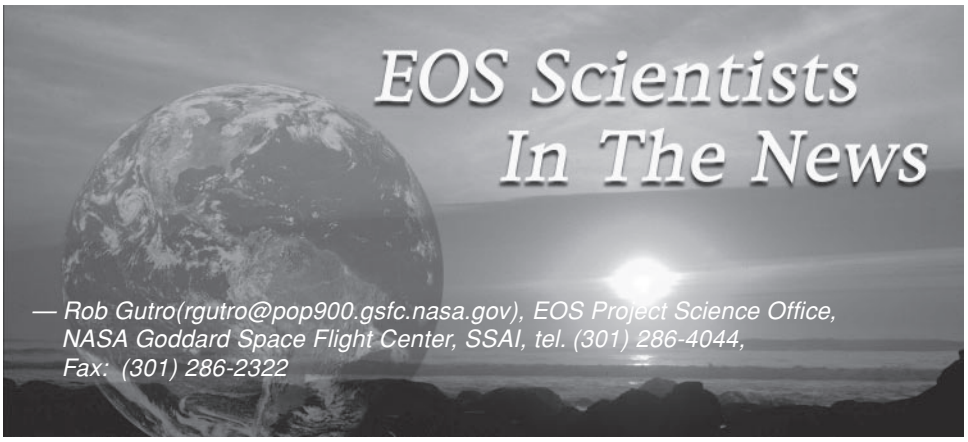
Dramatic changes in the timing of both the appearance and fall of leaves are recorded in these two decades of satellite data. The authors report a growing season in Eurasia that is now nearly 18 days longer. Spring arrives a week early and autumn is delayed by 10 days. In North America, the growing season appears to be as much as 12 days longer.

The researchers used a temperature data set developed from the Global Historical Climate Network. Dr. James Hansen, of NASA's Goddard Institute for Space Studies in New York, developed this data set and said, "The data were compiled from several thousand meteorological stations in the United States and around



Greenness is measured here as an average change from April to October of each year. Researchers used satellite data of red and near-infrared solar radiation reflected back to sensors to determine that vegetation north of 40 degrees latitude has become more lush.

(Continued on page 15)



— Rob Gutro(rgutro@pop900.gsfc.nasa.gov), EOS Project Science Office, NASA Goddard Space Flight Center, SSAI, tel. (301) 286-4044, Fax: (301) 286-2322

Major EOS news hotspots in this period include tracking microbes in African dust, increases in solar activity affecting cloud cover and chipping away at ozone, Atlantic Ocean 'Overturning,' and a boost given to the TRMM satellite.

"TRMM Satellite to Gather More Weather Data," (August 28) Weather.com. Research Meteorologist **Marshall Shepherd** (NASA/GSFC) discussed the benefits of boosting the orbit of the Tropical Rainfall Measuring Mission Satellite, which will continue to help weather forecasters for up to six more years.

"NASA Pulling the Plug on Ozone-Studying Satellite," (August 23) ABCnews.com. Former Project Scientist **Mark Schoeberl** (NASA/GSFC) expressed his dismay at the decommissioning of the Upper Atmosphere Research Satellite.

"Solar Storms Deplete Ozone," (August 3), Weather.com, Space.com. **Charles Jackman**'s (NASA/GSFC) research confirmed that large solar storms send electrically charged particles to Earth and those particles deplete upper-level ozone.

"Study Shows Faster 'Overturning' of Atlantic," (July 17) United Press International. Research by **Sirpa Hakkinen** (NASA/GSFC) using a NASA satellite confirmed the overturning process that drives the Gulf Stream current, which sped up and slowed down by as much as 30 percent over a decade.

"Sizzling Sun Makes Cloudy Days," (July 13) CNN.com, Astronomy.com. Research by **Petra Udelhofen** (State University of NY at Stonybrook) indicates that the United States becomes cloudier during periods of greater solar activity, possibly because the increased radiation heats the upper atmosphere and nudges the jet stream northward.

