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All EOS AM-1, PM-1, ACRIM, Data Assimilation, LIS, SAGE III, and SeaWinds science teams developed Algorithm Theoretical Basis Documents (ATBDs) that were recently reviewed by peer review panels in November and December 1996, and March 1997. These documents, developed for each data product, consist of a detailed physical and mathematical description of the algorithm, variance or uncertainty estimates, and practical considerations, such as calibration and validation, exception handling, quality assessments, and diagnostics. In addition, seven of these teams have also developed validation plans that describe in considerable detail their pre-launch and post-launch validation activities. Once updates resulting from the written reviews and panel report recommendations are integrated, revised versions of these documents (80 ATBDs and 10 validation plans) will replace the older versions currently residing on the EOS Project Science Office Web site.

This peer review process is extraordinarily valuable to the science teams and engages the larger scientific community, both nationally and internationally, in the process of providing feedback on approaches to routine data reduction from EOS sensors. At present, 12 of the 19 algorithm teams of EOS have gone through at least one of these peer review processes, with the other teams (Jason-1, Chemistry-1, EOSP, and GLAS) to follow at an appropriate point in the future. The Landsat-7 ETM+ does not have any standard data products and hence is unlikely to have any ATBDs developed in the future.

The first biennial review of MTPE is now scheduled to present findings and recommendations to an external review committee chaired by Prof. Pamela Matson on June 2-3, 1997. The purpose of this review is to assess whether the MTPE approach for planning and implementing programs to address its science themes are sound, and to comment on such questions as (i) does MTPE have effective processes for incorporating new scientific and technological advances?, and (ii) how well is MTPE positioning itself to engage in fruitful partnerships with commercial, interagency, and international partners?

In addition, this review will consider (i) implementation strategies and scientific priorities for EOS Chemistry-1, in the broader context of the entire MTPE chemistry program (space-based, *in situ*, validation, and modeling), (ii) ground system architectures for operation of future MTPE/EOS missions after the early release of software needed to support TRMM and EOS AM-1, (iii) justification and appropriate level of support for the MTPE research and analysis program, and (iv) strategies for defining and implementing post-Chemistry-1 missions, such as just-in-time procurements, international partners, interagency priorities, appropriate technologies, etc.

Finally, I am happy to report that MODIS (Moderate Resolution Imaging Spectroradiometer), and MISR (Multi-angle Imaging Spectroadiometer) have been delivered to Lockheed Martin Missiles and Space, King of Prussia, Pennsylvania, for integration on the AM-1 spacecraft. Those instruments join ASTER (Advanced Spaceborne Thermal Emission and Reflection radiometer) and CERES (Clouds and the Earth's Radiant Energy System), bringing the first four of five instruments that will fly on AM-1, scheduled for launch in June 1998.

—Michael King
EOS Senior Project Scientist

Announcing an EOS AM Bulletin Board System

— David Herring (dherring@pop900.gsfc.nasa.gov), EOS AM-1 Science Outreach Coordinator, Goddard Space Flight Center

In order to facilitate better communication and interaction in the EOS community, a Web-based bulletin board system (BBS) was recently established. The URL is http://modarch. gsfc.nasa.gov/EOS-AM. It contains bulletin boards for discussion about "EOS AM Education and Outreach," "EOS Early Science Results," and "EOS AM-1 Calibration Attitude Maneuvers (CAMs)."

The BBS, accessible via your World Wide Web viewer (e.g., Netscape), maintains threaded, ongoing discussions in a central location. The system is intuitive and easy to use—there is a "Help and Hints" section should you have questions. Users may find particularly useful the ability to build hyperlinks to other Web resources into their postings.

There is also a "User Information and System Administration" section whereby users may look up another user's contact information (e.g., e-mail address or phone number), or users may modify their own information (e.g., change password). Numerous names have already been added to the list of users—most EOS Instrument Science Team Members and Interdisciplinary Science Investigators now have login ids and passwords.

Please note that the "Education & Outreach" and "Early Science Results" boards are open for viewing by the general public. However, only those users with login ids and passwords may post information there. Access to the CAM board is limited to select users. Anyone who wishes to get access to the BBS should contact:

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Please access the system and let Herring know what you think. You are encouraged to respond to any of the initial threads of discussion you see there, or start a new one.

Minutes of the Twelfth Mission to Planet Earth/Earth Observing System (MTPE/EOS) Investigators Working Group Meeting

— Renny Greenstone (rgreenst@pop900.gsfc.nasa.gov), Hughes STX

The Investigators Working Group (IWG) of the Mission to Planet Earth/Earth Observing System (MTPE/EOS) met for three days at the Mission Valley Marriott Hotel, San Diego, California—February 25-28, 1997.

Tuesday Morning, February 25

Ghassem Asrar, EOS Program Scientist, opened the meeting with a brief introduction. He said that many of last year's newly selected winners in the competition to be EOS investigators were with us at the meeting, and that this was the first opportunity for many of us to meet them and hear about their work. The focus of this first day's sessions would be on the early MTPE/EOS science, and the following morning (Wednesday) would be the occasion for reviews of programmatics. The afternoon would be set aside for poster presentations by the AM-1 and PM-1 instrument teams and also by the newly selected investigators. The final day's sessions (Thursday) would again be devoted to early MTPE/EOS science along with a special presentation updating alternative plans for the CHEM-1 mission.

Asrar then introduced Mike Mann, NASA's Deputy Associate Administrator for MTPE. Mann gave the *good news* that MTPE is doing much better than is reported by the press. The program funding has been stable throughout the past year. The issues confronting us are changing as we approach the first launch, TRMM, in November of this year. He said that it is good that we now have "real" results from MTPE of the sort to be reported at this meeting. Good scientific results justify support for the program–they keep the program alive.

Mike Freilich (Oregon State University), speaking for himself and Tim Liu (JPL), presented "NASA Scatterometer Measurements of Wind, Land, and Ice: Early Science Results." It was 14 years from the time the NASA Scatterometer (NSCAT) project was approved until the first results came down from the Japanese ADEOS satellite.

Freilich explained that NSCAT gives near-surface *vector* winds over oceans as its primary product. However, it also provides useful information, with better than 10-km resolution, through backscatter over land and ice. The major activity of the science team at this time is in the area of calibration/validation of the data, but he would not be discussing this aspect of the work in this talk. Rather he would devote most of his time to discussing the data products that have already been received and analyzed.

