THE EARTH OBSERVER

A Bimonthly EOS Publication

May/June 1997, Vol. 9 No. 3

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Editor's Corner

The first Biennial Review of MTPE is nearing completion. The key recommendations of the Biennial Review team include: (i) implementing the EOS Chemistry-1 mission on the common spacecraft as presently planned, but using an optimized build schedule that saves $27 M over the mission costs in the FY98 President's budget, (ii) accelerating EOS Laser Altimetry-1 to 2001 (from 2002) and using a small spacecraft procurement strategy developed during the Chemistry mission study, (iii) enhancing the role and responsibilities of the Data Processing Resources Board and establishing a peer review process to permit an interactive dialog on requirements, capabilities, and cost of data reduction, (iv) reducing the at-launch data processing capability of EOSDIS, phasing in full capacity over a two-year period based on a reassessment of early science needs, and (v) phasing in selected interdependent data sets over a two-year period. Recommendations on the EOSDIS Core System will be made in October, after assessment of the results of an August demonstration of EOSDIS Version B.0' capabilities.

In addition, the Biennial Review team recommended (i) restoring the Research & Analysis (R&A) budget to historical levels, (ii) establishing tighter linkages between the EOS validation and R&A programs for optimized allocation of resources, (iii) funding technology development that supports more efficient and cost-effective instrument implementation and shortens mission development cycles, and (iv) adopting a new, more flexible strategy for planning post-2002 missions.

The Biennial Review team presented findings and recommendations to an external review panel chaired by Prof. Pamela Matson, University of California-Berkeley, in two meetings in June and July 1997. This Panel concurred with the key recommendations of the Biennial Review team, and offered specific advice on the process for managing EOSDIS data products and on science management. Further information on the Biennial Review, including its final report and that of the external review panel (when completed), can be found under "What's News" on the MTPE Homepage, http://www.hq.nasa.gov/office/mtpe/.

An Investigators Working Group (IWG) meeting is now scheduled for November 4-6 in Atlanta, Georgia. As in the past couple of years, the primary focus of this meeting is to: (i) learn of recent progress and exciting accomplishments obtained thus far by various EOS investigations, (ii) assess progress and expectations for EOSDIS in the next couple of years, (iii) discuss objectives and status of Earth System Science Pathfinders (ESSP) that were recently selected for launch at the beginning of the next decade, and (iv) review the status and plans for data processing and validation of EOS instruments to be launched in the next couple of years.

—Michael King
EOS Senior Project Scientist

Our Changing Planet:
The FY 1998 Global Change Research Program

The U.S. Global Change Research Information Office (GCRIO) is pleased to announce that *Our Changing Planet: The FY 1998 Global Change Research Program* is now available in print and online.

Our Changing Planet: The FY 1998 Global Change Research Program is a report to Congress supplementing the President's FY 98 budget, pursuant to the Global Change Research Act of 1990. The report describes the U.S. Global Change Research Program (USGCRP); reviews progress in global change research over the past decade; presents highlights of recent and current research on key global change environmental science issues; outlines integrative activities and perspectives supported by the USGCRP; discusses new global change research challenges in the coming decade; and provides a detailed view of the FY 98 USGCRP budget, including FY 98 program components and program highlights by agency.

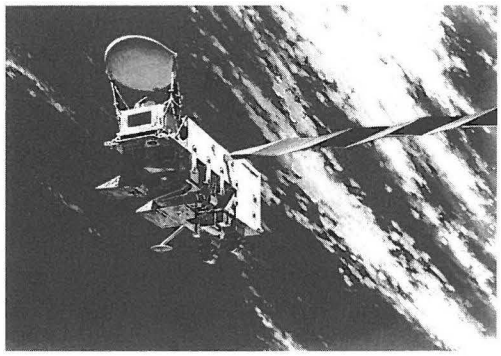
Achieving the goals and objectives of this program will require continued strong support for the scientific research needed in order to improve understanding of how human activities are affecting the global environment, as well as how natural and human-induced change is affecting society. *Our Changing Planet FY 1998* is available online at: http://www.gcrio.org/ocp98/toc.html.

Printed copies of *Our Changing Planet: FY 1998*, as well as previous editions and other global change publications, are available free of charge. Copies may be ordered by using the GCRIO Document Request Form at: http://www.gcrio.org/OnLnDoc/docreq-form.html.

Copies may also be requested via the address, e-mail, phone, and fax numbers shown below:

U. S. Global Change Research Information Office
User Services
2250 Pierce Road
University Center, MI 48710
Phone: (517) 797-2730
Fax: (517) 797-2622
E-mail: help@gcrio.org
URL: http://www.gcrio.org

PM Science Working Group Meeting on Spacecraft Maneuvers



— **Claire L. Parkinson** (clairep@neptune.gsfc.nasa.gov), PM Project Scientist, NASA Goddard Space Flight Center

The EOS PM Science Working Group met on May 6, 1997, to examine the issue of spacecraft maneuvers. The meeting was held at NASA Goddard Space Flight Center and was attended by the Team Leaders of all four instrument science teams with instruments on the PM-1 spacecraft, additional representatives from each of the four teams, the PM Project management, and random others. The meeting was chaired by the PM Project Scientist and open to all.

The meeting was called in order to untangle some of the concerns raised over the past several months regarding whether or not the PM-1 spacecraft should undergo spacecraft maneuvers to allow the instruments to obtain deep-space views. Two of the Science Teams, those for the Moderate-Resolution Imaging Spectroradiometer (MODIS) and the Clouds and the Earth's Radiant Energy System (CERES), had strongly expressed the need for deep-space views in order to calibrate their instruments properly and conveniently. The other two teams, those for the Advanced Microwave Scanning Radiometer (AMSR-E) and the Atmospheric Infrared Sounder (AIRS), the Advanced Microwave Sounding Unit (AMSU), and the Humidity Sounder for Brazil (HSB), had expressed concerns that the maneuvers involve risks to the instruments and undesired gaps in the data sets.

The meeting began with introductory statements by the PM Project Scientist, Claire Parkinson, the PM Project Manager, Marty Donohoe, and the EOS Program Scientist, Ghassem Asrar. Parkinson opened the meeting by briefly summarizing the basic positions of the four teams and expressing the desirability of coming to a resolution on the maneuver issue early, so that each team can proceed accordingly. Donohoe explained that the spacecraft contractor's (TRW's) specifications include the possibility of a maneuver, and that the Project management will task TRW to study whatever consensus maneuver the scientists decide upon. Asrar reiterated the importance of the maneuver issue, explained that he is anxious to hear the arguments of each of the teams, and mentioned that we cannot ignore the international dimension and must be particularly sensitive to concerns the Japanese have raised concerning the AMSR-E instrument that they are providing for the PM-1 mission. All other instruments on the PM-1 spacecraft are from the U.S. with the exception of the HSB, which is being provided by Brazil.

The introductory statements by Parkinson, Donohoe, and Asrar were followed by a short presentation by the AIRS/AMSU/HSB (or AIRS for short) Team Leader, Mous Chahine, laying out what he sees as the appropriate metric for making a decision. In particular, although he is convinced that the MODIS and CERES calibrations will be helped by a maneuver, Chahine feels that the decision on whether or not to have a maneuver should be based, in part, on the quantitative impact on the accuracy of the derived geophysical parameters, specifically the Level 2 products. Bruce Barkstrom, the CERES Team Leader, indicated that it would be best to add Level 3 products to the metric, and Chahine readily agreed.

The setting-the-scene presentation by Chahine was followed by presentations by each of the four science teams, detailing their respective positions.

The MODIS Team Position

The MODIS Team Leader, Vince Salomonson, began the MODIS presentation by explaining that he and his team have been considering whether they need a maneuver for quite some time and are convinced that a maneuver is essential for them in order to meet their most visible Level 1 requirement, which is to obtain sea surface temperatures (SSTs) to an accuracy of 0.3-

0.5 K. The MODIS Project Scientist, Bob Murphy, then explained the flow-down from the SST requirements to the MODIS instrumental requirements and indicated that a simple single-axis nighttime maneuver taking 40 minutes would meet most of the MODIS needs. Murphy stepped through a schematic of the maneuver sequence and showed, using several relevant plots, that, with the maneuver, the MODIS instrument will meet the specifications for absolute radiometric uncertainty for most of the MODIS bands.

Otis Brown, in collaboration with Peter Minnett, presented the rationale for SST accuracy requirements, made comparisons with earlier instruments, and gave details on the MODIS scan mirror characteristics and the usefulness of the maneuver to the SST accuracies. Typical SST anomalies, for instance for El Niño, are on the order of 2 K, guiding the desire for an SST error of less than 0.5 K. The Advanced Very High Resolution Radiometer (AVHRR) currently in operation obtains such accuracies on a global basis without the need for a spacecraft maneuver. However, because of the differing scan geometries and mirror coatings, MODIS will not be able to obtain the same accuracies without the desired deep-space view. (A Denton coating was selected for the MODIS mirror because of the wide spectral range to be covered, although it would not be the ideal choice if the only channels were the infrared channels used in the SST calculations.) The uncertainties in the MODIS mirror properties cannot be compensated by routine in-flight calibration, but should be compensated by the deep-space view, as recently demonstrated with the Geostationary Operational Environmental Satellite (GOES), which also has a Denton mirror coating. Efforts preparatory to the MODIS SST validations have confirmed the ability to obtain *in situ* skin surface temperatures to an accuracy of 0.1 K.

The next portion of the MODIS presentation was given by Chris Moeller, who, in collaboration with Paul Menzel, is developing a cloud mask for the MODIS data. A good cloud mask is essential for obtaining accurate MODIS-derived SSTs. Moeller explained the experience with GOES and its Denton mirror coating, as well as the impact of scan mirror uncertainty on both the MODIS radiances and the MODIS cloud mask. Comparisons between the water vapor measurements from radiosondes and GOES have quantified the value of the GOES scan mirror correction. Data from the MODIS Airborne Simulator (MAS) suggest a loss in accuracy of about 0.6 K due to the uncertainties in the scan mirror emissivity. Results for one case study show that, with the current cloud mask, about 1% of the pixels change classification after removing the scan-error uncertainty, although final fine-tuning of the cloud mask will have to await satellite MODIS data. Moeller warned that there could be major delays in data processing if no maneuver is performed, as in that case corrections will probably be made using an Earth-scene regression that is time-consuming and not as reliable as the deep-space view.

Murphy summarized the MODIS position by stating that a maneuver at the start of the PM-1 mission is essential in order to bring the MODIS performance to required levels and allow the SST, land surface temperature, and atmospheric algorithms to meet their required accuracies. Experience with the AM-1 mission will help determine whether subsequent PM-1 maneuvers are also desired.

Extensive discussion occurred during the MODIS presentations. One highlight was the analysis by Ghassem Asrar that, consequent to the convincing argument by Otis Brown, Earth observations alone will not be sufficient to eliminate the largest uncertainty in the MODIS data, i.e., the scan error emissivity bias; it becomes critical either to perform the maneuver or to devise an alternative strategy for removing the uncertainty. Chahine indicated that alternative strategies might be possible.

The CERES Team Position

The CERES Team Leader, Bruce Barkstrom, presented the CERES Team position, which, like the MODIS Team position, also includes a very strong desire for deep-space observations. The CERES Team has had extensive experience with the Earth Radiation Budget Experiment (ERBE), which flew on the Earth Radiation Budget Satellite (ERBS) with a spacecraft maneuver and on NOAA 9 and NOAA 10 without a spacecraft maneuver. Barkstrom estimates that the NOAA 9 ERBE data set required approximately one year's extra data processing because of not having the calibration benefit of a deep-space view. The agonizing experience with the NOAA 9 ERBE data has led to a very strong desire of the CERES Team to make sure that the PM-1 spacecraft obtains the needed deep-space view. The CERES Team will produce ERBE-like data products

from the PM-1 data as well as the more-advanced CERES/MODIS products incorporating the cloud property identification from the MODIS radiances.

The CERES Team desires for a deep-space view include: (1) limb-to-limb observation of deep space at all azimuths, and (2) timing the observations to occur on the dark side of the Earth. The team has no requirement on the maneuver mechanism but would like to divide the maneuver into segments of about 10 minutes at each of three scan positions. The most critical need is for a maneuver early in the mission, at about 45 days after launch, but they could also benefit from a second maneuver one year later and will know better after experience with AM-1, following its 1998 launch, whether additional maneuvers will be desired. The deep-space view will reduce the time needed both for CERES validation and for getting the CERES data products to EOSDIS.

The AMSR-E Team Position

The AMSR-E Team Leader, Roy Spencer, explained that he and the other AMSR-E Team members might be able to derive a small calibration benefit from a maneuver if the AMSR-E were operating during it, but that this potential benefit might become irrelevant, because the AMSR-E might have to be turned off in the event of a maneuver. The Japanese providers of the instrument (along with the AMSR-E Team and the PM Project management) are concerned about the risks involved in having the spacecraft turn over while the 220-kg mass of the spinning portion of the AMSR-E is in its spinning mode, rotating at 40 revolutions per minute with a 1.6-m antenna. Further study is needed regarding whether the instrument and the satellite could withstand the torques imposed by a maneuver carried out with the AMSR-E operating. Until such studies can be done and confirm the safety of the procedure, the Japanese have indicated that they would want to spin down the AMSR-E prior to any maneuver, followed by spinning it back up after the maneuver. They estimate that the combined spin-down/spin-up procedure would result in approximately a two-week data gap centered on each maneuver. Facing two-week data gaps, the AMSR-E Team would be very adverse to having a maneuver any more frequently than once a year. They are not adverse, however, to a single maneuver at the start of the mission to satisfy the major needs of the MODIS and CERES Teams.

The AIRS Team Position

The AIRS Project Scientist, George Aumann, presented the AIRS Team position. He emphasized that from what is known about the AIRS instrument as of May 1997, the AIRS does not need a deep-space view and that, because of the data losses and risks involved with a maneuver, the preference of the AIRS Team is that no maneuver be done. He explained three significant differences in the AIRS and MODIS situations in spite of their both having a Denton coating:

1. AIRS uses a Denton coating only on the scan mirror, with all other AIRS mirrors being gold-coated. Furthermore, the AIRS scan mirror is used at a fixed angle of 45°. In contrast, the MODIS mirrors are all Denton coated, and the MODIS scan mirror is used at angles of incidence ranging from -11° to +65°.

2. The required absolute calibration accuracies for the two instruments differ significantly, that for AIRS being 3% and that for MODIS being 0.5%.

3. The AIRS data processing uses routine daily checking of the calibration and, on a monthly timescale, tuning of geophysical parameters relative to a global set of co-located radiosondes.

In response to a query on whether the AIRS would be turned off in the event of a maneuver, Aumann replied that this would not be done. The maneuver itself, if executed as planned, might not pose a risk to the AIRS instrument, but it is expected to shift the spectral response of the AIRS outside the range permissible for normal Level 2 data processing. Aumann fears that the resulting disruption of the data processing would likely appear as an artifact in the long-term AIRS Level 2 data record, a situation that would not be acceptable for the AIRS mission objectives.