"Send in the Clouds," (July 12) Christian Science Monitor. **Bruce Wielicki** (NASA/LARC) was interviewed about the difficulty of using computer models in simulating cloud-cover.

"African Dust Brings Germs Across the Ocean," (July 1) Associated Press, CNN.Com, MSNBC.com. Researchers including **Jay Herman** (NASA/GSFC), **Gene Shinn** and **Dale Griffin** (USGS) have discovered that some of the dust from African deserts that is blown across the Atlantic Ocean contains bacteria and fungi, which could pose a health problem.

(Continued from page 14)

Earth's Becoming A Greener Greenhouse

the world. The stations also include many rural sites where the data are collected by cooperative private observers."

Scientists believe the results indicate a greener greenhouse. "This is an important finding because of possible implications to the global carbon cycle," said Ranga Myneni of Boston University. "However, more research is needed to determine how much carbon is being absorbed, and how much longer it will continue."

Carbon dioxide is a main greenhouse gas and is suspected of playing a role in rising global temperatures. If the northern forests are greening, they may already be absorbing carbon — a process that can impact global temperature changes.

Researchers used the Normalized Difference Vegetation Index (NDVI) to help determine the "greening" of plant life. Dr. Compton Tucker, of NASA's Goddard Space Flight Center, Greenbelt, Md., is a co-author of the report and developed NDVI to analyze spectral data collected by orbiting weather satellites.

This work was made possible through funding by NASA Headquarters' Earth Science Enterprise, a long-term research program dedicated to understanding how human-induced and natural changes affect our global environment.

Additional information is available on the Internet at URL: cybele.bu.edu; and URL: www.gsfc.nasa.gov/topstory/20010904greenhouse.html

Earth Science Education Program Update

AGU Special Education Session on NASA Earth and Space Science

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

"Strategies which Foster Broad Use and Deployment of Earth and Space Science Informal and Formal Education Resources" is a special session (ED 09) planned by NASA Earth Science Enterprise (ESE) at the December 10-14, 2001 American Geophysical Union (AGU) meeting in San Francisco. The session will include invited presentations as well as contributed presentations. For more information see www.agu.org or contact Frank Ireton at frank_ireton@ sesda.com.

ESE Sessions Planned for 2002 AAAS Conference

February 14-19, 2002, more than 5,000 scientists, engineers, educators, policy makers and students will gather in Boston, MA for the 168th national meeting of the American Association for the Advancement of Science (AAAS). NASA's Earth Science Enterprise is planning four symposiums at this conference on the following topics:

— Is Extreme Weather Now Better Understood and Predicted?

— The Challenges and Promise of Global Environmental Monitoring

— Deciphering the Complex Changes in Global Snow and Ice

— The Big Climate Impact of Tiny Particles

For more information about the NASA sessions, please contact Jim Closs at jcloss@pop500.gsfc.nasa.gov. For more information about the AAAS conference, see www.aaas.org/meetings/2002/index.htm.

Native Americans Participate in NASA Earth Science Education Workshop

Thirteen Native American teachers and tribal Elders from the Confederated Salish and Kootenai tribes, the Colville tribe, and the Nez Perce tribe participated in a week-long NASA education workshop at Goddard Space Flight Center. This workshop is the first part in a 3-year NASA grant to Salish Kootenai College, Montana. Led by Judith Gobert., workshop participants were from reservations in Montana, Idaho, and Washington.

While at GSFC, the teachers were given updates on Earth System Science content by NASA Earth Scientists, toured technology applications buildings, and worked with approved NASA-produced educational materials including the "Echo the Bat" web site and book. Workshop participants will now develop culturally-relevant Earth System Science lessons for reservation students in grades K-4. These lessons will be pilot tested in reservation schools and then disseminated to other reservation schools.

For more information about the NASA Native Earth System Science Education Project, contact: Dr. Judith Gobert, All Nations Alliance for Minority Participation, Salish Kootenai College, PO Box 117, Pablo, Montana 59864.