First, he reviewed the chronology of the ADEOS/NSCAT effort, starting with the ADEOS launch on August 17, 1996. The wind observation mode began on September 15; the first data were released to the science team on November 18; and the release of the data to the public occurred on February 24, 1997. Reprocessing of the data is to begin in March 1997, and a second reprocessing will begin in February 1998.

Freilich gave a quick review of the physical principles involved in NSCAT's wind determinations. NSCAT emits Ku band pulses at 14 Ghz. The pulses are scattered from cm-scale waves on the ocean surface with the scattering cross section, σ_0, an increasing function of wind speed. It is also angular dependent, with a maximum in the 0- and 180-degree directions. NSCAT has a 600-km swath coverage on either side of the orbit ground track, with a 300-km gap at nadir between the two swaths. Resolutions of 6-10 km have been achieved over land. A six-day image over Antarctica showed the difference between sea ice and glacier ice.

An interesting application of NSCAT over land was a study conducted during the eruption of a subsurface volcano over Iceland last September. In images on three-day centers the scattering cross section can be seen to increase, then drop, then rise again. All of this imaging was done under conditions of total cloud cover.

NSCAT can also be used to classify vegetation. Jungle areas are known to be isotropic homogeneous scatterers. Data collected for Amazonia were used to distinguish jungle from woodlands, from shrubs, and from grassland.

A comparison of Seasat data with NSCAT data for Amazonia (an 18-year separation between observations) brought out the development of a new reservoir and the presence of new settlement areas.

Freilich showed some examples of ocean wind data. Over the oceans, 25-to-50-km resolutions have been obtained. An image of NSCAT winds brought out the presence of both Typhoons Violet and Tom over the Pacific Ocean. Sequences of images brought out the transition of Typhoon Tom into an extratropical storm.

In a high-resolution mode, where the swath width is reduced to 300 km, but the resolution is increased to 12.5 km, Freilich showed the special advantages offered by NSCAT in an area where there is little conventional coverage. He showed data that had been obtained for South Georgia Island, in the South Atlantic to the east of Argentina, and compared his findings with the analysis provided by the National Centers for Environmental Prediction (NCEP). The NSCAT data showed the winds veering sharply to the left to run parallel to the length of the island (this was missed in the NCEP analysis). Freilich then performed a scale analysis, taking into account the presence of twelve peaks on the island, to show on theoretical grounds, that "upwind shadows" are to be expected with the sort of topography characterizing the island.

In weeks to come, Freilich expects to be providing air/sea-interaction study results. Looking further ahead, he said that SeaWinds on ADEOS II will be going up at the end of the century and will also have available water vapor information from the Japanese Advanced Microwave Scanning Radiometer (AMSR) instrument.

Freilich said that he could benefit from Tropical Atmospheric Ocean (TAO) buoy measurements to assist with NSCAT wind measurements in determining the 3-D wind fields, but that there is no sharp cut-off point as to where the supplementary data would be needed. He also pointed out that wind speed errors increase dramatically at wind speeds below 5 m/sec. (Tim Liu added that wind directions mean little at such low wind speeds.) Another point was that NSCAT wind speeds are significantly more accurate than Seasat winds.

Carl Wunsch (Massachusetts Institute of Technology) described "Science Accomplishments for TOPEX/Poseidon Mission." The mission was launched over four years ago with strong international participation. Areas of improvement to Earth science knowledge have included ocean tides, gravity field, orbit determination techniques, understanding of scattering from rough surfaces, and understanding of ionospheric structure.

Wunsch said that TOPEX/Poseidon is the first true global tide gauge. As a result of the mission, tidal elevations are now known to ~ 1 cm almost everywhere. As another consequence of the mission we now have rapid improvements in determinations of tidal dissipation rates. (Tidal dissipation dominates the evolution of the Earth/moon system, and is responsible for changing the moon's orbital characteristics.)

The TOPEX/Poseidon data allow the determination of global mean sea level variations. We can determine sea level changes at the scale of 2 mm/year. The data confirm a correlation between sea surface temperatures (SST) and sea level changes. The data also make clear that the ocean currents are not well represented by a static picture of the "conveyor belt," as has been described by Broecker.

TOPEX/Poseidon was able to achieve 1-to-2-cm accuracy in determining the shape of the ocean surface, in contrast to the ~10-m accuracy of previous determinations.

In a series of charts, Wunsch showed improvements in determinations of changes in temperature with depth in the oceans, leading to major corrections to model calculations of fresh-water fluxes and heat fluxes. The steps leading to the improvements involved adding in results from acoustic tomography of the oceans, GCMs, NCEP winds, and, finally, the TOPEX/ Poseidon altimetry.

Within about a year, Wunsch said, it will be possible to have estimates of the 3-D time-evolving ocean circulation. It will be possible to calculate fluxes of biochemical constituents such as carbon, methane, and other nutrients.

He concluded his formal presentation by saying that with four years of TOPEX/Poseidon data it has been possible to carry oceanography from the geological era, in which the ocean currents are regarded as moving slabs, to something more like meteorology, in which daily patterns are viewed, and there is a predictive capability.

In answer to a question, he said that a currently available global synthesis of Earth's gravity field uses the best available geoid, and that the importance of the geoid varies on a case-to-case basis. Answering another question, he said that prior calculations using atmospheric residuals to determine oceanic heat fluxes between the equator and the poles are wrong. It may be necessary to achieve 5-km resolution over the oceans to get the right answers.

Charles Keeling (Scripps Institution of Oceanography) presented "Enhanced Plant Growth in the Northern High Latitudes," speaking for himself and Ranga Myneni (Boston University). He had been looking at signs of increased plant growth in the northern high latitudes, which may be related to global warming as the result of the carbon dioxide greenhouse effect. In particular, he has found evidence for advances in the time of the beginning of the growing season of plants in the high latitudes.

Keeling showed the monthly variation of the carbon dioxide cycle in the atmosphere for the period 1957-1995. The amplitude of the seasonal cycle has been increasing and has, in fact, increased by 17% over the past 20 years. He has used vegetation index data from the Pathfinder AVHRR analyses and also the GIMMS data supplied by Jim Tucker of the Goddard Space Flight Center.

One of the problems he has encountered, in looking for trends in the data, has been the apparent change in the calibration of the NOAA-7,-9, and -11 series spacecraft. Also, their equator crossing times have shifted over the years.