Decision and Remaining Issues

By the end of the meeting, it was agreed to request that the PM Project have TRW do a feasibility study for having a single maneuver at about day 45 of the mission, after turning on the MODIS and CERES instruments but prior to turning on the AIRS and AMSR-E instruments. All parties agreed to this as an appropriate first step, recognizing that the issue will have to be readdressed later, after additional information is obtained. In addition to the TRW study, the

Japanese will be examining the issue further for the AMSR-E instrument, and the AIRS Team has decided to undertake a study of the AIRS mirror similar to the study done by the MODIS Team for the MODIS mirror, with the possibility that the AIRS Team position could thereby be revised. Also, both the MODIS and CERES Teams will have a better handle on the value of the maneuver and the desired frequency after the EOS AM-1 spacecraft is launched, and they have a chance to analyze the effects on their data sets of the AM-1 maneuvers.

At the end of the meeting, David Starr, the EOS Validation Scientist, briefly discussed the major steps in the upcoming validation planning exercise for PM-1. Draft plans are due from the AIRS and AMSR-E Teams on August 15, following which a workshop will be held in September and revised plans will be due in December. An NRA for validation studies, specifically for PM-1, can be expected to be released in about two years.

NASA Selects 50 New Graduate Student Fellows in Response to the Earth System Science Graduate Student Fellowship Announcement

The selection of this year's recipients of NASA Earth System Science Graduate Student Fellowships is complete. A total of 323 applications were received by the Office of Mission to Planet Earth at NASA Headquarters in response to the announcement released in December, 1996. In all, over 94 universities and educational institutions from 41 states were represented. The applicants represent 27 countries, however, they are all currently accepted/enrolled as full-time M.S. and Ph.D. graduate students at one of the 94 universities in the United States.

The applications were evaluated through a two-step peer review process: first through mail/panel review, and then by evaluation of a panel composed of members of professional scientific societies, academic institutions, and the Educational Affairs Office and the Office of Mission to Planet Earth at NASA Headquarters.

A total of 50 new candidates from 20 states representing 32 academic institutions and 7 other countries were identified to receive the fellowships this year. The new fellowships, added to the pool of students whose support continues from last year, brings a total of 148 students being funded by this program during this academic year. This educational program is intended to support graduate students involved in Earth system science research as part of NASA's contribution to the U.S. Global Change Research Program.

The purpose of the Fellowship program is to train a pool of highly qualified scientists to help analyze and interpret the wealth of data generated by the Mission to Planet Earth programs. NASA understands that the future of Earth science rests with today's students, who will be tomorrow's scientists. The financial wherewithal to pursue an advanced education obviously plays a vital role in securing the necessary talent to further Earth system science objectives.

Fellowships are given for an initial 1-year term and may be renewed annually for up to 3 years, based on satisfactory progress as reflected in academic performance and evaluations made by faculty advisors. The amount of award is $20,000 per annum, which may be used to defray living expenses, tuition, fees, and other educational expenses. An additional $2,000 may be requested by the faculty advisor to support the student's research. Students receiving these stipends must not receive other Federal funding.

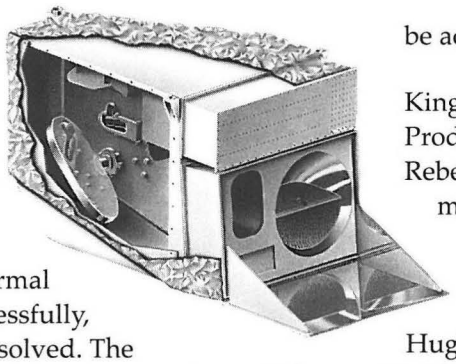
An announcement for the 1997-98 Fellowships will be released in December 1997 and the deadline for submission of new applications to NASA is March 15, 1998. To obtain a list of this year's recipients and additional information on this program you may check the NASA Mission to Planet Earth (MTPE) home page: http://www.hq.nasa.gov/office/mtpe/ under the "Education and Outreach" or "Research Announcements" links, or contact Dr. Ghassem Asrar, Mail Code YS, NASA Headquarters, Washington, DC 20546.

Moderate-Resolution Imaging Spectroradiometer Science Team Meeting Summary

— **Bob Kannenberg** (rkannenb@pop900.gsfc.nasa.gov), Science Systems & Applications, Inc.

The complete set of these minutes and attachments is available in Portable Document Format (PDF) on the MODIS Home Page at http://modarch.gsfc.nasa.gov/MODIS/MODIS.html.

Introduction



Vince Salomonson, MODIS Team Leader, convened the MODIS Science Team (MST) meeting and welcomed participants. Salomonson stated that the instrument is currently undergoing consent-to-ship review at SBRS. Thermal vacuum testing was completed successfully, and polarization issues have been resolved. The instrument will soon be shipped to Valley Forge, and it is expected to launch in 13 months.

EOS Project Science Report

Michael King, EOS Senior Project Scientist, reported that the biennial review process has been instituted to look at things like how MTPE programs are addressing science themes, processes for incorporating new technologies, partnerships with commercial and international entities, etc. EOS is implementing an interagency validation strategy, incorporating satellites, surface networks and field campaigns. King presented a timeline showing Earth system model development; the goal here is to have fully coupled Earth system models by the year 2010.

King presented a table comparing the numbers of EOS data products in May 1993 to the numbers in April 1997. The total number has increased from 239 in 1993 to 282 in 1997; this jump is attributable to certain algorithms, most notably data assimilation, that were mistakenly neglected in the 1993 database. King dispelled the perception that there is an astronomical overload of data products; many of these products can be accounted for as front-end calibration.

King announced that the Standard Data Products Resources Board, chaired by Skip Reber, has been established to assess and manage changes to the EOS data products list. Currently the Board's main dilemma is the accuracy of the data products database. Hughes ECS is building its database to the February 1996 baseline, although the 1997 Data Products Handbook differs substantially. Discrepancies have emerged as some interim products have drifted to standard. King expressed concern that a mechanism be put into place to provide a reality check between actual MODIS sizing requirements and what Hughes understands the requirements to be.

AM-1 Project Science Status and Early Science

Yoram Kaufman, EOS AM Project Scientist, announced that David Herring, recently hired as Outreach Coordinator, has created an EOS AM Bulletin Board System (BBS) and will be creating an EOS AM Web site as well. Kaufman encouraged use of the BBS to discuss issues like the calibration maneuver and early science. He stated that he is actively seeking to hire an outreach scientist to coordinate MTPE PAO outreach efforts like brochures, museum exhibits, articles and press releases. Herring will assist in promoting a contest to name the AM-1 platform. Kaufman indicated that AM-1 is assessing how best to perform the calibration maneuver, or deep space look, for MODIS and CERES.

PM-1 Status
Claire Parkinson, PM Project Scientist, reported that the spacecraft is now in month 13 of its 54-month development period. The work by TRW, the spacecraft contractor, was delayed by 6 months (September 1995 through April 1996) because of a protest to the Common Spacecraft contract, but launch is still scheduled for December 2000, and overall progress has been rapid since TRW came onboard. Parkinson announced that TRW has signed off on interface control documents (ICD) for all but one (Humidity Sounder for Brazil [HSB]) of the instruments planned for PM-1.

Parkinson indicated that on May 6 a meeting was held to discuss the feasibility of conducting a PM-1 calibration maneuver. MODIS and CERES are in favor of the maneuver, while AMSR and AIRS are opposed. TRW will examine the feasibility and potential impacts associated with performing the maneuver one time on day 45 of the mission, with MODIS and CERES powered on, and AMSR and AIRS powered off.

EOSDIS Status Report
Rick Obenschain, EOSDIS Project Manager, reported that Release B.0, due May 15, 1998, will have limited product generation capability but will allow MODIS all the capabilities necessary to support early mission calibration and algorithm testing and refinement. Release B.0', an early incremental build, will be demonstrated in August; it will provide the capabilities necessary for critical functions. If B.0 is delayed and not delivered as scheduled, then B.0' can at least provide the capabilities critical for launch. Release B.1 is scheduled for delivery January 15, 1999. Obenschain expressed his concern that the August demo of B.0', initially intended as an internal demo, has evolved into a "go/no-go" decision point. As such, the scope of the demo has been expanded to the point where preparation is impacting development of B.0. This impact, estimated to be about 4 to 6 weeks, will be taken into consideration by Sara Graves' review committee. Funds have been allocated and held to support AM-1, Landsat-7 and SAGE III emergency backup plans. MODIS is currently revising its backup plan proposal.

Chris Justice voiced his concern that ESDIS is considering the reduction of instrument interdependencies and, from the Land point of view, these interdependencies are critical. Obenschain replied that ESDIS had been asked to look at ways to cut costs in the out years. ESDIS is evaluating the savings associated with data volume reductions of 25% and 50%. The likely scenario is that the number of Level 2, 3 and 4 products will be reduced, at least for the initial phases of each flight mission, and 100% of the Level 1 products will be produced.

Coordination with Integrated Program Office (IPO)/ National Polar-orbiting Operational Environmental Satellite System (NPOESS)
Stan Schneider reported that NPOESS intends to fly in three orbits: 0530 sun-synchronous, 1330 and EUM (between 930 and 1030). Of most interest to MODIS is the Visible and Infrared Imaging Radiometer Suite (VIIRS), which will be a single sensor or suite of sensors that address visible IR imagery and radiometric measurements. VIIRS meets critical NPOESS requirements for imagery, sea surface temperature (SST) and soil moisture. Delivery of the first flight unit is slated for January 2004.

The RFP for VIIRS differs from the typical NASA RFP in that the vendors were asked to deliver the algorithms as well as the product. However, most of the expertise in algorithm development resides in universities and the government, so Operational Algorithm Teams (OAT), consisting of DoD, NOAA and NASA representatives, have been formed to oversee the algorithm development process. Schneider announced that the NPOESS Web site is located at: http://www.laafb.af.mil/SMC/PK/NPOESS/rfp.htm.

Level 1B Validation Plans
Bob Murphy reported that the Level 1B plan is not as well-developed as we would like it to be. The validation approach will incorporate aircraft, ground-based, ship-based and mooring platform sensors. MODIS derived TOA spectral radiances will be validated in the 16 VIS/NIR and 4 SWIR bands using high radiance sites (i.e., White Sands) and low radiance sites (i.e., Lake Tahoe). TIR bands 31 (11 μm) and 32 (12 μm) will be validated directly; other TIR bands will be validated by referring to 31 and 32 via the onboard blackbody. Long-term stability will be monitored by lunar looks through the space view port 3 to 7 times per year. Radiometric calibration change over days to weeks will be checked with solar diffuser measurements. Murphy noted that in the Level 1B draft algorithm, no follower algorithm is incorporated. Until the MODIS Science Team allows a follower algorithm, the solar

diffuser will not be integrated. He anticipates that the Level 1B Validation Plan will be revised and available for review sometime in early 1998.

Version 2 Delivery Schedule
Ed Masuoka, SDST Leader, reported that software will be received from April through October, and that science software need dates are driven by synthetic data, product dependencies, time to test at TL-SCF, and time to integrate and test at the DAACs. Version 2 software requirements are completed. SDST is finishing up metadata work with ECS, and Masuoka stated that he would like to put a freeze on metadata this month (May), and the earlier the better.

Phase-in Plan for Data Products
Masuoka indicated that the phase-in plans for data products are being worked by the discipline groups. He cited the dependencies between Land and Atmosphere as a key issue that needs to be worked.

Direct Broadcast/Reception
Murphy reported that the Project has a Level 1 requirement to provide direct broadcast (DB) of data, but there is no requirement for reception of same. EOS AM-1 Direct Access System (DAS) capabilities include real-time DB of MODIS data and ancillary data, as well as real-time direct downlink (DDL) of ASTER (Vis-NIR-Thermal High Resolution) data. Murphy stated that DB would promote the use of MODIS data by our international colleagues, and enable their participation in our validation programs. NASA HQ is interested in DB, and a joint EOS-HQ effort may produce a cost-effective way to receive, process and distribute data.

Geolocation Validation
Strahler reported that the Geolocation Validation meeting held May 13 was very successful. Overall, good progress has been made; there are no showstoppers, although the schedule is tight. Participants reviewed Version 3.0 of the Geolocation ATBD. Strahler anticipates that Version 2 production code should be delivered as scheduled on June 9, 1997. The Version 2 base algorithm should be delivered between June and September 1997. The Geolocation Group will take the action to work the issue of band-to-band registration in the event of SRCA failure.

Data Assimilation Office (DAO) Status Report
Yong Li reviewed the methodology behind GEOS-3 Gridded Data Products. The GEOS-3 system is expected to be operational in June 1998. He encouraged Science Team members to contact him for copies of the file specification. Anyone in need of DAO data should complete the DAO data survey form; the DAO will then respond as to whether their data are suitable for the user's purposes as described in the survey. Justice questioned the need for the survey, saying that by this time the DAO should be addressing the requirements that it has already been given. Li encouraged more direct communication between the MODIS Discipline Groups and himself.

Li presented a sample test data set that DAO had already created, which covers the period July 31 through September 1, 1996. This data set was created for MODIS software testing and based on the requirements received in that time frame. The test data set is available now in HDF-EOS format. ECS is currently working on the metadata for this data set.

Early Results from the Ocean Color and Temperature Scanner (OCTS)
Hajime Fukushima, Leader of the OCTS Sensor Team, reported that OCTS is collecting global VIS and IR data with a 700 m resolution. Overall instrument performance has been satisfactory, although he noted a couple of problems (tilt mechanism and sensor degradation in the IR bands). Fukushima stated that calibration numbers for the visible bands will soon be updated using AVIRIS data from observations made in April and May. He noted that on April 10 the calibration system was changed to allow for the vicarious calibration factor and, so far, the vicarious calibration results appear to be good.

Early Results from Polarization and Directionality of Reflectances (POLDER)
Didier Tanré reported that the POLDER instrument utilizes a camera composed of a two-dimensional CCD detector array, wide FOV telecentric optics and a rotating wheel carrying spectral and polarized filters. Planned products include ocean color and marine aerosols, land surfaces and aerosols over land, radiation budget, water vapor content, and clouds. Calibration is being done with radiometric methods such as absolute calibration using Rayleigh scattering, polarization calibration over sunglint and clouds, inter-band calibration over sunglint and clouds, multitemporal calibration over desert sites, OCTS/POLDER

intercalibration and statistical relative calibration over clouds. Salomonson inquired about the accuracy that POLDER aims to achieve, and Tanré responded that an accuracy of ± 2-3% is anticipated. The spec for polarization is better than ± 1%. Tanré stated that POLDER is looking at the cloud mask by using the reflectance threshold in IR and NIR data, polarization and the oxygen-A absorption band. Data will be available late 1997 (point of contact: Anne. Lifermann@cst.cnes.fr).