New AirMISR Data Available from the ASDC

— Nancy Ritchey, (n.a.ritchey@larc.nasa.gov), NASA Langley Research Center

The Earth Observing System Data and Information System (EOSDIS) NASA Langley Atmospheric Sciences Data Center (Langley DAAC) announces the release of Airborne Multi-angle Imaging SpectroRadiometer (AirMISR) data from three field validation campaigns:

Lunar Lake, Nevada
Monterey, California
Wisconsin (including the ARM/CART site in Oklahoma)

These data sets are available through the Data Center's home page at eosweb.larc. nasa.gov.

AirMISR is the airborne instrument for obtaining multi-angle imagery similar to that of the satellite-borne MISR instrument. AirMISR utilizes a single camera in a pivoting gimbal mount to obtain data in four spectral bands at nine viewing angles. The available data include the Level 1 Radiometric Product (L1B1) and the Level 1 Georectified Radiance Product (L1B2).

The Level 1 Radiometric Product contains data that have been scaled to convert the digital output of the cameras to radiances and have been conditioned to remove instrument-dependent effects. Additionally, all radiances are adjusted to remove slight spectral sensitivity differences among the detector elements of each spectral band. These data have a 7-meter spatial resolution at the nadir view angle.

The Level 1 Georectified Radiance Product contains the Level 1 radiometric data that have been resampled to a 27.5 meter spatial resolution and have been mapped into a standard map projection. Initially the data are registered to each camera angle and to the ground. This processing is necessary because the nine views of each point on the ground are not acquired simultaneously.

For information regarding NASA Langley Atmospheric Science Data Center data or for assistance in placing an order, please contact:

NASA Langley Atmospheric Sciences Data Center
Science User and Data Services
Mail Stop 157D, 2 S. Wright Street
Hampton, VA 23681-2199
Phone: 757-864-8656
Fax: 757-864-8807
E-mail: larc@eos.nasa.gov

Validated Level 1 ASTER Data Available

— Anne Kahle, (anne@lithos.jpl.nasa.gov), U.S. ASTER Team Leader, Jet Propulsion Laboratory

On April 28 the Japanese ASTER Ground Data System (GDS) began generating Level 1 ASTER data with the "Validated" Release Designation. They also began reprocessing earlier data, and will gradually reprocess all data acquired since start of the mission. Although reprocessing of the earlier data will stop at 1A, 1B data can be ordered from the GDS Main Menu page at imsweb.aster.ersdac.or.jp/ims/html/MainMenu/MainMenu. html

Click on the "DPR (Data Processing Request)" link to begin. Users that are new to GDS first need to register by following the instructions in the "User Registration" link.

As always, all 1A and 1B data generated by GDS are shipped to and archived at the EROS Data Center (EDC) DAAC, and can be ordered using the EOS Data Gateway (EDG). However, any 1B data granule that has not been generated can be ordered using this method. There is no charge for EOS Investigators.

An alternative route is to go to the "Obtaining Data" page of the U.S. ASTER Website at asterweb.jpl.nasa.gov gettingdata/ and follow the instructions for "On-Demand Processing" (this will take you to the GDS Main Menu).

Finally, remember that if the data need has not yet been acquired, you can submit a request for acquisition — see the U.S. ASTER Website for details, and be sure to allow plenty of time to get your proposals through the system.

Dust from Africa Leads to Large Toxic Algae Blooms in Gulf of Mexico, Study Finds

— Cynthia M. O'Carroll, (Cynthia.M.O'Carroll.1@gsfc.nasa.gov), Goddard Space Flight Center
— Michelle Carlyon (Mcarlyon@admin.usf.edu), University of South Florida, Florida.

Saharan dust clouds travel thousands of miles and fertilize the water off the West Florida coast with iron, which kicks off blooms of toxic algae, according to a new study. The research was partially funded by a NASA grant as part of ECOHAB: Florida (Ecology and Oceanography of Harmful Algal Blooms), a multi-disciplinary research project designed to study harmful algae.