There was a comment from the audience that atmospheric interference over forests in northern New England has made vegetation index determinations from that region very difficult.

Pat McCormick (Hampton University) and **P. K. Bhartia** (Goddard Space Flight Center) gave a joint presentation on "Aerosol Measurements from Space: Current State-of-the-Art." McCormick led off with a short tutorial on sizes and characteristics of aerosols in the atmosphere, pointing out that they can be very regional, and that they can have stratospheric lifetimes of about one year.

Aerosol particles can cause changes in the number concentrations of cloud condensation nuclei (CCN) thus leading to smaller cloud particles as revealed, for instance, in the study of ship tracks evidenced in cloud images.

McCormick gave the lineage of the increasingly sophisticated passive spaceborne sensing of aerosols, which began with SAM II on Nimbus-7 (1 aerosol channel), followed by SAGE I on the AEM-2 satellite (4 aerosol channels), and then ending (so far) with SAGE II on the ERBS satellite (7 channels). He then went on to discuss the use of lidar for active sensing of aerosols, referring specifically to the Space Shuttle experiment known as LITE (Lidar in-space Technology Experiment). LITE had 30 nsec pulses and produced a 280-m footprint on the ground from the Shuttle.

It took ten years from starting point to implementation of the LITE Shuttle experiment. LITE used old-technology laser equipment and only functioned in the nadir direction (there was no scanning). Many interesting results were achieved with LITE in the short flight time of the Shuttle. By chance it was possible to detect the eye of Typhoon Melissa. Other observations clearly showed the presence of biomass burning over South America, and aerosol trajectories, from source on downstream, clearly brought out urban pollution plumes.

McCormick said that the recent IPCC report had singled out the low confidence now felt by the scientific community in the aerosol contribution to radiative forcing. He feels that improvements will come through combining lidar measurements with measurements from an oxygen A-band spectrometer (ABS) and also through using measurements from other instruments on board the EOS PM-1 platform. Later on, he feels that even more improvements will come from a complementary instrumented spacecraft that he called PICASSO. It would be ideal to have both passive and active measurements for tropospheric aerosol retrievals.

In the EOS era, SAGE III will be adding a lunar capability to the solar capability now offered by SAGE II for occultation measurements. SAGE III will have an 800-channel linear array.

P. K. Bhartia discussed new techniques for using the TOMS instrument to detect tropospheric aerosols. He said there have now been 18 years of TOMS data, starting in October 1978. In his new method, he uses the difference in absorption between 340 and 380 nm radiances. For the method to work, he must eliminate interfering cloud signals. He demonstrated the method, showing results of tracking the cloud from the Mt. St. Helen's eruption. He is now working to achieve quantitative estimates of the aerosol amounts. This requires determining the aerosol altitude, which he proposes to do by making use of the "Ring" effect. Ultimately, he believes that that there should be a new instrument dedicated to the operational measurements of aerosols and he is working on this. He has used lidar altimetry to confirm his altitude estimates.

V. Ramanathan (Scripps Institution of Oceanography) presented "Past Progress and Future Challenges," speaking for himself and **Bruce Wielicki** (Langley Research Center). Ramanathan gave a little historical perspective, saying that Samuel Pierpont Langley had invented the bolometer and that his measurements had been used by Svante Arrhenius to understand the Earth's radiation budget (ERB). Ramanathan referred to the difficulty posed by the angular-sampling bias in radiative flux determinations from satellites.

In his work, he has been trying to learn the effect of clouds on ERB. He stated that ERBE gave the first quantitative estimate of the net radiative effect of clouds on the radiation budget. ERBE showed that clouds on an annual and diurnal average basis led to a net radiative cooling of about 18 W m^{-2}.

He asked what happens when Top-of-the-Atmosphere (TOA) measurements are combined with surface radiative energy measurements. In more-recent work using surface data collected over the western Pacific warm pool, Ramanathan (in addition to Robert Cess and Francisco Valero) has found a systematic 25 W m^{-2} discrepancy (between models and observations) for the amount of radiative energy reaching the surface. Some groups (Cess *et al* ., Ramanathan *et al.*, Kiehl *et al.*, and Pilewskie and Valero) have suggested that the discrepancy is due to unaccounted-for excess absorption in the atmosphere. He pointed out the very controversial nature of this issue, since many other groups (Stephens, Charlock *et al.*, Arking, King, Ackerman, and others) do not find such a major discrepancy between observations and models.

CERES measurements may settle the issue of "excess" absorption by the atmosphere since it is the first satellite radiation budget experiment that will attempt to combine the TOA radiation budget with the surface radiation budget.

In addition, Ramanathan suggested the need for 3-D radiation modeling, as against plane-parallel modeling, as a way to understand the causes for the model-vs.-observation discrepancy.

Lastly, CERES on TRMM will provide a first look at the diabatic heating (latent plus radiative) in the tropical atmosphere.

Tuesday Afternoon, February 25, 1997

Robert Haskins (JPL) and **Robert Atlas** (GSFC) gave a joint presentation on "Prospects for Improved Weather Forecasts." Haskins opened with a discussion of improvements that may be achieved at the operational centers through improving input data, use of data, and forecast methodology.

He listed the space-based observational requirements and described the contributions to be made by EOS/ AIRS toward improving weather forecasts. He pointed out that HIRS is an "undetermined system." He described the process of "ensemble" forecasting, saying that it works because the largest analyzed errors are observational and are not due to model errors. Ensemble forecasting has added a one-day improvement to the forecast process. He noted that "adaptive/targeted" observations are used to remedy forecast errors.

Atlas dealt particularly with the impact of NSCAT data on improving weather forecasts. He showed a sample of NSCAT-determined winds, which had the effect of correcting errors in locations and wind speeds of cyclones as against analyses conducted without the benefit of NSCAT winds. In the limited sample that has been studied, the improvements due to NSCAT were less significant in the northern hemisphere. Forecast centers that have used ERS-1 winds have shown a small positive impact on forecasts. Atlas said that he sees potential for improvements if wind profiles over the oceans can be obtained.

Eric Barron (Pennsylvania State University) and **Soroosh Sorooshian** (University of Arizona) presented "Assessing the Impacts of Climate on Regional Water Resources." Barron began by pointing out that human impacts are part of the goals of the USGCRP, and therefore the precipitation/hydrological cycles are important. The problem is how to go from global to regional scales that are more meaningful for their human impact.