MODIS-like 1-km BRDF and Albedo Retrievals over New England

Strahler presented the work of Robert d'Entremont at Boston University, whose objective is to prototype the MODIS/MISR BRDF/albedo algorithm using satellite observations, as well as to demonstrate the retrieval of BRDF and spectral albedo at a 1-km spatial resolution. Strahler explained that the research plan is to obtain AVHRR data and make comparisons. The algorithm is a kernel-driven semi-empirical BRDF model based on view and illumination angles. Reflectance is based on 3 terms: a constant for isotropic scattering; a weight applied to a BRDF shape for volume scattering; and a weight applied to a BRDF shape for surface (geometric-optical) scattering. Strahler presented two examples of kernel shapes, the Ross (thick) kernel and the Li (sparse) kernel. (The first is for volume scattering, and the second for surface scattering.) The data set comes from AVHRR and GOES visible band data. Strahler showed a number of images taken over New England, and demonstrated how the Ross kernels have BRDF with a moderate-to-strong bowl shape, and no hotspots. These are associated with forests and dense crops. The Li kernels are more dome-shaped, with hotspot peaks. These are associated with urban and suburban regions. Strahler concluded that this work is moving beyond the theoretical stage, and he is looking forward to using the algorithms on real MODIS and MISR data.

Evaluation of MODIS Fire Algorithm Using SCAR-B Results

Kaufman explained the methodology that he and Justice used to construct the MODIS fire algorithm. MAS data gathered over fires in Brazil indicate that MODIS fire detection capability will be much better than that of AVHRR. Kaufman indicated that MODIS data will be used to generate a fire energy product that will distinguish the order of magnitude of fires. He noted that the combination of both AM- and PM-data will be essential to doing real science related to fires.

MODIS Cloud Mask Progress and Current Status

Steve Ackerman announced that there have been two significant changes regarding cloud mask since the ATBD review. The first change involves replacing the wetland bit with a desert scene bit in the land water flag. That change will be contained in Release 2. The second change will not show up in the 48-bit cloud mask file spec. This change involves putting a cloud adjacency effect into bit field 12. This change will not show up until after launch. Ackerman encouraged MST members to obtain the available code to read MAS HDF files, run the cloud mask on a MAS scene, and let him know the results.

MODIS Instrument Status

Bill Barnes stated that sometime in the next 3 to 6 months MCST intends to hold a workshop to present an in-depth analysis of instrument test data. Overall, though, we believe we have a good data set, and that we can get all of the characterization that we need. Barnes concluded by saying that Dick Weber has retired and will be succeeded by Ken Anderson as MODIS Instrument Manager. Barnes thanked Weber for all of his efforts.

Tom Pagano stated that comprehensive environmental tests have validated the instrument's principal design features and demonstrated that MODIS is an excellent spectroradiometer. He reported that all ambient and thermal vacuum tests were performed at hot, cold and nominal temperatures, ten degrees beyond what we expect to see in the space environment. Pagano showed a video entitled "MODIS Calibration and Environmental Testing," and indicated that he would make copies available if requested.

Pagano reported that most major performance areas have some non-compliances but, in most cases, the instrument complies with specifications. Waivers are out for non-compliant areas. Pagano reiterated that overall instrument performance is excellent, and he expects improvements in many noncompliant areas with further data analysis. Concerns include crosstalk, which is higher than expected. It may be possible to improve this by a factor of 4. Another concern is the Near Field Response, which is mostly noncompliant. Finally the dynamic range is noncompliant on several bands, although Band 21 represents the biggest concern.

Algorithm Developers Meeting Summary
Joe Glassy reported that overall the Algorithm Developers feel they have made progress working as a team amongst themselves and with their SDST contacts. Programmers are encouraged to see a reduction in SDST staff turnover, as this aids "institutional memory." Some long-standing issues persist, however, such as frequent specification changes within a given development cycle. Glassy suggested that better communication between algorithm developers and SDST personnel would be mutually beneficial, and encouraged use of Mike Heney's Programmer BBS where appropriate.

Ocean Group Splinter Summary
Wayne Esaias, Ocean Group Leader, enthused that MODIS looks great, and added that we probably know more about MODIS than we even thought to ask about previous sensors. Ocean algorithms and software are on schedule. Esaias stressed that emergency backup planning (and testing) is essential. The Ocean Group would like to see a full end-to-end data flow demonstration included in the August ECS demo. Murphy added that, within MODIS, we need to define our own success criteria—independent of the criteria defined by the Graves committee—for the August demo.

Atmosphere Group Splinter Summary
Michael King, Atmosphere Group Leader, announced that the Atmosphere QA Plan was submitted to the ESDIS Project Office in March 1997; the next iteration, to include Level 3 QA, is expected in July 1997. King reviewed figures showing the data volume increases due to QA; cloud mask accounts for the most significant increase. Liam Gumley at UW demonstrated a prototype of a MAS online visualization tool, which will be very useful for cloud mask development. King reported that since the ECS February 1996 baseline, Atmosphere storage volume requirements have grown by roughly 30%, and this increase has been driven by cloud mask and QA. Atmosphere data still represents a relatively small fraction of overall MODIS data volume.

Land Group Splinter Summary
Chris Justice, Land Group Leader, cited the need for a MODIS instrument "performance/operation" log to establish a link to QA. Land has asked MCST to look at this. Land has suggested that SDST assess establishing a similar platform-wide performance log. Justice reported that the Land Version 2 code delivery schedule currently meets SDST needs. Land needs simulation and DAO test data sets for Version 2. Justice indicated that the Land Group is aware that it is the "tall pole" when it comes to volumes and loads, and the Group is currently looking at how to refine these areas. Justice discussed Land validation activities, including the upcoming Grassland PROVE field campaign at the Jornada Experimental Range in New Mexico.

MODIS Science Team Meeting Summary
Salomonson stated that in his mind the intensity of the MODIS effort has now shifted from the instrument itself to the software, and it will stay that way until launch. The issues surrounding software and validation require attention from us all. If not now, soon flexibility with requirements will be clamped, and we will have to become more creative. We have an exercise to look at validation and products, and we need to establish these numbers. We must provide specifics to EOSDIS in order to justify and obtain what we need. The next MST meeting will be held in October 1997 in the GSFC area.

SSM/I Pathfinder Web Site
http://www.ssmi.com

We have finally completed our SSM/I Pathfinder Web Site. You can now click on any day for the last ten years (starting with F08, July 9, 1987) and simultaneously see global images of wind, vapor, cloud, and rain (either local morning or evening). Any of these images can be quickly downloaded as byte maps for data analysis. Our most recent data are usually yesterday's observations. Each day, we are uploading images and byte maps for four SSM/Is: F10, F11, F13, and F14. Come see us at www.ssmi.com, and let us know what improvements we could make. Note that the same algorithm (both Level 1 and Level 2) was used to process all 10 years. Also all 5 SSMIs (8,10,11,13,14) were first intercalibrated.

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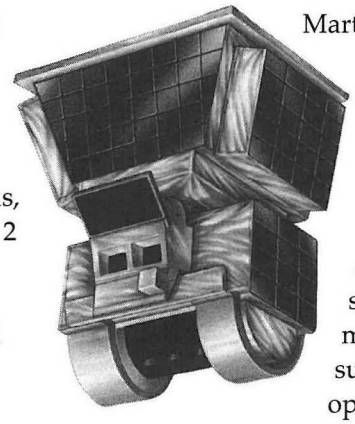
Clouds and the Earth's Radiant Energy System Science Team Meeting

— **Bruce R. Barkstrom** (brb@ceres.larc.nasa.gov), Co-Principal Investigator, and **Gary G. Gibson** (g.g.gibson@larc.nasa.gov), NASA Langley Research Center

The 15th Clouds and the Earth's Radiant Energy System (CERES) Science Team meeting was held at the NASA Langley Research Center (LaRC) in Hampton, VA, April 16-18, 1997. The focus of the meeting was CERES instrument status, data management system status, Release 2 algorithms and issues, and validation plans. The first CERES launch is scheduled for October 31, 1997, on the Tropical Rainfall Measuring Mission (TRMM) spacecraft. The Science Team guides the definition of the CERES instrument and science studies to provide a climate data set suitable for examining the role of clouds in the radiative heat balance of the climate system.



Bruce Wielicki, CERES Co-Principal Investigator, opened the meeting with a program status report. The EOS AM-1 and EOS PM-1 platforms are on schedule. The EOS AM-1 project agreed to perform a space-look orbital maneuver required by CERES and the Moderate-Resolution Imaging Spectroradiometer (MODIS). The National Polar-Orbiting Operational Environmental Satellite System (NPOESS) wants to fly a "CERES Lite" instrument on their 1:30 p.m. platform in 2009 and beyond. The EOS Biennial Review is currently underway with plans to re-compete the EOS-2 missions.

CERES Instrument Status: TRMM and EOS AM-1

Leonard Kopia (LaRC) presented the instrument status report. The CERES Proto-Flight Model (PFM) instrument on the TRMM spacecraft successfully completed thermal vacuum and vibration testing at the spacecraft level. Both the FM1 and FM2 instruments successfully completed Bench Acceptance Tests at the Lockheed-Martin Valley Forge facility, and on March 26, 1997 became the first science instruments to be mechanically integrated on the EOS AM-1 spacecraft. Larry Brumfield (LaRC) reviewed the planned in-orbit checkout and calibration activities, spacecraft yaw maneuvers, and orbit adjust maneuvers. He issued a call for science team requests for special TRMM measurements and outlined procedures for submitting and evaluating requests for operational changes.

Data Systems: EOSDIS, LaRC DAAC, and CERES DMS

As the launch of TRMM approaches, the team placed special emphasis on the readiness of data processing and dissemination systems. In an overview of the EOS Data and Information System (EOSDIS), Bruce Barkstrom (LaRC) noted that the system would likely not be ready by the time of the TRMM launch. The EOSDIS Core System (ECS) Release A is being replaced by a backup processing and distribution system, the Langley TRMM Information System (LaTIS), at the LaRC DAAC for TRMM processing. Also, the Science Working Group for the AM Platform (SWAMP) insisted on an Emergency Backup to cover the first 6 months of AM-1 processing in case of additional EOSDIS delays. Richard McGinnis (LaRC) presented the LaTIS customer requirements, design assumptions, system architecture, and proposed hardware/software.

Jim Kibler (LaRC) presented the CERES Data Management System (DMS) status. Code development, integration, and test activities are all on schedule for TRMM. The CERES Release 2 Data Products Catalog was published to define at-launch products. The

catalog is accessible on the Internet from the CERES home page at: http://asd-www.larc.nasa.gov/ceres/ASDceres.html. CERES and DAAC teams at Langley and TRMM and EOSDIS teams at the Goddard Space Flight Center (GSFC) conducted the first end-to-end TRMM mission simulation in November 1996. Several anomalies in both the software and the operational procedures were found and corrected as a direct result of the realistic simulation. This simulation demonstrated the successful operation of virtually all elements of the data systems needed to support the CERES launch on TRMM. Near-term plans include: 1) a second TRMM mission-simulation test with live CERES data; 2) Release 2 integration and testing on Science Computing Facilities; 3) staged deliveries of Release 2 code to the DAAC for LaTIS integration; 4) testing LaTIS with a month of simulated CERES data prior to the TRMM launch; and 5) modification to maintain compatibility with ECS Release B for EOS AM-1 processing.

CERES Release 2 Algorithms and Issues

The Release 2.1 CERES Algorithm Theoretical Basis Documents (ATBDs) have been completed for all subsystems and reviewed by the EOS Project Science Office.

Instrument: Robert B. Lee III (LaRC) reported that the Release 2 algorithm was delivered to the DAAC in March 1997. The algorithm is a debugged version of Release 1 with upgraded data handling features for calibration and coastline validation data. Release 2 system architecture has been implemented, and testing and verification are underway.

Clouds and Top-of-Atmosphere (TOA) Fluxes: Bruce Wielicki (LaRC) stated several arguments against merging the CERES/MODIS cloud products. It is unlikely that a single cloud product will be optimal for all users. Cloud validation is being coordinated with the MODIS team. CERES, MODIS, and International Satellite Cloud Climatology Project (ISCCP) product intercomparisons will be performed. MODIS is concentrating on aircraft field experiments, and CERES is focusing on long-term surface site measurements. MODIS Airborne Simulator (MAS) data are useful for validation over ocean backgrounds, but are more difficult to use over land. Issues of consistency in Visible Infrared Scanner (VIRS) and MODIS cloud properties will be addressed by averaging MODIS to VIRS resolution and using only the VIRS channels. Full MODIS capability will be used for EOS AM-1 and EOS PM-1. Polarization and Directionality of Earth's Radiances (POLDER) and Multi-Angle Imaging Spectroradiometer (MISR) data will be used to verify consistency of multi-angle optical depth retrievals.

Surface and Atmospheric Radiation Budget (SARB): Thomas P. Charlock (LaRC) reviewed Release 2 improvements for SARB: maximum of two cloud layers per footprint; use of Data Assimilation Office (DAO)-based Meteorology, Ozone, and Aerosol (MOA) data; two-stream Fu-Liou model; updated derivative and sigma tables; and processing nighttime footprints. For SARB, a cloud will be either all liquid or all ice. For each existing cloud layer, given the cloud-top pressure, effective temperature, optical depth, and particle size, the liquid ice water content and the cloud bottom height are determined. The Fu-Liou results will be constrained to match CERES-observed TOA fluxes. David P. Kratz (LaRC) reported that the Li et al. all-sky shortwave (SW), Ramanathan/Inamdar clear-sky longwave (LW), and Gupta *et al.* all-sky LW TOA-to-surface parameterizations have been completed. He also noted that surface emissivity maps are now being produced for broadband infrared (4.5-100 μm), CERES window (8-12 μm), Fu-Liou infrared intervals, and 3.7 μm.

Temporal Interpolation and Spatial Averaging (TISA): David F. Young (LaRC) reported that TISA algorithms are developed and operating, but several issues must still be considered. Spatial averaging issues include: vertical averaging of clouds, cloud layer averaging, combining data from multiple satellites, spatially averaging rotating azimuth plane (RAP) scanner data, and data ordering and gridding. Temporal interpolation issues include: data gaps greater than 24 hours, augmenting clear-sky interpolation with geostationary data, interpolation of atmospheric fluxes, instantaneous or 3-hour average synoptic maps, mixing crosstrack and RAP data, and using geostationary data to reduce cloud interpolation errors.

Invited Presentations

Leo Donner (GFDL) gave a modeller's perspective on using CERES data to evaluate cloud and convective processes in General Circulation Models (GCMs). He addressed current GCM parameterization development issues and the critical need for expanded and

improved observational data. CERES data will be used to evaluate 3-D distributions of clouds and radiative fluxes, with special emphasis on the surface radiation budget for issues related to atmospheric absorption and surface temperature control. CERES data are also needed to improve diurnal cycle parameterizations and to examine synoptic evolution of cloud systems.

Elsworth Dutton (NOAA) discussed the Baseline Surface Radiation Network (BSRN) status and future. He noted the principal features of BSRN sites including location criteria, data quality control, World Climate Research Programme (WCRP) organizational support and oversight, uniform measurement specifications, irradiance and atmosphere observations, and uniform archiving. Basic observations include direct and diffuse solar, downward infrared, and basic surface meteorology. There are currently 24 active BSRN field sites around the globe sponsored by 10 different countries.