Toxic algal blooms, sometimes called red tides, have in the past killed huge numbers of fish, shellfish, marine mammals, birds, and can cause skin and respiratory problems in humans.

Each year iron from Saharan dust clouds is deposited in the waters off the West Florida coast. Once there, plant-like bacteria use the iron to set the stage for red tides. When iron levels go up, this bacteria, called Trichodesmium, 'fixes' nitrogen in the water, converting it to a form usable by other marine life. The addition of biologically usable nitrogen in the water makes the Gulf of Mexico a more likely environment for toxic algae to bloom.

"This is one of the first studies that quantitatively measured iron from the dust and tied it to red tides through Trichodesmium," said Jason Lenes, a graduate student at University of South Florida's College of Marine Science, and the lead author in the study. Lenes works under John J. Walsh, one of the principal investigators for ECOHAB, and one of the paper's coauthors. The research appears in the September issue of the scientific journal, Limnology and Oceanography.

Storm activity in the Sahara Desert region generates clouds of dust that originate from fine particles in the arid topsoil. Easterly trade winds carry the dust across the Atlantic Ocean and into the Gulf of Mexico. "Because iron is one of the most common elements in most soils, a certain percentage of the dust contains iron," said Lenes.

The study used satellite and ground based measurements to track large dust clouds leaving Africa on June 17, 1999. Lenes and his colleagues followed the clouds using data from the Advanced Very High Resolution Radiometer (AVHRR), an imager aboard the National Oceanic and Atmospheric Administration's (NOAA's) Polar Orbiting Environmental Satellites (POES).

The Saharan dust reached the West Florida shelf around July 1st, increasing iron concentrations in the surface waters by 300 percent. As a result, Trichodesmium counts shot up 10 times what they had been prior to this event. Through a complex process involving a special enzyme called nitrogenase, the Trichodesmium used the iron to convert nitrogen in the water to a form more usable for other marine life. In October, after a 300 percent increase of dissolved organic nitrogen, a huge bloom of toxic red algae (Karenia brevis) had formed within the study area, an 8,100 square mile region between Tampa Bay and Fort Myers, Florida.

Scientists have labored for several years in an effort to develop a reliable method to predict red tides, particularly because the results of these blooms can be both physically and economically devastating to a region.

"The West Florida shelf is a hot spot for fishing, aquaculture and tourism, all of which can be drastically affected by a surprise visit from a red tide," said Lenes.

Humans who swim in the Gulf can experience respiratory problems by breathing toxins from K. brevis that get in the air. Also, eating shellfish poisoned by red tides can lead to paralysis and memory problems. Around the Gulf of Mexico, scientists and others have recorded fish kills totaling in the millions and manatee deaths in the hundreds resulting from a single red tide bloom.

By using satellites to monitor dust arrivals and Trichodesmium blooms, Lenes believes that scientists might someday be able to predict the onset of red tide. "If you could predict when a red tide is coming, you could close beaches and fisheries ahead of time," Lenes said.

EOS Science Calendar

October 29 - November 1
U.S. TRMM Science Team Meeting, Fort Collins, CO. Contact Robert Adler, e-mail: Robert.Adler@gsfc.nasa.gov.

October 30-November 1
EOS IWG Meeting, San Antonio, TX Contact Mary Floyd, e-mail: mfloyd@westover-gb.com. For registration and location details see URL: eospso.gsfc.nasa.gov.

November 1-2
NSIDC DAAC User Working Group Meeting (PoDAG.19), Goddard Space Flight Center. Contact Ron Weaver, e-mail: weaverr@kryos.colorado.edu.

November 6-8
AIRS Science Team Meeting, Pasadena, CA. Contact Hartmut Aumann, e-mail: hartmut.h.aumann@jpl.nasa.gov.