He is concerned with embedding a mesoscale model in a GCM and has found that downscaling to the regional level does improve the forecast, both for a season and for a decade. In order for the nested-model approach to work, the GCM has to have good large-scale fields. He has found improvements in the precipitation fields but not the geopotential height fields or the zonal winds.

The improved precipitation analyses come from the improved topography and the improved physics in the regional modeling. He has also found that a neural net approach can work for the precipitation analysis. The technique shows promise for river-flow forecasts.

Sorooshian said that scale issues are important for the Colorado River basin. The mountains act as snow-water storage elements. He said that 98.7% of the precipitation in Arizona evaporates, whereas a far lesser amount evaporates over Louisiana. Unfortunately, the NEXRAD radar gives poor storm coverage in the southwestern U.S. because of the mountainous topography.

Sorooshian's group is looking at artificial neural network modeling, working with GOES data to provide a quarter-degree field of precipitation. Then, a stochastic approach can be used to distribute the precipitation at subgrid scale.

Richard Willson (Columbia University) presented "UARS/ACRIM II Results and the Long-term Solar Irradiance Database." He began by saying that sustained Total Solar Irradiance (TSI) changes have altered climate in the past. There is an "inverse" relation between solar activity and climate. Low solar activity has led to climate minima.

He said that an overlap strategy is needed for the satellite measurements in order to relate the TSI results over 100s of years.

He listed some of the relevant missions: UARS was launched in September 1991, and the ACRIM II data quality has been good. NPOESS will be launched in 2009 carrying an ACRIM instrument. SOHO/VIRGO data will be coming in March of this year.

Wilson said that there is always a problem in connecting results from various instruments on various spacecraft. The SMM/ACRIM-1 mission provided the longest period of spaceborne looking at the sun for TSI measurements. The upcoming problem will be the lengthy gap between the end of the EOS series 2 ACRIM II flight and the operation of ACRIM on NPOESS in 2009.

Steve Running (University of Montana) presented "New Applications of Remote Sensing for Wildland Fire Management." He started by saying that about $1 B is spent each year on wildfire suppression in the United States. Wildfire acreage is suddenly taking off. Dry trees don't decompose readily, and therefore about every ten years wildfires clean them up.

In one notable instance about $250 M was spent on halting the Yellowstone Park fires, but they didn't stop the fires—snow did!.

In current practice, fuels in the forests are mapped as a static parameter. Landsat, working with MISR, could give an up-to-date topography and fuels inventory. The instruments on the EOS PM-1 spacecraft will have a relevant "resistance" product. [Peter Mouginis-Mark pointed out that near-real-time fire and volcanic eruption data will both be provided by MODIS.] It was also pointed out that GOES 8 and 9 would provide data every half hour as against the two looks per day that might be had from MODIS.

Yoram Kaufman said that fire *detection* is not too important in the United States. It is really more important to monitor the *growth* of the fires. Reinhard Beer suggested that TES could be used to monitor flame temperatures if that turned to be useful.

Robert Harriss (Director, Science Division, Mission to Planet Earth, NASA Headquarters) presented "Planning the Next Generation U.S. Environmental Observing System." Harriss began by welcoming the new IDS investigators and said that he would be addressing issues of global change and what he called the "sustainability transition."

He stressed the great concern for the world population growth that may lead to 8 to 9 billion people in the next 50 years. The National Academy of Sciences Board on Sustainable Development, headed by Ed Frieman, is looking at the sustainability transition. The Board is to produce a "road map" for science and technology to face the problem. At the same time the national budget for the kind of multidisciplinary research that would address the population problem is shrinking.

There is now a National Environmental Monitoring Initiative with these elements:

- Mid-Atlantic Pilot Study
- National Index Sites
- Environmental Report Card
- Next-Generation Monitoring Strategy

[Interested people can check the world wide web at www. epa.gov/cludygxb.]

Harriss said that we need to move from global science to local/regional scales. Routine monitoring at the federal level costs about $600 M/yr, and yet these programs do not have high productivity—they are not highly policy relevant.

The *Mid-Atlantic Policy Study* inventories all activities related to environmental monitoring with the intention of fusing such activities to make them more efficient.

National Index Sites is a program to provide networks among such governmental programs as the NSF LTER and nongovernmental organizations (NGO) such as the Nature Conservancy. The intent is to get the science community to establish principles for operating integrated measuring sites.

The *Environmental Report Card* will tell the public the status of the environment. It was requested by Vice President Gore to be ready in 2001, and the first draft is due in 18 months. Harriss intends to spend a few thousand dollars with universities to have students prepare examples of the report cards that will lead to the final report.

The *Next–Generation Monitoring Strategy* for the United States will stress the contributions to be made by remote sensing. MTPE will lead the activity. There is a need to assess the activities that are now producing data that go unused. [For further information interested parties can check the world wide web or contact Don Pryor of OSTP: dpryor@ostp.eop.gov]

In the decade ahead there is to be an unusual convergence of issues including: slow productivity growth in the U.S. economy, major structural reform, and knowledge increasingly replacing land, labor, and capital. Also in the decade ahead all major policy issues will be confronted by new budget deficits. The good news is that the annual deficit is down; but the bad news is that the easy deficit reductions have been taken—increased taxes carry over from the Bush administration, and the DoD budget has been reduced probably as far as is likely or practicable.

Harriss asserted that through MTPE/USGCRP science there could be an increase in America's productivity by 1%/yr (or more) over the next ten years. He gave examples of how this increase could be achieved including: 10% from improvements in NCEP 14-day prediction skill; 30% from a shift to precision agriculture; improved energy demand forecasting; and growth of the commercial remote-sensing community, etc.

Wednesday Morning, February 26

Mike Mann (Deputy Associate Administrator for MTPE, NASA Headquarters) presented "MTPE/EOS Program and Project Updates." Mann started by reiterating the MTPE mission and goals, which are to develop understanding of the total Earth system (the mission) and to do so by expanding scientific knowledge of the Earth system; disseminating information about the Earth system; and enabling the productive use of MTPE science and technologies in the public and private sectors (the goals).

MTPE has the problem of translating diverse requirements into an integrated plan. It is driven by the USGCRP scientific requirements. There is an increasing stress on applications. Mann advised looking at the MTPE homepage to see the MTPE science research plan, the commercial strategy, the education strategy, and the program plan. This year's focus is on technology strategy.