J. P. Duvel (Laboratoire de Meteorologie Dynamique, France) briefed the team on the POLDER experiment which is being flown aboard Japan's Advanced Earth Observing Satellite (ADEOS) polar orbiting platform launched in 1996. POLDER measures reflected solar radiance and observes a given Earth target pixel under various geometrical, spectral, and polarization conditions. POLDER data provide an opportunity to conduct climate-related research on aerosol cycling, aerosol-cloud-radiation interactions, the Earth radiation budget, ocean primary production, and continental biosphere dynamics.

Working Group Reports

Cloud Working Group: Bruce Wielicki led discussions of Angular Distribution Models (ADMs), smoke retrievals and radiative effects, and MODIS field programs for validation. Yong Xiang Hu (College of William and Mary) constructed theoretical ADMs using both stochastic and plane parallel models. He made a database of broadband radiances as a function of solar and viewing angles, phase, and optical depth for the two models and compared the results. Steve Platnick (GSFC) noted that MAS data are proposed for studies related to the remote sensing of clouds, surfaces, smoke, fires, fog, etc. Options and data availability for post-launch CERES/MODIS validation studies were discussed.

Surface and Atmospheric Radiation Budget (SARB) Working Group: Thomas Charlock led the SARB Working Group in discussions of anomalous SW absorption, smoke effects on surface properties, and meteorological data sources. Bob Cess (State University of New York at Stony Brook) presented theoretical results and ARM Enhanced Shortwave Experiment (ARESE) data taken on clear and cloudy days to show that excess SW absorption occurs only on cloudy days. In a discussion of the spectral dependence of excess absorption, Cess explained that it occurred at most visible and near-IR wavelengths, but not at 0.5 μm. Sundar Christopher (S. Dakota School of Mines & Technology) showed the effect of smoke from biomass burning on surface insolation, and the smoke radiative forcing of the climate system. He also demonstrated a new algorithm for detecting biomass burning events from imager data. Shi-Keng Yang (NOAA) presented a new ozone product called SMBOA (Stratospheric Monitoring-group's Blended Ozone Analysis), which is an analysis/assimilation product based on Solar Backscatter UltraViolet (SBUV/2) data. This may be the best ozone product for CERES MOA use because it provides ozone mixing ratios at many more levels. Man-Li Wu (GSFC) discussed problems affecting the meteorological fields of the Goddard Earth Observing System (GEOS)-1 GCM and the steps being taken to remedy those problems.

In a joint meeting of the SARB and Cloud Working groups, Charlock presented full-day, global Pathfinder results from the SARB constrainment algorithm. ADM errors were also discussed, particularly the possibility of large Earth Radiation Budget Experiment ADM errors over large-optical-depth convective regions in the tropics. Wielicki concluded that global statistics of all output products should be closely examined.

Time Interpolation and Spatial Averaging (TISA) Working Group: David Young led discussions of algorithm changes, code development, validation plans, and ongoing temporal and spatial averaging studies. All TISA subsystems are on-target for delivery to meet TRMM schedules. Takmeng Wong (LaRC) showed initial validation results for the CERES-algorithm-derived monthly average products. Martial Haeffelin (Virginia Tech) used CAGEX (CERES/ARM/Global Energy and Water Cycle Experiment, GEWEX) data to evaluate temporal sampling errors in atmospheric and surface fluxes. Dave Doelling (AS&M) presented

results of CERES spatial sampling studies. Steven Dewitte (Belgium) presented a spherical wavelet transform technique for radiation budget data compression.

Investigator Presentation Highlights

Bryan Baum (LaRC): Reviewed the goals, data products, and access information for the CERES Pathfinder. He presented a new algorithm for detecting overlapped cloud pixels based on the relationship between reflectance and brightness temperature.

Bob Cess (State University of New York at Stony Brook): Examined the role of clouds in the relation between surface downward LW and outgoing LW radiation. Results suggest that a new LW TOA-to-surface parameterization might be feasible.

Tom Charlock (LaRC): Compared SW results from the Fu-Liou code with ARM measurements. Results from CAGEX Version 2 indicate the Fu-Liou code significantly overestimates clear-sky surface insolation measurements. Evidence exists for enhanced SW absorption by clouds.

Dominique Crommelynck and **Steven Dewitte** (Royal Meteorological Institute of Belgium): Presented an overview of determining radiation budget parameters from geostationary and polar measurements. Discussed the application of the Space Absolute Radiometric Reference (SARR) to adjust solar measurements since 1978 to the same reference.

Jennifer Francis (Rutgers University): Presented a method for detecting nighttime polar clouds that combines wavelengths with different cloud absorption characteristics to detect clouds over snow, determine cloud phase, and estimate thickness of thin clouds.

Laura Fowler (representing Dave Randall, Colorado State University): Simulated the orbital coverage of the Geoscience Laser Altimeter System (GLAS) and Pathfinder Instrument for Cloud and AeroSol Spaceborne Observations (PICASSO) satellites in the Colorado State University (CSU) GCM. The approach is to sample the hourly GCM cloud/radiation gridded fields using the satellite sampling (near-simultaneous observations of GLAS or PICASSO with EOS) and then compare it with the truth field, which includes all samples.

Qingyuan Han (representing Ron Welch, S. Dakota School of Mines & Technology): Examined the relationship between liquid water path (LWP) and droplet size used in GCMs with a near-global data set. Presented an improved smoke retrieval algorithm and showed how combining the smoke mask with the CERES cloud mask could improve retrievals.

Anand Inamdar (representing V. Ramanathan, Scripps): Analyzed global-scale water vapor radiative feedback. Derived the greenhouse effect for oceans and land separately and combined, and examined the annual cycles of the atmospheric greenhouse effect, surface temperature, and total precipitable water. Inferred the water vapor sensitivity factor from the annual cycle. CERES will provide additional insights into the role of continuum, water vapor feedback, and lapse rate effects.

Robert Kandel (Laboratoire de Meteorologie Dynamique, France): Gave an overview of the year of Scanner for Radiation Budget (ScaRaB) data with regard to the effects of restricted time sampling.

Bing Lin (Hampton University): Developed a microwave cloud retrieval method to detect water clouds beneath upper-level ice clouds.

Norman Loeb (representing Jim Coakley, Oregon State University): Examined the influence of cloud-top structure on the view-angle dependence of reflectances from overcast cloud layers.

Pat Minnis (LaRC): Examined the use of narrowband geostationary data as a surrogate for broadband data with applications for time interpolation of the CERES data and the use of geostationary data for estimating broadband flux fields.

Larry Stowe (NOAA): Presented the status of two-channel algorithm development for aerosol retrievals. Derived aerosol products using Advanced Very High Resolution Radiometer (AVHRR) 0.63- and 0.83-μm channels. Discussed the 5-μm leak in the VIRS 1.6-μm channel.

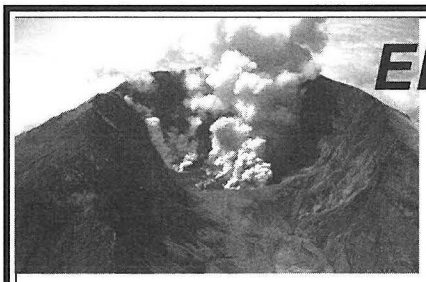
Shi-Keng Yang (NOAA): Showed diagnostic results of an experimental SW code in the National Centers for Environmental Prediction global forecast model.

CERES Educational Outreach

Lin Chambers (LaRC) briefed the team on the CERES S'COOL (Students' Cloud Observations On-Line) Project. Schools observe and report clouds at the time of CERES instrument overpass, compare their observations to CERES cloud retrievals, and provide feedback on up versus down-looking results. The program has already been tested locally, and is expected to expand to national, international, and global scales within the next year. The S'COOL internet interface is: http://asd-www.larc.nasa.gov/Outreach/SCOOL/SCOOL.html

Science Team Logistics

The next CERES Science Team meeting is scheduled for September 16-18, 1997, at Oregon State University in Corvallis, Oregon. Major topics will include readiness of all systems for the TRMM launch on October 31, and subsequent processing and validation of CERES and VIRS data.



EDUCATION HIGHLIGHTS

Winds of Change — the NSCAT CD-ROM

"Winds of Change" is a curriculum resource CD-ROM on the subject of global weather, primarily aimed at middle school level. It has been critically evaluated by the Mid-Continent Regional Educational Laboratory and received high marks on its educational value and approach. Orders can be placed via the NSCAT homepage at http://winds.jpl.nasa.gov. It will also be available at the NASA Educational Resource Centers.

New Earth System Science Education CD-ROM

Planet Earth Science, with support from NASA and the Department of Energy, is releasing its first CD-ROM "Ocean Expeditions: El Niño" for use as teacher training and/or classroom activities. This CD-ROM is an interactive, educational tool designed for high school science teachers to bring Earth System Science concepts into their classrooms. To order a review copy contact Jeanette Downes, Jeannett@PlanEarthSci.com or telephone (805) 730-1622

The Earth Sciences@ CD-ROM

The University of Southwestern Louisiana has produced a CD-ROM titled "The Earth Sciences@" through a grant from the Stennis Space Center. It includes chapters on various biomes and components of the biosphere, and a tutorial on making Earth observations/measurements from spacecraft. Contact Nnan Touchard, email: Nan.Touchard@ssc.nas.gov.

ON THE WEB

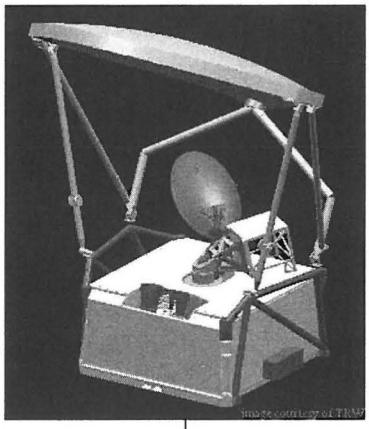
U.S. Global Change Research Information Office's (GCRIO) first lesson plan in their educational initiative: International Environmental Treaties for Conserving Biological Diversity - http://www.gcrio.org/lp/biodiv/biodiversity.html. Other global change and environmental education resources from GCRIO: http://www.gcrio.org/educ.html.

The **U.S. Geological Survey** has published an interdisciplinary set of materials on volcanoes for grades 4-8. It is available free from USGS at 1-800-USA-MAPS. The USGS educational learning Web page is at http://www.usgs.gov/education/.

EOS PM-1 Advanced Microwave Scanning Radiometer Science Team Meeting

— **E. Lobl** (elena.lobl@msfc.nasa.gov), Team Coordinator, Earth System Science Laboratory, University of Alabama in Huntsville

EOS PM-1 AMSR-E homepage: wwwghcc.msfc.nasa.gov/AMSR



The U.S. EOS PM-1 AMSR-E Science Team meeting was held on 10-12 June 1997, at the Global Hydrology and Climate Center (GHCC) in Huntsville, Alabama. A team of three Japanese AMSR scientists attended and participated in all science discussions. Besides the research status, the scientists discussed a joint validation plan and the organization and charter of a joint US-Japan AMSR Science team. The last day and a half, the software support personnel attended a separate session dealing with metadata and the integrated software architecture.

Roy Spencer, Team Leader, opened the meeting by introducing Ron Greenwood, GHCC Director, who welcomed everyone and explained briefly the makeup of the center from scientists to archeologist to engineers to students. Spencer then updated the team on the NASDA-NASA Memorandum Of Understanding (MOU). The NASA responsibilities are: for the hardware (to integrate, launch AMSR-E, check-out the performance post launch) and data (do Level 0 processing, participate in the definition of product generation algorithms, and produce, archive and distribute Level 2 standard products only when "NASDA decides not to produce certain standard data products required by the EOS Senior Project Scientist"). NASDA responsibilities are to provide the hardware, and all ground support before launch, participate in the definition of product generation algorithms, perform Level 1 and higher processing, if the products and the generating algorithms are agreed upon by the EOS Senior Project Scientist and the Joint Science Team, and archive and distribute these standard products worldwide. Spencer concluded this portion with a brief discussion of the responsibilities of a Joint Science Team; these included making decisions on the algorithms to be used for generating the standard products (should they be the same algorithms as for AMSR on ADEOS-II and PM-1), decisions on algorithm upgrades, and planning for cal/val activities.

Akira Shibata, NASDA Senior Scientist and AMSR Science Team Leader, presented his view of a Joint Science Team and joint algorithms to be used by NASDA-EORC for processing the standard products: intercomparison of performance of several invited algorithms will be the major factor in choosing an ADEOS-II algorithm, and then minor modifications for that algorithm to be used for EOS PM-1. The main roles for the Joint Science Team are "promoting exchange of scientific information, and stimulating scientists to develop and improve their algorithms." Dr. Shibata also presented photos of the AMSR engineering model being integrated on ADEOS-II and photos of the Airborne Microwave Radiometer (AMR), an airborne radiometer that has all the AMSR channels, but does not scan.

The two issues that came up repeatably were: who will process the standard products for AMSR-E (following the standards, NASDA will do the processing because AMSR-E is a Japanese manufactured instrument) and what are the responsibilities of the Joint Science Team. The answer to the first issue lies with NASDA management. For the second issue, we drafted a charter and a block diagram showing the connections between NASA and NASDA. The draft charter follows: 1)

promote science information exchange; stimulate algorithm development; 2) plan and coordinate validation activities; 3) facilitate development of, and update, the joint science algorithms, and 4) coordinate NASDA/NASA AMSR science related issues: e. g. data formats. The organizational aspects are: 1) co-chair by the two Team leaders; 2) membership (including the Team Leaders): 5 members from NASDA and 8 members from NASA; 3) observers: NASDA/NASA HQ representatives and NASDA/NASA project representatives, and 4) meetings as needed, at least once a year.

Paul Hwang, PM-1 Project, presented the project status: the spacecraft PDR was successfully completed at the end of April, the spacecraft deep-space-view maneuver is continuing, the Interface Control Document (ICD, between the s/c and the ground system) and the Spacecraft Operation Requirement Document are in review, Humidity Sounder from Brazil (HSB) is having a design review, and the ICD between the s/c and AMSR-E is completed. Mr. S. Tanaka will be the new liaison with NASDA and Mr. T. Kurosaki heads the newly formed ADEOS II/EOS PM-1 Project office at NASDA.

For the rest of the afternoon, M. Schwaller and K. Cox of EOSDIS presented AMSR-E network requirements and an overview of ECS metadata content and population. Matt Schwaller showed a rough schedule for AMSR-E network services, with their definition being completed by mid-1999 and installed a year later. Current estimates of requirements are 640 kbps to Japan, and 265 kbps to US; these estimates assume a 2.34x loading factor. Karl Cox reviewed, again, the metadata content and gave some detail of the 'bare bones' vs. the minimum desired vs. mandatory metadata. He also explained how the data providers and consumers, the DAAC, the ECS Science Data Engineering Office, and the ECS developers interact.

At the close of the first day, Robbie Hood, Airborne Microwave Instruments Manager at MSFC, gave a tour of the Atmospheric Research Facility, where Airborne Microwave Precipitation Radiometer (AMPR) and Conically Scanning Two-look Airborne Radiometer (C-STAR) reside.