November 14-15
PO-DAAC User Working Group Meeting, Pasadena, CA. Contact VictorZlotnicki, e-mail: Victor.Zlotnicki@jpl.nasa.gov.

Date (to be determined)
MODIS Science Team Meeting POSTPONED-NEW DATES AND LOCATION TO BE DECIDED! Contact Barbara Conboy, NASA GSFC, barbara.conboy@gsfc.nasa.gov.

Global Change Calendar

October 7-10
2001 International Conference on Image Processing, Thessaloniki, Greece. Call for Papers. Contact Diastasi, e-mail: diastasi@spark.net.grtel. +30 31 938 203, Fax +30 31 909 269.

October 15-18
11th Conference on Satellite Meteorology & Oceanography, Madison, WI. Contact Christopher Velden, e-mail: chrisv@ssec.wisc.edu, URL: fermi.jhuapl.edu/sat_met_ocean.

December 5-7
'The times they are a changing': Climate change, phenological responses and their consequences for biodiversity, agriculture, forestry, and human health, Wageningen, The Netherlands. Call for Papers. Contact Arnold van Vliet, e-mail: arnold.vanvliet@algemeen.cmkw.wau.nl, tel. 31 317 485091/484812, URL: www.dow.wau.nl/msa/epn/conference.

December 10-14
2001 AGU Fall Meeting, San Francisco, CA. For more informatino, tel. 1 (800) 966-2481 or 1(202) 462-6900; Fax: 1(202) 328-0566; e-mail: meetinginfo@agu.org; URL: www.agu.org.

2002

January 21-23
Non-CO_2 Greenhouse Gases (NCGG-3) scientific understanding, control options and policy aspects, Maastricht, The Netherlands. Contact Dr. Joop van Ham. e-mail: j.vanham@plant.nl; tel. 31-15-285-2558; Fax: 31-15-261-3186; URL: www.et.ic.ac.uk/Dept/Local/News/greenhouse.htm.

Feb. 26-28
Science Data Processing Workshop 2002, "From Data to Knowledge. Delivering Data to the End User," Greenbelt, Md. Call for Papers. Contact Mary Reph, e-mail: mary.g.reph.1@gsfc.nasa.gov; URL: that.gsfc.nasa.gov/gss/workshop2002/index.html.

April 7-12
29th International Symposium on Remote Sensing of Environment "Information for Sustainability and Development," Buenos Aires, Argentina. Call for Papers. Contact Secretariat, e-mail: 29isrse@conae.gov.ar, URL: www.symposia.org.

May 20-22
Seventh International Conference Remote Sensing for Marine and Coastal Environments, Miami. Call for Papers. Contact Nancy Wallman. e-mail: nancy.wallman@veridian.com; URL: www.erim-int.com/CONF/marine/MARINE.html.

July 7-10
2nd Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) Science Conference, Manaus, Brazil. Contact Flavio Luizao of the National Institute for Space Rsearch (INPE), Manaus, Brazil, e-mail: luizao@cptec.inpe.br.

July 9-12
2002 Joint International Symposium on GeoSpatial Theory, Processing and Applications, Ottawa, Canada. Call for Papers. For details, tel. +1 613 224-9577; e-mail: exdircig@netrover.com; URL: www.geomatics2002.org.

September 2-6
ISPRS Commission V Symposium, Thessaloniki, Greece. Call for Papers. Contact Prof. Alexandra Koussoulakou, e-mail: kusulaku@eng.auth.gr.

September 3-6
Pan Ocean Remote Sensing Conference (PORSEC) 2002, Bali, Indonesia. Contact Bonar Pasaribu, e-mail: bonarpp@indosat.net.id, URL: www.porsec2001.com.

October 26-28
3rd International Symposium on Sustainable Agro-environmental Systems: New Technologies and Applications, Cairo, Egypt. Contact Prof. Derya Maktax, e-mail: dmaktav@ins.itu.edu.tr.

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