Under the heading of "science planning" Mann reported a number of accomplishments and activities underway, including: Volume 1 of the MTPE Science Research Plan with 5 themes (published in September 1996); EOS Science Plan with 7 themes (now underway—needs to be tied to the 5 MTPE themes); a USGCRP 10-year plan underway; and work in progress to integrate EOS science with other MTPE science.

Mann listed the five MTPE science themes:

- Land-cover and land-use change research
- Seasonal-to-interannual variability and prediction
- Natural hazards research and analysis
- Long-term climate change
- Atmospheric ozone

Describing the MTPE program architecture, Mann said that the Earth System Science Pathfinder (ESSP) program is part of MTPE and will continue. It aims to have one low-cost/short-development-time spacecraft launch per year. Regarding *in situ* measurements, he said that there needs to be integration of platforms to include piloted aircraft and uncrewed airborne vehicles (UAV). UAVs are getting new emphasis.

He then discussed the international Earth observing programs. Japan is offering to step up its role. The international partners overall are putting about $4 B directly into the program, with a roughly equal amount in complementary activities, whereas NASA is spending about $7 B.

Changes in MTPE have brought out its increasing relevance and flexibility. The EOS program funding has gone from $17 B in 1990 to $7 B in 1997. We now recompete the IDS teams every three years, and there will be an Announcement of Opportunity (AO) to recompete the instruments for the second EOS series. There is now an aggressive move toward small satellites. The New Millennium Program (NMP) looks toward new technology. After the AM-1 launch the Delta-launched satellites will be the largest class of spacecraft in MTPE/EOS. We are heading toward formation flying. We will have an aggressive scientific research and applications program. New ways of doing business have us heading toward about 3.5- year mission-development times from the current 7-to-8-year pattern.

There has been a technology development transition. MTPE is now responsible for NMP, the Small Satellite Technology Initiative, and the Commercial Remote Sensing Program at the Stennis Space Center. Headquarters Code X has been eliminated, with its responsibility being transferred to the various NASA "enterprises." The "instrument incubator program" carries development through to laboratory or aircraft demonstration of feasibility. An advanced geostationary platform concept has been added to MTPE. As part of the Integrated Global Observing Strategy (IGOS) six pilot projects have been identified for consideration as international efforts.

MTPE has been reviewing recommendations that have come recently from the Earth System Science and Applications Advisory Committee (ESSAAC). There were three recommendations (necessarily paraphrased here) :

1. Regarding EOSDIS, MTPE should devise and

implement a fundamental change in EOSDIS, limiting support to just the scientific and applications communities.

2. Critically assess each mission after PM-1 to ensure its scientific contribution.
3. Concerns with program balance—there is too much emphasis on observations and not enough on scientific analyses.

Mann then showed the proposed MTPE response to the ESSAAC recommendations:

1. Regarding the future missions (beyond PM-1), he started with CHEM-1, and said that it will be difficult to break up the mission because of the specific contractual agreements on the common spacecraft. Nonetheless, the TES and MLS PIs have been asked to do "first-round" analyses of having independent launches. MTPE is asking ESSAAC to review the CHEM-1 science questions and to prioritize the measurements.
2. Regarding changes in EOSDIS/ECS (EOSDIS Core System), Mann said that there are alternatives such as implementing the Federation and having the PIs do more of their own data processing. MTPE will involve the EOS community in discussions concerning alternative strategies and potential changes to requirements. Mann also noted that a recommendation to limit support just to scientists and applications would have to involve a much-larger decision process.
3. On the topic of program balance and the adequacy of science funds, Mann said that the ESSAAC will be asked to review the balance in the Atmospheric Chemistry Plan. This is a natural follow-on to their CHEM-1 effort and would allow a real test of the balance between spacecraft, research and analysis, and *in situ* observations.

Mann described the "Biennial Review" process that is now underway.

There are to be study teams functioning in three phases: Phase 1 has 7 study teams and was to report by the end of February. Phase 2 is to assimilate the results of the 7 teams of Phase 1. Phase 3 will involve a broadly-based external review process to support proposed program changes. IWG members are participants on each of the study teams.

Mann then moved to a review of other MTPE programs.

Thirteen proposals have been received in a second round to participate in ESSP. Selection is due by mid-March, and three awards are to be made in April. There is to be a first launch by March 2000, and one launch per year is planned thereafter. The third selection will be a backup, in case one of the first two selectees falters.

The New Millennium Program (NMP) will focus on land observations, using an advanced land imager (ALI). EO-1 is to be launched in May 1999, and EO-2 is to follow in the spring of 2002.

EOSDIS Federation planning is taking shape. The Earth Science Information Partners (ESIPs) will constitute a "working prototype" of the Federation. The existing DAACs are undergoing a certification process.

Turning to the MTPE budget, Mann said that there is to be a $50 M increase in FY 98. This, coupled with efficiencies implemented during the past year, permits the addition of SeaWinds II to the program. In the "big picture," MTPE is experiencing budget stability, although "earmarks" are having a significant impact. Congress is putting increasing emphasis on near-term applications. We need to step up our Science Outreach to demonstrate the usefulness of MTPE.

At the end of Mann's presentation there were a few comments. Dennis Hartmann said that "science" seems to have a decreasing percentage of the NASA budget. Bob Harriss said that we are losing "enormous" opportunities to be scientifically productive because the NASA grants program is going down; polar research, in particular, is dropping.

There was a question about the MTPE education program, and Ghassem Asrar said that the program has its own budget for the first time. It was suggested that it would be a mistake to cut back on the availability of science data to the public, and Mann replied that we need to know the cost of providing this access.

Mark Abbott (Oregon State University) and **Ed**

Frieman (Scripps Institution of Oceanography) presented, jointly, "National Research Council/NAS: Recent Changes." Frieman, leading off, described the National Academy of Sciences (NAS) Board on Sustainable Development (BSD) and then gave the structure of the National Research Council (NRC). The Policy Division of the NRC includes: GUIRR, COSEPUP, STEP, and the BSD. The BSD was created by request of OSTP head, John Gibbons, as a body that would interface with OSTP and also interface with the President's Council on Sustainable Development. (PCSD).

The BSD is pursuing three overarching studies:

- Sustainability Transition—long-time-scale issues relating to the anticipated world population on the order of 9-to-10 billion people. (George Mitchell who did the "global commons" study is funding much of this effort.)
- Pathways—Berrien Moore is heading this effort, an activity of the Committee on Global Change Research.
- Observations and Sustainability—a CENR activity that is just beginning.