For the remainder of the meeting, the scientists and the software engineers supporting them had parallel sessions.

Science

The science session consisted of a review of the research status of all US and Japanese scientists, with a short review of the before launch validation plans. Peter Ashcroft, Remote Sensing Systems, presented the status of his work on the data simulator. Two versions of the Level 0 data have been produced: an entire orbit of data using a coarse integration, and a subset of the channels and a fraction of the orbit, using fine integration. All of these data are based on uniform Tbs, or SSM/I derived meteorology.

Frank Wentz, Remote Sensing Systems, showed how his algorithm calculates the four ocean parameters (wind speed, water vapor, cloud water, and sea surface temperature) with much better accuracy when using the AMSR channels vs. the SSM/I simulations or the SSM/I real data.

Chris Kummerow, GSFC, showed some sensitivity studies of his algorithm to different input data bases (hydrometeor profiles), the performance of the convective/stratiform rain index, and lastly, error estimates due to these input, a-priori data bases.

Dan Redmond, Texas A&M University, Tom Wilheit's student, presented a dual-channel estimation of monthly rainfall using minimum chi-squared estimation parameters.

Don Cavalieri and Joey Comiso presented their studies of sea ice standard products: sea ice concentration, sea ice temperature and snow depth on sea ice. Cavalieri discussed the sea ice concentration and the snow depth on sea ice, and showed the flow diagrams of the algorithms to arrive at the results. He also presented some field data that will be used to verify the performance of the algorithm. Comiso showed the flow diagram for the temperature corrected Bootstrap algorithm and physical sea ice temperature. He then described validation issues (gridding, ocean/land contamination, ocean and land masking, emissivity/polarization effects, etc...) and the desired validation data sets: high resolution satellite images, aircraft field data, and laboratory studies.

Al Chang, GSFC, presented details of his snow water equivalent (SWE) algorithm, and the ancillary data bases needed. He also had details on the snow screening and weather filter needed to compute the SWE.

Eni Njoku (JPL) is responsible for the standard land products: surface soil moisture, vegetation water content and land-surface temperature, and he is planning to calculate five research products (Level 3) 3-day averages of soil moisture, vegetation water content, surface temperature, gridded brightness and surface classification. For validation, Njoku plans to use data from different ecosystems from around the world.

The Japanese scientists, Akira Shibata, F. Nishio and T. Koike, presented the status of their research. Akira Shibata started by giving their definitions of all the standard products: Level 1 to Level 3 and browse products. Shibata also presented the NASDA strategy of selection of PIs for developing the precipitation algorithms for use with the AMSR data. The cases used in the intercomparison project were four instantaneous cases and a monthly-mean case. An algorithm's success will be measured by the correlation coefficients and rms., with G. Petty's skill scores to be also considered.

Fumihiko Nishio discussed the principles and criteria for AMSR algorithm intercomparison for sea ice. The intercomparison will focus on comparing retrieved sea ice extent and concentration (the two NASDA standard products) over the Okhotsk Sea and the Antarctic, the method of tuning the algorithms, and the performance when compared with AVHRR images.

Toshio Koike is responsible for both the land (standard product is soil moisture) and snow products (standard product is the snow water equivalent). Koike introduced the GEWEX (Global Energy and Water Cycle EXperiment) Asian Monsoon Experiment (GAME), a program to understand the role of Asian monsoon in the global energy and water cycle. This program is a comprehensive program including satellites and automatic weather stations, intensive field based regional experiments, modeling studies and data archive and dissemination network.

Software

The primary topics of discussion for the software meeting were the EOSDIS metadata requirements, the software responsibilities of the team members, and the schedule for team member software delivery to the team leader science computing facility. Dawn Conway opened the software meeting with a discussion of the goals for the meeting. The morning session of the June 11 software meeting continued as Karl Cox presented an in-depth look at the EOSDIS metadata components and led a discussion of metadata specifics as applied to the AMSR-E. In conjunction with the discussion, Richard Ullman demonstrated the use of the EOSDIS Web-based tool METADATA_WORKS in defining and developing metadata. The afternoon session was an open question and answer period on metadata, led by Karl Cox. During this session, a preliminary list of AMSR product short and long names was developed.

Dawn Conway led the half-day session on June 12th. Ms. Conway reviewed the proposed software responsibilities document and the team member software delivery schedule. Each attendee received a copy of the document and the schedule. Ms. Conway requested that each software contact review these with her. The document will be made available on the AMSR home page (http://wwwghcc.msfc.nasa.gov/AMSR) when it is finalized.

The next AMSR-E meeting will be a Joint AMSR Science Team meeting, probably taking place the day before the ADEOS II workshop, in Tokyo, Japan, at the end of October.

HTTP://EOSPSO.GSFC.NASA.GOV

What's New!

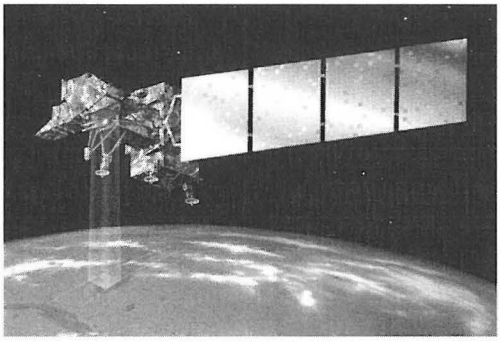
- NASA Airborne Science Program Homepage
- NASA Research Announcement: Satellite Remote Sensing Measurement Accuracy, Variability, and Validation Studies (NRA-97-MTPE-03).
- The Remote Sensing Tutorial
- Advanced Solid-state Array Spectroradiometer (ASAS) Project

New links to EOS Investigations

- An Investigation of the Coupling Between Tropospheric Ozone, Sulfate Aerosols, and Climate Using a General Circulation Model

Second Landsat Science Team Meeting

—**Darrel Williams** (Darrel.Williams@gsfc.nasa.gov), Landsat-7 Project Scientist, Goddard Space Flight Center



The second Landsat Science Team meeting was held April 15-17, 1997, at the Lockheed Martin Missiles and Space (LMMS) facilities in Valley Forge, Pennsylvania. The meeting was chaired by Landsat Science Team Leader, Samuel Goward (University of Maryland), and Project Scientist, Darrel Williams (GSFC). The 49 attendees included delegates from all 14 science investigations, as well as representatives from NASA HQ, the NASA Landsat Project Office, and the NOAA Landsat Commercialization Office.

The meeting commenced with a status report on the Landsat project by Phil Sabelhaus, the Landsat Project Manager. At that time, Sabelhaus reported that the project remained on schedule for a late May 1998 launch despite some lingering problems with the ETM+ instrument delivery from the Hughes SBRS fabrication facility. These problems included some bad wiring harnesses and faulty power supplies, both of which resulted in unacceptable noise levels, primarily in the 15-m panchromatic band. Since the Science Team meeting, additional problems associated with scan mirror start-up have also been encountered. The net result is that delivery of the instrument to the LMMS plant is not expected until mid-October, making it nearly impossible to meet a late May launch date. In a recent development, NASA and the Air Force have agreed to swap their respective Delta launch dates at Vandenberg AFB next year. Landsat-7 is now slated for a mid-July launch. On a more positive note, Sabelhaus stated that initial tests at SBRS indicated that noise levels for the seven spectral bands meet requirements and are significantly lower than those of Landsat-6.

Art Azarbarzin and Robert Menrad (NASA GSFC) presented overviews of spacecraft integration and ground system status, respectively. The Landsat-7 spacecraft is currently being assembled at the LMMS plant in Valley Forge. Spacecraft integration and test activities were proceeding smoothly, with power and electrical systems being checked out at the time of the meeting. The solid-state recorder was in the final stages of integration, although minor performance issues remained unresolved. After lunch, the meeting attendees were given a guided tour of the LMMS integration facilities for both Landsat-7 and the EOS AM-1 spacecraft.

The Landsat-7 ground system consists of a Command and Control Group, including the Mission Operations Center (MOC) at NASA GSFC, and a Data Processing Group, including the Landsat Processing System (LPS), a Level-1 Product Generation System (LPGS), and an Image Assessment System (IAS). The LPS, LPGS, and IAS will be located at the EROS Data Center (EDC) in Sioux Falls, South Dakota, along with the primary X-band receiving station. Hardware installation at EDC is proceeding on-schedule (the X-band antenna was installed in mid-May), and all ground system software development tasks are proceeding smoothly. R.J. Thompson presented a summary of activities at the EDC DAAC, which will be responsible for archiving and distributing Landsat-7 data, while Daniel Devito gave a status report on the EOS Data and Information System (EOSDIS) project. Current plans call for the EOSDIS Core System (ECS) to support management and distribution of Level 0R data at launch (Release B.0), with retrieval of fixed WRS-scene subsets. Floating scene and band subsetting and distribution of Level 1 products will be supported by Release B.1 approximately 7 months after launch. To provide additional schedule contingency, EOSDIS project management has authorized funding for an "Emergency" Landsat backup archive and limited distribution system.

Jim Ellickson of the NOAA Landsat Commercialization Office presented a preview of NOAA Mission Operations, which will be transferred to NOAA from NASA 90 days after launch. Ellickson stated that although NOAA has responsibility for long-term Landsat operations, no money has been allocated to NOAA's budget by OMB/Congress for that purpose. As a result, NOAA's current plans call for making up the operational budget from a license fee levied on each International Ground Station (IGS). A number of Science Team members expressed concern that: (1) Landsat operations were, in effect, being jeopardized by placing funding of day-to-day operations at the whim of IGS participation in the program, and (2) by placing a hefty acquisition fee on the IGSs, they might be less likely to willingly participate in assisting the U.S. in creating and refreshing a seasonal, global archive. Team Leader Goward took an action item to write a letter expressing these concerns to key administrators at NASA, NOAA, and USGS. [NOTE: This letter was sent, and the issues summarized in the letter are actively being worked by representatives of all three agencies.]

Terry Arvidson (Lockheed Martin) and Samuel Goward discussed acquisition strategies and limitations for the ETM+ sensor. Arvidson pointed out that the on-board Solid-State Recorder has a capacity of ~100 scenes. Depending on the number of daily opportunities for direct downlink to U.S. ground stations, the number and spatial distribution of possible acquisitions may be limited during certain Worldwide Reference System (WRS) orbits, but we can still meet the Level-1 requirement of acquiring 250 scenes per day. Goward presented plans for a Long-term Acquisition Plan (LTAP), designed to optimize coverage for global change and land-use/land-cover change studies. The LTAP seeks to incorporate vegetation phenology, cloud cover climatology, and gain sensitivity into an algorithmic acquisition strategy that can be used to optimize Landsat-7 operations.

On the second day, the team heard a briefing by Project Scientist Darrel Williams on preliminary ideas for a Landsat-7 follow-on mission. Williams indicated that thermal infrared (TIR) coverage in future Landsat sensors was doubtful, since accommodation of TIR capability significantly increases sensor development costs, mid-morning orbits are not ideal for making thermal measurements, and the Landsat TIR Band 6 data have been the least used. Williams further stated, however, that the improved 60-m single TIR band on the Landsat-7 ETM+, and the multispectral, 90-m TIR data to be acquired by ASTER, would create a larger user community and demand for TIR data. He suggested that a stand-alone TIR sensor, placed in a more ideal early afternoon orbit, should be seriously considered. However, during last year's first wave of New Millennium Project (NMP) proposals, it was determined that there was no new technology yet available that would substantially reduce the cost of building such a TIR sensor. Following the presentation by Williams, additional ideas for next-generation imagers were presented by Steve Ungar, Mission Scientist for the NMP Earth Orbiter-1 (EO-1) mission. When launched in 1999, EO-1 will test innovative ideas in high-resolution, broad-area-coverage and low-cost hyperspectral imaging.

Following status briefings on individual science investigations, the Science Team meeting concluded with reports from two working groups which had initially met the afternoon prior to the Team meeting. The first working group addressed the need for a Landsat-7 Science Plan, recommending that it be released in stages during the next several years. The group also edited and ratified the Science Team charter. The second working group addressed ETM+ performance and calibration. The group expressed concern that schedule pressures were compromising the robustness of calibration tests and made several recommendations to modify or reinstate calibration tests to insure the scientific quality of Landsat-7 data. Williams subsequently presented these concerns to Landsat Project management, and mutual agreements were reached on the instrument test schedule during the remainder of the development and integration phases of the Project.

The next Landsat Science Team meeting is scheduled for October 21-23, 1997, at, or near, Goddard Space Flight Center in Greenbelt, Maryland.

More information on the Landsat Science Team is available through the Team WWW page: http://www.geog.umd.edu/landsat7. Mail may be directed to Science Team Leader: Sam Goward at sg21@umail.umd.edu; a "cc" copy to Darrel Williams, Landsat Project Scientist, would also be appreciated at Darrel.Williams@gsfc.nasa.gov.

High Spatial Resolution Airborne Multispectral Thermal Infrared Data to Support Analysis and Modeling Tasks in EOS IDS Project ATLANTA

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Background

Project ATLANTA (ATlanta Land-use ANalysis: Temperature and Air-quality) as a newly-funded NASA EOS Interdisciplinary Science (IDS) investigation in 1996, seeks to observe, measure, model, and analyze how the rapid growth of the Atlanta, Georgia, metropolitan area since the early 1970s has impacted the region's climate and air quality. The primary objectives for this research effort are: 1) to investigate and model the relationship between Atlanta urban growth, land-cover change, and the development of the urban heat-island phenomenon through time at nested spatial scales from local to regional; 2) to investigate and model the relationship between Atlanta urban growth and land-cover change on air quality through time at nested spatial scales from local to regional; and 3) to model the overall effects of urban development on surface energy budget characteristics across the Atlanta urban landscape through time at nested spatial scales from local to regional. Our key goal is to derive a better scientific understanding of how land-cover changes associated with urbanization in the Atlanta area, principally in transforming forest lands to urban land covers through time, has, and will, affect local and regional climate, surface energy flux, and air quality characteristics. Allied with this goal is the prospect that the results from this research can be applied by urban planners, environmental managers, and other decision-makers, in determining how urbanization has impacted the climate and overall environment of the Atlanta area. It is our intent to make the results available from this investigation to help facilitate measures that can be applied to mitigate climatological or air quality degradation, or to design alternative measures to sustain or improve the overall urban environment in the future.

Project ATLANTA is a multidisciplinary research endeavor and enlists the expertise of 8 investigators: Dale Quattrochi (PI) (NASA/Global Hydrology and Climate Center); Jeffrey Luvall (NASA/Global Hydrology and Climate Center); C.P. Lo (University of Georgia); Stanley Kidder (Colorado State University); Haider Taha (Lawrence Berkeley National Laboratory); Robert Bornstein (San Jose State University); Kevin Gallo (NOAA/NESDIS); and Robert Gillies (Utah State University).