Frieman said that we are now taking advantage of intelligence assets as well as the civil operational systems in these environmental studies. There is a focus on "user pull"—finding out who wants the information. Also, there is a need to identify "Indicators for Sustainability." We want to know how observing systems will contribute to these studies.

Following Frieman, Mark Abbott discussed changes at the NAS. There are now about 23 panels and committees at the NAS looking at matters related to USGCRP. There is an attempt to study interactions between NOAA and NASA that may lead to satisfying the CEOS requirements. Also being reviewed is the slowly evolving interplay between NASA and NOAA in the EOS series-2 development and how this will lead to support of NPOESS. Likewise, the interplay between NASA and NOAA in support of an advanced geostationary platform is under review. It is necessary to maintain harmony between the rapidly developing technology of NASA/EOS and the slowly evolving NOAA operational requirements.

William Chameides (Georgia Institute of Technology) presented "The Yangtze Delta of China: A Case Study of an Evolving Metro-Agro-Plex." (This is the work of a new EOS IDS study, the CHINA-MAP Project, that just received funding seven days before the presentation!) The study overall relates to aspects of world food production, NO_x emissions, and SO_x sources.

Chameides said that there is a strong correlation between industrial activity and food production. Air pollution is more than an urban problem. Pollution from urban areas is known to waft over food production areas. The presence of NO_x and NO_y is diagnostic of ozone production.

The biggest increase in pollution is expected to occur in East Asia, notably China. China is the world's most populous nation and is also the most rapidly developing. China's coal production will have doubled by the year 2010. They plan to move 500 million people from farms to urban areas! At this time China has adequate food production for its people, but they need to increase their grain supplies at the rate of 1%/year for the next 30 years. Unfortunately, pollution could have the effect of reducing their crop yields by the same amount.

Chameides listed some key issues that need to be addressed in his study: land-use change; SO_x and NO_x emissions as they lead to acid deposition; ground-level ozone; and climate change.

Rick Obenschain (Goddard Space Flight Center) gave the final formal presentation of the day. (The afternoon was set aside for viewing posters from the EOS instrument teams and the new IDS teams.) Obenschain's presentation was entitled "EOS Data and Information System Update."

Obenschain first described the functions of the administrative office, Earth Science Data and Information System, at Goddard, and described the "contents" of EOSDIS. He said that his presentation would focus on cost control, future directions for the EOSDIS Core System (ECS), long-term maintenance of cost containment, and Project-specific implementation. As part of a discussion of ECS "Replan and Implementation" he started with an overview. The transfer of TRMM responsibility from ECS to the DAACs has enabled reallocation of part of the Hughes staff to a focus on Landsat-7/AM-1/SAGE III. A stop-work order on TRMM had been issued on December 27 to Hughes, thus releasing 40 people. He noted that a major problem for ECS has been the high turnover rate for the people involved.

The Replan has two releases: B.0 for early mission instrument and algorithm calibration, and B.1 for full product generation and search and access capability. Development under the replan is proceeding apace to meet the mission schedules. A pre-Release B testbed will be available in mid-May, and a demonstration of critical Release B functions is scheduled for August 1997. A "points system" is now used to track the contractor's progress. About $5 M was transferred from ECS to provide TRMM operational capability.

Dave Glover (Woods Hole Oceanographic Institution) gave a brief response on behalf of the Data (EOSDIS) Panel, which had met just a few weeks earlier in Boulder, Colorado. Glover listed EOSDIS issues as: backup plans (they would be meeting with the SWAMP team on this); metadata (they plan a series of workshops on this); and the ESSAAC recommendations.

Glover said that the metadata issue is one source of tension between algorithm producers and database creators. There is disagreement on the number of metadata items required. The first workshop on this subject will try to establish B.0/B.1 metadata needs.

The Data Panel is concerned with the fundamental changes sought by the ESSAAC. They do not like the idea of assigning additional data responsibilities to the instrument PIs. The Panel has defined long-range goals for EOSDIS in the period following AM-1 and PM-1. Glover suggested that the Congress might not be happy with a data system that was available just to about 1000 NASA-related scientists.

There was general discussion after the short presentation by Glover. Hartmann asked whether there was still a desire for one-stop shopping, and if so, what is the cost? He urged that we still want data interoperability.

Eric Barron asked about the sustainability of EOSDIS once the system is fully underway. What would the required staffing be for continuous operations? Obenschain replied that the operations staffing plans have been significantly reduced. Barron wondered whether the ESSAAC estimate of about 1600 people working at ECS was correct, and Obenschain said that he now sees the continuing need for just 100's of people for operations, including the DAACs and ECS.

Mike Freilich commented that the best understood system is the one we have now, and asked whether we can assign the costs appropriately now. Obenschain replied that individual requirements are supported by many elements of the system and that it is still not possible to trace individual requirements to cost. Mike Mann added that $1 B has already been spent to date, with $1 B to go, and that $600 M of this has already been committed. Thus the concern now is how best to spend the remaining $400 M.

Skip Reber stated that the Data Panel is trying to establish a first cut at EOSDIS as it will be after release B. He asked for feedback from the IWG on what is needed and noted that we still need to have the 250 standard data products. Harriss said that the ESSAAC thinks, wrongly, that we're inventing a new data system. The ESIPs have been given $12 M as an experiment to see how a system run by scientists might operate. This seems to be inadequate funding.

Obenschain said that to assure the functioning of the system, the B.0 release has to be ready by June 23, and a demonstration will be underway by the end of August. He also said that back-up plans are being considered right now. In answer to another question, Obenschain said that the data server is the "tall pole." "If it slips we lose our contingency."

Asrar urged that the PIs get involved directly in problem solving, rather than have a chain in which ESDIS works with ECS and then with the PIs. Freilich said that the problems should be stated directly, and then the scientists would respond.

Mark Abbott said that the system has to be organized so that when things break they have minimal damage effects. Timely delivery of products is the key to outside support. Obenschain's concern was that having a "B.0'" system with only limited output could hurt the program.

Jeff Dozier pointed out the underlying issue, that today's concerns are not new but, that what is new, is that now we have a *crisis*. We need to think about getting out of "management by crisis." He asked what we are doing to address the crisis concerns? He thought we ought to consider the cost of setting too high a reliability goal.