Atlanta Urban Growth and Effects on Climate and Air Quality

In the last half of the 20th century, Atlanta, Georgia, has risen as the premier commercial, industrial, and transportation urban area of the southeastern United States. The rapid growth of the Atlanta area, particularly within the last 25 years, has made Atlanta one of the fastest growing metropolitan areas in the United States. The population of the Atlanta metropolitan area increased 27% between 1970 and 1980, and 33% between 1980-1990 (Research Atlanta, Inc. 1993). Concomitant with this high rate of population growth, has been an explosive growth in retail, industrial, commercial, and transportation services within the Atlanta region. This has resulted in tremendous land-cover-change dynamics within the metropolitan region, wherein urbanization has consumed vast acreages of land adjacent to the city proper and has pushed the rural/urban fringe farther and farther away from the original Atlanta urban core. An enor-

mous transition of land from forest and agriculture to urban land uses has occurred in the Atlanta area in the last 25 years, along with subsequent changes in the land-atmosphere energy balance relationships.

Air quality has degenerated over the Atlanta area, particularly in regard to elevations in ozone and emissions of volatile organic compounds (VOCs), as indicated by results from the Southern Oxidants Study (SOS), which has focused a major effort on measuring and quantifying the air quality over the Atlanta metropolitan region. SOS modeling simulations for Atlanta using U.S. Environmental Protection Agency (EPA) State Implementation Plan guidelines suggest that a 90% decrease in nitrogen oxide emissions, one of the key elements in ozone production, will be required to bring Atlanta into attainment with the present ozone standard (SOS 1995).

Project ATLANTA Science Approach

The scientific approach we are using in relating land-cover changes to modifications in the local and regional climate and in air quality, is predicated on the analysis of remote sensing data in conjunction with *in situ* data (e.g., meteorological measurements) that are employed to initialize local- and regional-level numerical models of land-atmosphere interactions. Remote sensing data form the basis for quantifying how land covers have changed within the Atlanta metropolitan area through time from the mid-1970s, when Atlanta's dramatic growth began in earnest, to the present. These remotely sensed data will be used to provide input to numerical models that relate land-cover change through time with surface energy flux and meteorological parameters to derive temporal models of how land cover changes have impacted both the climatology and the air quality over the Atlanta region. Current remote sensing data (i.e., data obtained during 1997) will be used to calibrate the models and as baseline data for extending the models to predict how prospective future land cover changes will affect the local and regional climate and air quality over the Atlanta-north Georgia region. Additionally, remote sensing will be used as an indirect modeling method to describe urbanization and deforestation parameters that can be used to assess, as well as predict, the effects of land use changes on the local microclimate.

In concert with the remote sensing-based analysis and modeling of land-cover changes is an extensive numerically-based modeling effort to better understand the cause-and-effect relationships between urbanization and trends in climatology and air quality. Sophisticated numerical meteorological models can complement extensive field monitoring projects and help improve our understanding of these relationships and the evolution of the urban climate on a location-specific basis. Measured data alone cannot resolve the relationships between the many causes of urban heat islands/urban climates and observations. For example, measured data cannot directly attribute a certain fraction of temperature rise to a certain modification in land-use patterns, change in energy consumption, or release of anthropogenic heat into the atmosphere. These are aspects that numerical modeling can help resolve. Similarly, monitored air quality data cannot be used to establish a direct cause-and-effect relationship between emission sources, activities, or urbanization and observed air quality (e.g., smog). In this sense, photochemical models can be used in testing the sensitivity of ozone concentrations to changes in various land-use components, emission modifications and control, or other strategies. Thus, we are incorporating an assessment of land-cover/land-use change, as measured from remote sensing data, with temporal numerical modeling simulations to better understand the effects that the growth of Atlanta has had on local and regional climate characteristics and air quality.

ATLAS Data: Role and Characteristics

To augment the quantitative measurements of land-cover change and land-surface thermal characteristics derived from satellite data (i.e, Landsat MSS and TM data for assessment of land-cover change; Landsat TM thermal, and AVHRR and GOES data for land-surface thermal characteristics), we are employing high-spatial-resolution airborne multispectral thermal data to provide detailed measurements of thermal energy fluxes that occur for specific surfaces (e.g., pavements, buildings) across the Atlanta urban landscape, and the changes in thermal energy response for these surfaces between day and night. This information is critical to resolving the underlying surface responses that lead to development of local- and regional-scale urban climate processes, such as the urban heat island phenomenon and related characteristics (Quattrochi and Ridd 1994, 1997). These aircraft data will also be used to develop a functional classification of the thermal attributes of the Atlanta metropolitan area to better understand the energy budget linkages between the urban surface and

the boundary layer atmosphere. This will be performed using the Thermal Response Number (TRN) (Luvall and Holbo 1989; Luvall 1997) that is expressed as

$$TRN = \frac{\sum_{t1}^{t2} R_n \Delta t}{\Delta T} \quad (1)$$

where R_n is total net radiation and ΔT the change in surface temperature for time period t_1 to t_2.

Because urban landscapes are very complex in composition, the partitioning of energy budget terms depends on surface type. In natural landscapes, the partitioning is dependent on canopy biomass, leaf area index, aerodynamic roughness, and moisture status, all of which are influenced by the development stage of the ecosystem. In urban landscapes, however, the distribution of artificial or altered surfaces substantially modifies the surface energy budget. Thus, one key component of Project ATLANTA is to measure and model surface energy responses in both space and time, to better understand the processes-responses of urban climate and air quality interactions across the Atlanta metropolitan area.

The airborne sensor used to acquire high-spatial-resolution multispectral thermal infrared data over Atlanta is the Advanced Thermal and Land Applications Sensor (ATLAS), which is flown onboard a Lear 23 jet aircraft operated by the NASA Stennis Space Center. The ATLAS is a 15-channel multispectral scanner that basically incorporates the bandwidths of the Landsat TM (along with several additional channels) and 6 thermal IR channels similar to those available on the airborne Thermal Infrared Multispectral Scanner (TIMS) sensor (Table 1). Of particular importance to the Atlanta study is the multispectral thermal IR capability of the ATLAS instrument. ATLAS thermal IR data, collected at a very high spatial resolution, have been used to study urban surface energy responses in a previous study over the Huntsville, Alabama, metropolitan area with excellent results (Lo et al. 1997).

Table 1.

Channel Number	Bandwidth Limits (μm)	NER mW/cm^2 μm^{-1}	NEΔT °C	MTF@ 2 mrad	Cooling
1	0.45-0.52	<0.008	N/A	0.5	Ambient
2	0.52-0.60	<0.004	N/A	0.5	Ambient
3	0.60-0.63	<0.006	N/A	0.5	Ambient
4	0.63-0.69	<0.004	N/A	0.5	Ambient
5	0.69-0.76	<0.004	N/A	0.5	Ambient
6	0.76-0.90	<0.005	N/A	0.5	Ambient
7	1.55-1.75	<0.05	N/A	0.5	77K
8	2.08-2.35	<0.05	N/A	0.5	77K
9	3.35-4.20	N/A	<0.3	0.5	77K
10	8.20-8.60	N/A	<0.2	0.5	77K
11	8.60-9.00	N/A	<0.2	0.5	77K
12	9.00-9.40	N/A	<0.2	0.5	77K
13	9.60-10.2	N/A	<0.2	0.5	77K
14	10.2-11.2	N/A	<0.2	0.5	77K
15	11.2-12.2	N/A	<0.3	0.5	77K

ATLAS Data Collection

ATLAS data were collected over a 48 x 48 km^2 area, centered on the Atlanta Central Business District (CBD) on May 11 and 12, 1997. An early May data acquisition window was selected to facilitate the collection of ATLAS data during the spring when the vegetation canopy was filled out, surface temperatures were high enough to permit substantial heating of the urban landscape, and there was a high probability that cool fronts would still be moving through the Atlanta area to permit clear skies, as opposed to later in the spring or summer when increased cloud cover or convective storms become limiting factors in obtaining aircraft data. ATLAS data were collected at a 10-m pixel spatial resolution during the daytime, between approximately 11:00 a.m. and 3:00 p.m. local time (Eastern Daylight Time) to capture the highest incidence of solar radiation across the city landscape around solar noon. ATLAS 10-m data were also obtained the following morning (May 12) between 2:00-4:00 a.m. local time (Eastern Daylight Time) to measure the Atlanta urban surface during the coolest time of the diurnal energy cycle. Eleven flight lines were required to cover the 48 x 48 km^2 area at a 10-m spatial resolution. To permit the derivation of TRN values, all 11 daytime flight lines were flown and then repeated later at about a 2-hour interval. Nighttime overflights were not repeated because of the relative invariance in thermal energy fluxes at night, which obviated the need to calculate TRNs.

Sky conditions at the time of the

daytime overflights were mostly clear with some cirrus clouds present. The Lear jet aircraft flew at an altitude of 5,063 m above mean terrain to achieve a 10-m pixel resolution which was well below the cirrus clouds. Cirrus clouds covered the entire Atlanta metropolitan area during the night flights. The presence of cirrus cloud cover at night did, to some extent, dampen the cooling effect of thermal energy release to a clear sky, but air temperatures were still sufficiently cool to provide ample difference with daytime heating. Maximum air temperatures during the daytime overflights were approximately 25° C, while air temperature during the nighttime flights was around 10° C. Sample surface temperatures for tree-shaded grass, tree canopy, and asphalt in full sunlight recorded with a hand-held infrared thermometer (8-14 μm) during the afternoon were 28° C, 21° C, and 50° C, respectively. Daytime temperatures for a commercial building roof composed of rock/membrane coating ranged from 49° to 52° C. This illustrates that although air temperatures were cooler than optimal for development of the urban heat island effect, there was still significant heating by artificial urban surfaces to permit good contrast with nighttime cooling.

Atmospheric radiance must be accounted for in order to obtain calibrated surface temperatures. Although the ATLAS thermal channels fall within the atmospheric window for atmospheric longwave transmittance (8.0-13.0 μm), the maximum transmittance is only about 80%. The amount of atmospheric radiance in the atmospheric window is mostly dependent on the atmospheric water vapor content, although there is an ozone absorption band around 9.5 μm. To assist in obtaining accurate thermal surface energy response measurements from the ATLAS data, radiosonde launches were made concurrently with both the daytime and nighttime overflights. The atmospheric profiles obtained from these radiosonde data are then incorporated into the MODTRAN3 model for calculation of atmospheric radiance (Berk et al. 1989). The output from MODTRAN3 is combined with calibrated ATLAS spectral response curves and blackbody information recorded during the flight, using the Earth Resources Laboratory Applications Software (ELAS) module TRADE (Thermal Radiant Temperature) (Graham et al. 1986), to produce a look-up table for pixel temperatures as a function of ATLAS values (Anderson 1992).

One pyranometer and one pyrgeometer were also stationed on a rooftop within one of the aircraft flight lines for use in measuring incoming shortwave and longwave radiation within the study area. Additionally, two shadowband radiometers were placed in strategic locations within the flight path for use in measuring shortwave visible radiation for determining visibility parameters for input into MODTRAN3. The output from MODTRAN3 is combined with calibrated ATLAS spectral response curves and onboard calibration lamp information recorded during the flight in TRADE to produce calibrated at-sensor radiance for the visible wavelengths.

ATLAS Data: Some Examples

Approximately 5 Gb of raw (unprocessed) ATLAS data were collected during the May 11-12 aircraft overflights. In addition to the digital ATLAS data, color infrared aerial photography at 1:32,000 scale was obtained during a daytime mission. Figure 1 illustrates daytime thermal (channel 13 - 9.60-10.2 μm) ATLAS data collected over the Atlanta CBD area. Figure 2 provides an example of ATLAS data (channel 13) acquired during the night over the Atlanta CBD. Both images are oriented with north at the top. Excluding the effects of the highly variable emissivities of urban building materials, an empirical observation of the images presented in Figures 1 and 2 illustrates the wide range of thermal energy responses present across the Atlanta city landscape, as well as the detail that can be discerned from the 10-m data. The Georgia Dome, an enclosed football stadium, appears as the large square-shaped structure due west of the Atlanta city center. Interstate highways 75/85, which traverse in a north-south direction around the city center, are seen as a dark "ribbon" on the day data (Figure 1) just to the east of downtown Atlanta. Just south of the city center, is the junction of Interstate Highways 75/85 and 20. Shadows from tall buildings located in the Atlanta city center can also be observed in the daytime data. In Figure 1, the intense thermal energy responses from buildings, pavements, and other surfaces typical of the urban landscape, as well as the heterogeneous distribution of these responses, stand in significant contrast to the relative "flatness" of Atlanta thermal landscape at night (Figure 2). Also, the damping effect that the urban forest has on upwelling thermal energy responses is evident, particularly in the upper right side of the daytime image where residential tree canopy is extensive. In Figure 2, there is still evidence, even in

Figure 1 (top left)
ATLAS daytime thermal image (channel 13— 9.60-10.2 μm) of the Atlanta central business district area. These data have not been geometrically or atmospherically corrected.

Figure 2 (bottom right)
ATLAS nighttime thermal image (channel 13— 9.60-10.2 μm) of the Atlanta central business district area. These data have not been geometrically or atmospherically corrected.

the very early morning, of elevated thermal energy responses from buildings and other surfaces in the Atlanta CBD and from streets and highways. It appears that thermal energy responses for vegetation across the image are relatively uniform at night, regardless of vegetative type (e.g., grass, trees).

ATLAS Data Analysis: The Next Steps

From the images in Figures 1 and 2, it is apparent that high-resolution ATLAS data offer a unique opportunity to measure, analyze, and model the state and dynamics of thermal energy responses across the Atlanta metropolitan landscape. In addition to deriving energy balance measurements for day and night, and TRN values for specific urban surfaces to better understand the thermal characteristics that drive the development of the urban heat island phenomena and the overall Atlanta urban climate, these multispectral ATLAS data also exist as a database record of current land cover/land use conditions for the Atlanta metropolitan area. Along with the extensive meteorological data available via a network of mesonet stations that are currently operating across the Atlanta area, the ATLAS data will be used to initialize and calibrate the meteorological and air quality models that will be run for the time period when the airborne data were collected. Moreover, one of the key facets from Project

ATLANTA is to work with local planning agencies, such as the Atlanta Regional Commission (ARC), to model how the continued growth of Atlanta will impact the climate and air quality of the north Georgia region. The ARC is currently developing a 20-year growth plan for a 10-county area around Atlanta. Using the ATLAS data obtained in May 1997 as a baseline for land cover/land use, our objective is to perform some "prospective" modeling on how meteorological conditions and air quality will change, predicated on the ARC's 20-year plan. By doing so, we hope to provide the ARC and other planning or decision-making bodies, with model output that can be used to modify or revise growth plans for the Atlanta metropolitan area, and to help mitigate or ameliorate the expansion of the urban heat island effect or the further deterioration in air quality.

Research updates and results from analysis of the ATLAS data collected over Atlanta will be posted on the Project ATLANTA Web Page, which can be accessed via the Global Hydrology and Climate Center Home Page at http://wwwghcc.msfc.nasa.gov. Additionally, progress and results from other aspects of Project ATLANTA research tasks, such as the planned acquisition of MODIS Airborne Simulator (MAS) data this August, temporal land use/land cover change detection for the Atlanta area as analyzed from Landsat MSS, TM, and AVHRR data, and mesoscale meteorological and air quality model output for different time slices between 1973 and the present, will also be posted on the Web Page.