Wielicki questioned whether we are taking too big a step in trying to go beyond the V0 system. He asked whether it was true that V0 meets our requirements right now.

Dozier said that what we have now is a geographically dispersed system, but it is not a "distributed" system. The PIs can take care of their own parts of the system with the certainty that there will be "screwups," but also with the certainty that *not everything* will go wrong.

Barkstrom asked whether there are any concepts or criteria as to when to go to a true distributed system. Obenschain replied that somewhere in the period, August to September, there should be a decision. Mike Mann said a decision should be made earlier.

This session ended with Mark Abbott saying that in all this discussion there is an implicit issue: that there is always just *one* path into the data system. In fact, there could be multiple paths to get to the data—open back doors, shadow systems, ...

Thursday, February 27, 1997

John Hrastar (Deputy Director, MTPE Program Office, Goddard Space Flight Center) substituted for Robert Price, presenting "EOS Chemistry-1 Internal Study Results." He noted that the CHEM-1 mission costs are projected to run to something like $700 M. There had been a CHEM-1 study in February-to-May of 1996 to see if there could be a 50% reduction in mission costs. As part of this study several alternative mission configurations were reviewed. Then in May-to-June of 1996 an Implementation Assessment found that there should not be any changes in the instruments, but there were reasonable options for splitting up the instruments among spacecraft.

The Project has been exploring the possibility of developing a $40 M spacecraft to be the CHEM platform. A way of doing this has been to set up cooperative agreements with industry on a 50% cost-sharing basis. Final results of this process are due in November. (This same approach is also to be used to explore platform possibilities for the laser altimetry mission.)

So far, eight contractors have participated in the cooperative study. They have offered possibilities of having new designs, using existing communications buses, and using existing Earth-imaging buses. The conclusion of this effort is that industry can provide the necessary class of medium satellites. The biggest cost drivers have been shown to include such elements as single fault tolerance (for a five-year lifetime) and labor costs. As the spacecraft get smaller the instrument costs tend to dominate the mission costs. A positive result of the study has been the establishment of a very good technology/cost database.

The current baseline is the common spacecraft to be supplied by TRW, but a mixed fleet is still a good option. The TES and MLS PIs have been asked to do a quick study of adopting the "PI Mode" for their own instruments.

At this time a December 2002 launch of CHEM-1 on the common spacecraft remains the baseline. It appears to be the best choice, based on the economics. There is a problem, however, with the cost of launch vehicles. Still, a decision on this is not needed until next year.

Richard Holdaway of the UK warned that the Europeans are worried about the US uncertainties of how missions are to be carried out. Hrastar replied that we *are* on track for the common spacecraft. Mike Mann said that we'll be "locked in" on our decision by this summer.

Daniel Jacob (Harvard University) presented "Latest Progress and Future Plans for Tropospheric Chemistry." He said that he was representing a new tropospheric chemistry interdisciplinary science investigation (IDS), which addresses the heart of environmental science and policy. Tropospheric chemistry is very important in terms of its consequences for climate, but also very uncertain. Regional differences are very important because of the short lifetimes of airborne pollutants and their inhomogeneous sources. It is important to resolve their coupling with weather phenomena on synoptic scales, and there are very complicated feedbacks that must be considered.

In the new IDS study the plan is to put all relevant chemistry into a GCM, but focusing on O_3 and SO_4. Jacob described the chemical reactions leading to the formation of OH, the "cleansing agent" of the atmosphere, and added that the cycling of NO_x is essential to maintaining the OH concentration. It is understood that transport of NO_x from the stratosphere is of little importance. So far, NO measurements have come from aircraft flights, which offer very limited coverage. TES from EOS will be the preferred source of tropospheric ozone measurements and the precursor gases.

Fossil fuel combustion plus biomass burning are the sources of about 70% of NO_x emissions. The measurements of HNO_3 and "PAN" are still poor. There is a question as to whether acetone is the source of HO_x in the upper troposphere.

Anthropogenic processes are the major source of sulfate aerosol formation. The conversion of SO_2 to H_2SO_4 takes place primarily in clouds. There is a big microphysical issue as to whether the conversion leads to the formation of new cloud particles or whether there is just condensation on existing particles.

Harvard's Chemical Transport Model (CTM) includes transport from the GISS GCM. Currently, the model lacks feedback from chemistry to meteorology, but this IDS investigation will be looking at feedbacks between chemistry and climate. Operational versions of the model are expected to be available by May, and then it will be possible to evaluate model results against observations. Heterogeneous chemistry in clouds will be modeled. There is a major problem in accounting for rainfall scavenging of aerosols.

Jack Fishman (Langley Research Center) presented "Progress on Measuring Tropospheric Ozone from TOMS/SAGE and Other Satellite Data." He said that tropospheric ozone is increasing worldwide, but not uniformly. The amount of increase depends on season and locale. He has been able to identify enhancements, which he can attribute to biomass burning and transport, in the total ozone measurements from TOMS for 1985 and 1986. He has also found tropical ozone enhancements over the mid-Atlantic, which he has been able to relate to biomass burning in Africa. He noted that some work by Anne Thompson (GSFC) has shown that clouds affect the ozone retrievals so that actual enhancements may be less than previously calculated by about five Dobson units. An interesting study result was the ability to follow a mass of ozone-polluted air as it moved from the northeast around a Bermuda high over the ocean and then back to the southeast.

Fishman believes that a geostationary platform would be ideal to capture the heterogeneity in time and space of the world's tropospheric ozone. He envisions an instrument that would measure carbon monoxide, nitrogen dioxide, and sulfur dioxide, as well as tropospheric ozone, all from a communications satellite on geostationary orbit. The measurements would have 0.5-to-2.5-km resolution and could be made every 15-to-20 minutes.

Brian Toon (Ames Research Center) presented "Aerosol and Climate Interactions." (He was reporting on a new EOS IDS project.) He gave three reasons as to "why aerosols matter":

- they provide forcing to the climate system, but with large error bars;
- they affect atmospheric chemistry through heterogeneous reactions; and
- at least 10% of incoming solar photons interact with aerosols.

The large error bars associated with aerosol forcing relate to the short lifetimes that rule out the use of climatological data in modeling their effects. There is also the problem of specifying correctly the aerosol characteristics such as size distribution and shapes.