References

Anderson, J.E., 1992: Determination of water surface temperature based on the use of thermal infrared multispectral scanner data. *Geocarto International*, **3**, 3-8.

Berk, A., L.S. Bernstein, and D.C. Robertson., 1989: MODTRAN: *A Moderate Resolution Model for Lowtran 7*. U.S. Air Force Geophysics Laboratory, Environmental Research Papers GL-TR-89-0122, Hanscom Air Force Base, MA, 37 pp.

Graham, M.H., B.G. Junkin, M.T. Kalcic, R.W. Pearson, and B.R. Seyfarth, 1986: *ELAS - Earth resources laboratory applications software. Revised Jan.1986*. NASA/NSTL/ERL Report No. 183.

Lo, C.P., D.A. Quattrochi, and J.C. Luvall, 1997: Application of high-resolution thermal infrared remote sensing and GIS to assess the urban heat island effect. *International Journal of Remote Sensing*, **18**, 287-304.

Luvall, J.C., and H.R. Holbo, 1989: Measurements of short-term thermal responses of coniferous forest canopies using thermal scanner data. *Remote Sensing of Environment*, **27**, 1-10.

Luvall, J.C., 1997: The use of remotely sensed surface temperatures from an aircraft-based thermal infrared multispectral scanner (TIMS) to estimate the spatial and temporal variability of latent heat fluxes and thermal response numbers from a white pine (*Pinus strobus L.*) plantation. In *Scale in Remote Sensing and GIS*, D.A. Quattrochi and M.F. Goodchild, eds. CRC/Lewis Publishers, Boca Raton, FL, pp.169-185.

Quattrochi, D.A. and M.K. Ridd, 1994: Measurement and analysis of thermal energy responses from discrete urban surfaces using remote sensing data. *International Journal of Remote Sensing*, **15**,1991-2022.

Quattrochi, D.A. and M.K. Ridd, 1997: Analysis of vegetation within a semi-arid urban environment using high spatial resolution airborne thermal infrared remote sensing data. *Atmospheric Environment* (in press).

Research Atlanta, Inc., 1993: *The Dynamics of Change: An Analysis of Growth in Metropolitan Atlanta over the Past Two Decades*. Policy Research Center, Georgia State University, Atlanta.

SOS, 1995. *The State of the Southern Oxidants Study: Policy-Relevant Findings in Ozone Pollution Research 1988-1994*. Southern Oxidants Study, Raleigh, NC, 94 pp.

New Format Highlights Land Processes Distributed Active Archive Center (LPDAAC) Science Advisory Panel Meeting

—**G. Bryan Bailey** (gbbailey@edcserver1.cr.usgs.gov), Earth Resources Observation System (EROS) Data Center, U.S. Geological Survey, Sioux Falls, South Dakota

Recognizing the growing importance of effective and timely interaction between the DAACs and the Instrument Teams they primarily support, the Land Processes DAAC Science Advisory Panel implemented a new meeting format for its April 1997 meeting. The Panel held its regular meeting at the USGS EROS Data Center (EDC) on April 23 and 24, but that two-day meeting was preceded by a one-day meeting devoted to addressing topics and issues of importance to the DAAC's support of and interaction with the ASTER, MODIS, and Landsat-7 Instrument Teams. That meeting, dubbed "Instrument Team Day," consisted of a morning plenary session where "across instrument" topics were discussed and afternoon concurrent sessions where instrument-specific topics were addressed.

Attendance at Instrument Team Day was optional for Panel members not associated with one of the three instrument teams. Panel members attending the meeting were Chris Justice (Panel Co-Chair and MODIS rep.), Darrel Williams (Landsat-7 rep.), Simon Hook (ASTER alt. rep.), Bryan Bailey (Panel Co-Chair), and Tom Kalvelage (DAAC Sys. Eng.). Also attending were several other MODIS Team associates, numerous LPDAAC staff, as well as staff from NASA HQ, the Earth Science Data and Information System (ESDIS) Project, and the Earth Observing System Data and Information System (EOSDIS) Core System (ECS) Contractor.

The plenary session included presentations by DAAC Manager Lyn Oleson on the status and plans for AM-1 and Landsat-7 operations at the LPDAAC, overviews by Instrument Team representatives on their team's Emergency Back-up Plans, and a summary of the activities and plans of the Science Working Group for the AM Platform (SWAMP) Ground Control Point (GCP) Working Group by LPDAAC Scientist, Bryan Bailey.

Oleson presented a chart of the key release B milestones for the Pre-release B Testbed, B.0, and B.1. He then summarized the status of activities as it relates specifically to the Pre-release B Testbed and to B.0. Oleson also pointed out certain B.0 functional limitations. He closed his presentation by noting both some positive aspects about the way things are going and some remaining concerns the DAAC has with Release B plans. In their summaries of Emergency Back-up Plans that have been developed, each team emphasized the need to ensure that acquired data are saved and maintained for later processing, while at the same time providing enough processing throughput to meet instrument team calibration and system and product verification requirements. Also, each instrument team would like to have an assortment of data and product samples easily accessible for use by the general user community shortly after launch. In each case, the Emergency Back-up Plan described reflects a mere shadow of the full-up production and distribution plans intended for MODIS, ASTER, and Landsat-7 data.

Bryan Bailey reported that the SWAMP GCP Working Group has defined a consolidated strategy for minimizing duplication of effort while providing GCPs needed to meet the geometric calibration requirements of ASTER, MODIS, MISR, and Landsat-7. Specific areas where GCPs will be established have been identified, as have most of the source data and information required for base imagery and positional information.

The Working Group will meet at EDC in June to finish as much of the remaining work as possible and to work on a final report/proposal that will recommend a course of action for getting the required GCPs produced.

Concurrent Instrument Team/DAAC staff meetings were held in the afternoon of Instrument Team Day. Later in the afternoon, the groups returned to a plenary session at which time the instrument team representatives to the Science Advisory Panel reported on the discussions and results of their specific session.

Simon Hook reported on the ASTER session. He noted that cooperation with the DAAC has been excellent and that there are no particular areas of major concern. Hook reviewed the status of various activities being carried out in cooperation with the DAAC, including the expedited data (Level 1) processing capability that will be at the DAAC; the ASTER Digital Elevation Model (DEM) standard data product software procurement; Quality Assurance (QA) plans and procedures; and Version 1 Science Software Integration and Test (SSI&T).

Darrel Williams reported that much of the Landsat-7 session addressed concerns about lack of progress on interagency agreements needed to ensure success of the Landsat-7 Program. An action to draft a letter expressing these concerns and providing appropriate recommendations was taken by the group. Other issues addressed were Level 1 QA and recent policy decisions that would severely limit access to Level 1 data by the general science user community.

Chris Justice reported that the spirited discussions which characterized the MODIS session resulted in significant progress being made. He noted that the LPDAAC has been frustrated with the lack of information they receive from MODIS and others, and MODIS is frustrated from the lack of attention they feel they are getting from the LPDAAC. Several actions were taken to improve cooperation and progress on various fronts. Also discussed were a variety of QA topics and issues. Actions were taken to better define QA procedures, roles, and responsibilities.

Attending the regular meeting of the LPDAAC Science Advisory Panel held on April 23 and 24 were panel members Dave Skole, Jim Merchant, Darrel Williams, Diane Evans, Chris Justice, Simon Hook, Tom Kalvelage, and Bryan Bailey, as well as participants and interested observers from EDC, NASA, the MODIS Instrument Team, and ECS. Panel Co-Chairman, Chris Justice, opened the meeting by noting the change in format of the meeting and focus of the agenda, as it relates to the emphasis being placed on areas where the DAAC believes it most needs the advice and counsel of the Panel.

Agenda item number one was to review the status of actions items from the November 1996 Panel meeting. The DAAC had distributed status summaries of action items not included on the current meeting agenda as separate discussion topics, and these summaries facilitated and expedited discussion. Notable among the discussions were those related to an action for the DAAC to write a status report on high-speed-network user models. The DAAC reported on its activities with DOD, the MODIS Science Team, and others relating to high-speed network development. However, a much clearer understanding is needed about EOSDIS-wide progress in network development. The Panel expressed concern that important network links between DAACs and between the DAACs and the users will not be sufficient to carry expected volumes of data at the necessary high transfer rates. Additional actions aimed at determining the network outlook and promoting progress in development were assigned by the Panel.

DAAC Manager, Lyn Oleson, led a discussion on assessing the LPDAAC user community needs, particularly as they relate to implications for the EOS AM-1 time frame. In its efforts to reconcile user community demands on the system with anticipated system resources and capacities, the DAAC will be developing end-to-end product generation and distribution scenarios on a product-by-product basis using product information compiled by the DAAC and the results of a user survey. Oleson also reported on current expectations regarding Version 0 systems and data in the post-launch time frame.

Tom Holm, EDC Program Manager for the National Satellite Land Remote Sensing Data Archive, presented a summary of Landsat data production at the EROS Data Center, particularly by the National Landsat Archive Production System (NLAPS). Landsat data production is not a DAAC activity, currently, but it is

of interest to the Panel because the DAAC will have Landsat-7 product generation and distribution responsibilities. It also is of interest because of requirements by users for inexpensive access to existing Landsat data.

John Dwyer reported on progress and plans being made toward ensuring DAAC User Services preparedness for the AM-1 time frame. He reviewed staffing plans, as well as current activities that DAAC User Services staff are involved with, including Version 0 data distribution, outreach activities, and participation in the EOSDIS User Services Working Group. Dwyer provided Panel members with copies of tabulated results from the recent LPDAAC User Services Survey.

Lyn Oleson presented an assessment of ECS readiness for AM-1 and Landsat-7 launches. He showed a master milestone chart that placed key milestones for testbed, B.0, B.1, and emergency back-up activities in context with the projected launches. He also commented on data ingest, data processing, and data distribution readiness. Concerns noted by Oleson included the facts that some production and distribution systems will be shared between instruments, and that measurements used in system allocation may not be applicable in practice due to requirements variations. Capacity is a big concern, he said, and the next step is to check the numbers various people are using to get a better handle on how close projected capacities will come to meeting identified requirements. Oleson told the Panel the DAAC will need their recommendations, as well as those of the Instrument Teams, in establishing priorities related to user categorization and data distribution.

A segment of the two-day LPDAAC Science Advisory Panel meeting was devoted to hearing reports from representatives of the Instrument Teams concerning the discussions and results of the concurrent Instrument Team meetings held one day earlier on "Instrument Team Day." Also presented was other relevant Instrument Team related information. Simon Hook summarized ASTER's science software delivery schedule, and he reviewed current validation plans. ASTER was delivered to Valley Forge some time ago. Chris Justice reported that the MODIS instrument had just completed thermal vacuum tests, and that progress was being made in the areas of software development, integration, and test. Specific important S/W milestones were cited by Justice, as were certain concerns. For example, Justice believes the B.0 LPDAAC system is significantly undersized and that MODIS needs increased support from the DAAC in a number of specific areas. He recommended that the DAAC implement a prototype operational L3 land cover product generation activity using 1-km AVHRR data. Darrel Williams reviewed the development status of both the Landsat ETM+ and the spacecraft. Instrument delays could force a launch delay. The Image Assessment System (IAS) completed a successful Critical Design Review (CDR) on April 8, and a Level-1 Product Generation System has been approved and is on a fast track development course for on-time delivery.

Vanessa Griffin provided a summary of the sequence and activities of various EOSDIS review panels that have operated over the past two years. She also overviewed the activities that NASA has undertaken in response to recommendations provided by the various panels. Griffin talked about the EOSDIS transition and the recertification process of the DAACs, and she reported that the Federation has been established.

The first day of the meeting concluded with a discussion session where Panel members raised issues of concern to them and offered recommendations to the DAAC. There was much discussion about future data sets, particularly as it relates to prioritization, capacity, and roles and responsibilities. Several Panel members expressed concern that work is being taken on by the DAAC when staffing and other resources already are burdened. The Panel encouraged the DAAC to pay particular attention to appropriate balance in preparation of next year's work plan.

The second day of the meeting began with John Daucsavage, Land Processes DAAC ECS Engineering Liaison, taking Panel members and others on a tour of the new DAAC computer floor. Daucsavage explained the functions of, and provided other information about, the various new ECS-purchased hardware that recently has been installed at the DAAC.

In response to a previous action item, R.J. Thompson reported on the DAAC's plans for managing future NASA data sets, such as Smallsat Technology Initiative (SSTI) data, Shuttle Radar Topography Mission (SRTM) data, LightSAR data, and others. Those plans require

additional clarification pending a meeting with NASA HQ staff scheduled for June. The fundamental issues involved relate to availability of funds to archive and distribute these future data and to potential impacts on other important DAAC requirements.

Lyn Oleson led a discussion of the "DAAC Activities Overview," which had been sent to Panel members prior to the meeting. That overview summarized highlights of DAAC operations and development activities during the past six months, and it provided a good lead-in to discussion of the DAAC's work plan for the final six months of FY 1997. In that regard, Oleson noted the DAAC's highest priority objectives for the remainder of the year in the areas of user assistance and outreach, data distribution, mission support, and engineering and development. The issue of data pricing policy again surfaced during these discussions in the context of concerns that "free data" may ultimately place prohibitive burdens on the DAACs and reduce service to the science community. Bill North indicated that V0 products, at least, will continue to be distributed "at no cost to the user."

Panel Co-Chairman, Chris Justice, led a wrap-up discussion of the meeting, including identifying issues to be addressed during transition from V0 to V1. He stressed that meeting user needs is critical. He pointed out that the Advisory Panel has a good relationship with the DAAC, which is responsive and committed, but the Panel needs to be more functional and members must be committed to participating in meetings. He commented that the pre-meeting package sent for Panel review worked well, the cross-instrument focus was good, and the Instrument Team Day is worth continuing. He said that while the DAAC at EDC is a good one, the goal is for it to be even better. He noted that there may be differences between what the DAAC would like to do and what it can do. Also, he said that partnerships are important, and they can be both formal and informal. The DAAC needs to view users as partners. He identified Panel priorities for the DAAC as: scoping and readiness; end-to-end operations planning; and user services.

Prior to adjourning, the Panel reviewed and listed its action items and set dates for its next meetings. The next meeting will be at EDC on September 9-11, 1997, and the following meeting will be February 3-5, 1998, probably at a less climatologically challenged site.

NASA Releases First Version Of Online Photo Database

—Brian Dunbar (NASANews@hq.nasa.gov), Headquarters, Washington, DC.

A new online collection of NASA photographs and images provides a single point of entry to various photographic databases of six NASA centers. The NASA Image Exchange (NIX) at: *http://nix.nasa.gov*, provides an umbrella over existing photo databases at the centers, providing better access to photos for NASA personnel and the general public. Search capabilities of NIX include simple searches, complex searches, and browse searches (prebuilt searches on a number of preselected topics). NIX also provides tips to users on searching, copyright information, and a comments section.

The NIX effort, which was spearheaded by NASA's Scientific and Technical Information (STI) Program Office at Langley Research Center, Hampton, VA, is a voluntary association of STI, Public Affairs, Web, photographic, graphic, and library personnel from all 10 NASA centers. The STI Program Office is issuing grants to selected NASA centers for the expansion of the capability of NIX.

Remote Sensing Tutorial

http://code935.gsfc.nasa.gov/Tutorial/TofC/Coverpage.html

This is a comprehensive survey of remote sensing from its inception in the 1840s through the famed pigeon fleet at the end of the last century to present day. "The primary purpose of this Web Site Tutorial is to inform both the professionals and the general public about the principles and the achievements of remote sensing, with emphasis on applications already demonstrated, and to point to the anticipated functions and benefits of the MTPE initiatives. As a secondary but nevertheless important goal, the tutorial is intended to be a learning resource for college students as well as individuals who require some indoctrination in the basics of space-centered remote sensing in support of various organizations....." Authors are Nicholas M. Short, retired from NASA and teaching remote sensing at Bloomsburg University in Pennsylvania, and Jon W. Robinson, Hughes STX Corporation, who has been involved with Landsat data since the launch of Landsat-1 in 1972.

NASA Studies High Altitude Radiation With Upgraded ER-2


NASA ER-2

— **Dwayne Brown** (Phone: 202/358-1726), NASA Headquarters, Washington, DC
— **Michael Finneran** (Phone: 757/864-6124), Langley Research Center, Hampton, VA
— **David Morse** (Phone: 415/604-4724), Ames Research Center, Mountain View, CA

Using an upgraded NASA ER-2 aircraft, researchers at NASA's Langley Research Center, Hampton, VA, have begun a month-long campaign to measure radiation at high altitudes.

This campaign, funded by NASA's High-Speed Research program, is the first of several campaigns that will measure naturally occurring cosmic and solar radiation at altitudes between 52,000 and 70,000 feet.

The data will be used to characterize the radiation environment for the aircrew and frequent-flying public on a future High-Speed Civil Transport. The High-Speed Civil Transport, a conceptual supersonic airliner, would carry 300 passengers at 2.4 times the speed of sound, at altitudes of up to 68,000 feet.

"The broad aim of the Atmospheric Ionizing Radiation ER-2 flight-measurements campaign is to understand the composition, distribution, and intensities of cosmic and solar radiation at commercial supersonic transport-cruise altitudes," said Allen Whitehead, the High-Speed Research Program Environmental Impact Manager.

"Our primary concern is the level of uncertainties in the knowledge of the upper atmosphere's radiation environment and the human body's response to that type of environment," said Dr. John Wilson, the Atmospheric Ionizing Radiation Project Chief Scientist.

"Radiation measurements will be obtained by an array of instruments from the United States, Canada, Germany, United Kingdom, and Italy in a collaborative effort devised by Dr. Wilson," said Donald Maiden, the Atmospheric Ionizing Radiation Project Manager. "The instrument types that make up the array were recommended by the National Council on Radiation Protection in a study sponsored by the High-Speed Research program. The primary thrust is to characterize the atmospheric radiation and to define dose levels at high-altitude flight. A secondary thrust is to develop and validate dosimetric techniques and monitoring devices for protection of the aircrew who work many hours at cruise altitudes," Maiden added.

According to Maiden, "Even though the exposure levels are higher at the higher cruise altitude, the typical flying public will actually receive less radiation exposure than on today's subsonic transports because of the higher speed of the High-Speed Civil Transport. This is another advantage for speed."

The flight program is a collaborative effort with the Department of Energy's Environmental Measurements Laboratory; NASA's Johnson Space Center; the Canadian Defense Research Establishment and Royal Military College; the German Aerospace Research Establishment; the United Kingdom's National Radiation Protection Board; the Boeing Company; and several domestic and foreign university guest investigators.

Recent modifications to the NASA ER-2, sponsored by NASA's Mission to Planet Earth program, increased its altitude capabilities, allowing it to reach easily those altitudes where the High-Speed Civil Transport will fly. The NASA ER-2 is based at NASA's Ames Research Center, Mountain View, CA.

Tropical Rainfall Measuring Mission Set for October 31 Launch

—**Douglas Isbell** (Phone: 202/358-1753), NASA HQ, Washington, DC
—**Allen Kenitzer** (Phone: 301/286-2806), Goddard Space Flight Center, Greenbelt, MD.
—**Yasuyuki Fukumuro** (Phone: 81-3-3438-6107), National Space Development Agency of Japan, Tokyo.

NASA and the National Space Development Agency of Japan (NASDA) have set October 31 at 3:40 p.m. EST (Nov. 1, 1997, 5:40 a.m., JST) as the official launch date for the Tropical Rainfall Measuring Mission (TRMM).

The first Earth science satellite dedicated to studying the properties of tropical and subtropical rainfall, the Tropical Rainfall Measuring Mission (TRMM) carries microwave and visible/infrared sensors, and the first spaceborne rain radar. Tropical rainfall comprises more than two-thirds of global rainfall and is the primary distributor of heat through the circulation of the atmosphere. More-precise information about this rainfall and its variability is crucial to understanding and predicting global climate change.

"We're very excited about this major opportunity for cooperation with Japan, which is NASA's largest international partner in Earth science," said William Townsend, Acting Associate Administrator for NASA's Mission to Planet Earth enterprise, Washington, DC. "The Tropical Rainfall Measuring Mission has great potential to improve scientific understanding of climate processes related to the heat released by tropical rainfall. In turn, this knowledge improves the global atmospheric circulation computer models that are used to make weather and climate forecasts."

NASDA will provide the Precipitation Radar for TRMM and an H-II rocket to launch the observatory on a three-year mission from the Tanegashima Space Center in Japan.

"We are very happy to provide the Precipitation Radar for TRMM and launch this first space mission to measure a driving force of the global atmosphere, tropical rainfall. We hope this U.S.-Japan joint mission provides important data for predicting global climate change and weather anomalies," said Dr. Kazuyoshi Yoshimura, Executive Director of NASDA in Tokyo.

"We will launch TRMM in November, and thereafter we can launch a rocket in each fall season. This is a good opportunity to expand the cooperation between the U.S. and Japan, and we expect a further cooperation in various fields, such as Earth observation satellites, Earth science, and global change research."

NASA's Goddard Space Flight Center in Greenbelt, MD, fabricated the observatory's structure and support systems, integrated and tested the spacecraft and is providing two science instruments. Two other instruments are being provided by NASA's Langley Research Center, Hampton, VA, and by NASA's Marshall Space Flight Center, Huntsville, AL.

Goddard also will operate TRMM via NASA's Tracking and Data Relay Satellite System. NASA and NASDA will share responsibility for science data processing and distribution to the global change research community.

Current knowledge of rainfall is limited, especially over the oceans. By flying in a low-altitude orbit of 217 miles (350 kilometers), TRMM's complement of state-of-the-art instruments will provide extremely accurate measurements of the distribution and variability of tropical rain and lightning, and the balance of solar radiation absorbed and reflected by Earth's atmosphere.

Extensive prelaunch testing of TRMM was completed recently, and the observatory currently is undergoing final preparations for its shipment to the Japanese launch site in late August.

The TRMM launch window opens at 5:40 a.m. JST on Nov. 1, with an approximate two-hour launch window daily for a 40-day period. TRMM's companion payload on the H-II rocket will be Engineering Test Satellite-7, a Japanese robotics experiment.

ACTES—An Associate of Arts in Community Colleges for Training in Earth Science

— Excerpts from an article by **J. W. Skiles** (jskiles@mail.arc.nasa.gov), Ames Research Center, in the electronic newsletter "Education Program Update," Nahid Khazenie (nkhazeni@pop100.gsfc.nasa.gov), Managing Editor, MTPE Education Program

ACTES is a project funded by NASA Headquarters Office of Human Resources and Education and Office of Mission to Planet Earth. The objectives of the project, now in its second year, include the development of a teaching laboratory, a curriculum, transferable classes using remote sensing, technical reading and writing, an occupational certificate based on specified courses, and dissemination of the materials by publicly accessible techniques.

This project has three major goals: 1) implementing remote-sensing data use in a broad range of community college courses; 2) creating curriculum modules and classes that are transportable to other community colleges via the World Wide Web, and 3) establishing a WWW server that will be an ongoing source of data and curriculum materials to other community colleges.

The result of this curriculum will be hands-on learning for students whether they are at a two-year college for an AA degree, retraining to improve their job skills, or taking classes to satisfy requirements for four-year colleges. The expectation is that these students will be able to continue their education in remote sensing / Geographic Information Systems (GIS) at a senior college, move into entry level positions at local companies where remote-sensing and GIS technologies are used, or have valuable skills to append to their resumes.

A sequence of courses has been established at a community college in San Mateo County, California for students wishing to earn an AA degree in this area of expertise. Following are titles of each of the five courses:

- Introduction to Earth Systems Analysis
- Spatial Analysis in Geographic Information
- GPS, GIS and Image Processing
- Remote Sensing Technology and Processing
- Laboratory Practicum.

This course sequence will give students the ability to identify, use, and analyze basic data structures from the point of view of sensor data, data base organization, and data representation. Students will be able to acquire data by a range of techniques including downloading from the Web, use of CD-ROMs, scanners, and satellite-transmitted data. Students will also gain a basic understanding of sensor technology and remote-sensing concepts, and will be able to acquire and use data from remote-sensing sources.

At the completion of the project, colleges throughout the nation will be able to download materials from the ACTES WWW site and use them for their own related course work and programs. These materials will include course outlines, classroom exercises, individual lessons, supporting graphics, and images.

For more information, please contact J. W. Skiles, NASA Ames Research Center, telephone (415) 604-3614, e-mail jskiles@mail.arc.nasa.gov.

EOS Science Calendar

September 9-11	Land Processes DAAC Science Advisory Panel, EROS Data Center, Sioux Falls, SD. Contact G. Bryan Bailey, e-mail: gbbailey@edcserver1.cr.usgs.gov.
September 16-18	CERES Science Team Meeting, Oregon State University, Corvallis. Contact Gary Gibson, e-mail: g.g.gibson @larc.nasa.gov.
October 13-14	Jason-1 Science Working Team Meeting, Biarritz, France. Contact Yves Menard, CNES, Toulouse, (33 5) 61 27 48 72, e-mail: Yves.Menard@cnes.fr.
October 21-23	Landsat Science Team Meeting, Goddard Space Flight Center. Contact Sam Goward, e-mail: sg21@umail.umd.edu, or Darrel Williams, e-mail: Darrel.Williams@ gsfc.nasa.gov.
October 22-24	MODIS Science Team Meeting, Greenbelt, MD. Contact Bob Kannenberg, e-mail: rkannenb@pop900.gsfc. nasa.gov.
October TBD	AMSR Science Team Meeting, Tokyo, Japan. Contact Elena Lobl, e-mail: elena.lobl@msfc.nasa.gov.
November 4-6	EOS-IWG, Renaissance Atlanta Hotel-Downtown, Atlanta, GA. Contact: Mary Floyd, 301/220-1701, e-mail: mfloyd@pop200.gsfc.nasa.gov.
December 9-12	14th ASTER Science Team Meeting, International Forum, Chiyoda-ku, Tokyo, Japan. Contact H. Tsu, e-mail: tsu@gsj.go.jp, or Anne Kahle, e-mail: anne@aster.jpl.nasa.gov

Global Change Calendar

September 22-26	Conference on Sensors, Systems and Next Generation Satellites III. Call for Papers. Contact Steve Neeck, tel. (301) 286-3017, e-mail: Steve.Neeck@gsfc.nasa.gov
October 13-16	International Conference on Earth Observation & Environmental Information, Alexandria, Egypt. Contact Bashir Saleh, tel. (203) 560-2578, Fax (203) 560-2915, e-mail: ruaafeng@rusys.EG.net, or Nader Nada, tel. (703) 993-1626, Fax (703) 993-3729, e-mail: nnada@osf1.gmu.edu. Internet: http://www.frcu.eun.eg/www/conference/.
October 16-25	Geological Society of America 1997 Annual Meeting, Salt Lake City, UT. Contact GSA Registration Coordinator, e-mail: meetings@geosociety.org or visit the Web site at http://www.geosociety.org.
November 16-19	International GCTE-BAHC-LUCC Workshop under auspices of IGBP and IHOP: Prospects for Coordinated Activities in Core Projects, Wageningen, The Netherlands. Call for Papers. Contact Irene Gosselink, tel. +31 317 475700 or 475731, Fax +31 317 423110, e-mail IGBP97@ab.dlo.nl, URL: http://www.wau.nl/CCB/.
December 1-4	Fourth Asia-Pacific Conference on Multilateral Cooperation in Space Technology and Application. Contact Waheeb Essa Alnaser, tel. +973 688381/683310, Fax +973 683278/688396, e-mail: waheeb@sci.uob.bh. Internet: http://www.uob.bh/.
December 3-5	Land Satellite Information in the Next Decade II: Sources and Applications Conference, Washington, DC. Contact: ASPRS, 5410 Grosvenor Lane, Suite 210, Bethesda, MD 20814-2160. Tel: (301) 493-0290; Fax: (301) 493-0208; e-mail: asprs@asprs.org.
December 8-12	American Geophysical Union, San Francisco, CA. Contact Karol Snyder, tel. (202) 939-3205, Fax: (202) 328-0566, e-mail: exhibits@kosmos.agu.org.
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January 11-16	American Meteorological Society, Phoenix, AZ. Contact AMS Office, tel. (202) 682-9006, Fax: (202) 682-9298, e-mail: ams@dc.ametsoc.org.
January 25-29	Space Technology & Applications International Forum, Albuquerque, NM. Contact Carolyn Marcum, tel. (505) 277-2813, Fax (505) 277-2814, e-mail: cmarcum@unm.edu.
March 25-29	Association of American Geographers, Boston, MA. Contact AAG, tel. (202) 234-1450, Fax (202) 234-2744, e-mail: gaia@aag.org, URL at http://www.aag.org.
March 30-April 4	ASPRS-RTI Annual Convention, Tampa, FL. Contact Dan French, tel. (301) 493-0290, Fax: (301) 493-0208, e-mail: dfrench@asprs.org.
June 8-12	27th International Symposium on Remote Sensing of Environment. Tromso, Norway. Contact 27th International Symposium on Remote Sensing of Environment, Norwegian Space Centre, P.O. Box 113 Skoyen, N-0212 Oslo, Norway. Fax: +47 22 51 18 01, e-mail: isrse@spacecentre.no. Internet: http://www.spacecentre.no/.

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The Earth Observer

The Earth Observer is published by the EOS Project Science Office, Code 900, NASA Goddard Space Flight Center, Greenbelt, Maryland 20771, telephone (301) 286-3411, FAX (301) 286-1738, and is available on the World Wide Web at http://eospso.gsfc.nasa.gov/ or by writing to the above address. Articles, contributions to the meeting calendar, and suggestions are welcomed. Contributions to the Global Change meeting calendar should contain location, person to contact, telephone number, and e-mail address. To subscribe to *The Earth Observer*, or to change your mailing address, please call Lynda Williams at (301) 286-0924, send message to lynda.p.williams.1@gsfc.nasa.gov, or write to the address above.

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