Toon emphasized that dust makes up a type of aerosol that is more important than sulfate aerosol for climate effects. Dust optical properties are widely varying, and they can have regional effects that are as great as those due to cloud forcing in the infrared. Among direct effects of aerosols on climate, uncertainties arise due to: (i) imprecise knowledge of aerosol optical depths, especially over land; (ii) changes in aerosol properties as they move away from their source region; and (iii) insufficient comparisons between model results and observations.

Toon discussed the "Twomey effect" (named after Sean Twomey). The effect relates to the phenomenon wherein, as aerosol concentrations increase, cloud droplet concentrations increase and droplet size decreases, leading to increases in cloud albedo. This is of interest because aerosol particles can serve as cloud condensation nuclei (CCN), thus leading to changes in cloud droplet concentrations. Other aerosol-related phenomena cited by Toon were these: (i) stratus cloud heights change over time as CCN are depleted; (ii) cirrus cloud characteristics show only a slight dependence on the presence of aerosol particles; (iii) in the presence of soot particles, cirrus clouds increase in area and optical depth; and (iv) clouds are sensitive to the abundance of CCN at low concentrations of CCN.

Toon reported successful modeling of the El Chichón and Mt. Pinatubo volcanic eruptions. The model results show, for example, the observed spread of the Mt. Pinatubo aerosol cloud into the southern hemisphere. Attempts to model dust events over the Persian Gulf have shown the need for high-resolution calculations.

Jim Hansen (Goddard Institute for Space Studies) presented "Forcing and Chaos in Interannual to Decadal Climate Change." (As an aside he noted that students in the GISS "outreach" program have been involved in testing the climate model by comparing it with climatological data and data for the study period, 1979 to 1996.)

His principal conclusions are that there is a clear indication in the data of a climate response to both natural and anthropogenic forcing, and that unforced atmospheric variability (chaos) is the principal source of change. Global annual mean temperature is strongly driven by radiative forcings, but on the average, about 3/4 of local variability is chaotic on the 17-year period of investigation.

In his modeling the oceans are represented by time-varying sea-surface temperatures (SSTs) and fixed sea ice. In assessing his atmospheric model, he found that the lower stratosphere was not well represented, and the forcing of the oceans by the atmosphere is deficient. In intercomparisons, he found that his model is "more or less" state of the art. Climate forcing from tropospheric aerosols was not included in the model.

Hansen credited the SAGE instrument with giving invaluable ozone profile information in the crucial tropopause region, but stated that verification is still needed, as well as data at lower levels.

In computing net forcing he took into account stratospheric aerosols, ozone, greenhouse gases, and solar irradiance. He has found that the net forcing in the study period was less than 1/2 W m^{-2}. Vegetation changes were not included in the 1979-96 study period, but a sensitivity study using preindustrial vegetation showed that anthropogenic land use causes a global forcing of about -0.4 W m^{-2}. Significant impacts on temperature occur in the regions of vegetation change.

In listing findings, he said that ozone changes and stratospheric aerosols have large demonstrable impacts on atmospheric temperature. Also, he has found evidence for a disequilibrium in the planetary radiation balance, presumably due to greenhouse gases added to the atmosphere prior to the study period.

Norman Miller (Lawrence Livermore Laboratory) presented "Coupling Global Climate Models to Regional Hydrometeorological Models." (Miller is another one of the new IDS PIs, collaborating with Jenwin Kim.) His work is greatly concerned with establishing soil moisture feedbacks. He has a "homogeneity algorithm" that converts fine-resolution imagery to coarse resolution. He uses multiple process models to determine impacts and make assessments of the effects of climate changes. As part of his regional work he has been able to match simulated precipitation with observed precipitation for northern and central California. He has found that his models do a good job on soil moisture simulations. Looking at the Russian River basin, he has found that his models are successful in simulating the river flow.

Some of his work is related to Eastern Asia hydroclimatologic research. There the goal is to understand the impacts of global climate variability on the hydrological climate, on the ecosystems, and on agriculture. For this work he uses 60-km topography, but then does "model nesting" down to 20 km, working with six-hour updates.

Cynthia Rosenzweig (Goddard Institute for Space Studies) presented "Assessing the Impacts of Climate on Regional and Global Agriculture." Hers is another of the new EOS IDS projects. Her study deals with the impacts of climate on agriculture and related areas such as ecosystems and fisheries. Her study objectives include providing a coordinated framework to assess and predict climate impacts of large-scale fluctuations in important food-producing systems around the world; improving forecasts of climate changes; and investigating means of mitigating the negative impacts of climate variability.

She started her talk by calling attention to improvements that are soon to be coming in predictions of ENSO events.

Two important concepts to keep in mind are these: 1) There is a "user pull" for information on climate impacts from farmers and related interests such as the industries that deal with fertilizers, storage, and processing, and also the consumers; 2) There is a need for improved communications on data and research activities among scientists who come from many different fields.

Rosenzweig's project has links to NOAA and to the International Research Institute for Climate Prediction. Her team makes use of Cane's work on ENSO forecasting, Rind's GCM studies, and Tucker's remote sensing of vegetation change. Study tasks include: test predictions vs. historical studies; develop near-real-time prediction tools; and test mitigation strategies.

Study regions for the project include the U.S. cornbelt, Northeast Brazil, Mercosur, and Zimbabwe. (There is also interest in Southern Brazil, Uruguay, and Argentina.) These regions are chosen for their differing vulnerabilities to climate change.

Scales of analysis, both spatial and temporal, have to be taken into account. Usefulness of information can be dependent in different ways on spatial scales that range from pixel size to GCM scales. Daily and weekly temporal scales affect crops in different ways. Rainfall timing is especially important to crop development.

The project has conducted experiments with GCM ensemble runs. There have been experiments using *global* observed SSTs, others using tropical Pacific observed SSTs, and others using Cane-Zebiak-predicted SSTs.

Tucker's work has identified a correlation between NDVI and SST anomalies (looking at the period 1982 to 1990). A strong correlation has been found between El Niño temperatures and rainfall effects on corn yield in Zimbabwe.

Anthony Michaels (University of Southern California) presented "Climate Variability and Insured Risk: What is the Value of Remote Sensing to the Global Insurance/Reinsurance Industry." Michaels focused on what he called the Risk Prediction Initiative (RPI), saying that the impetus for the Initiative was the big losses incurred by insurers in 1992, the year of Hurricane Andrew. His work is in the area of trying to bring scientific knowledge into the risk calculations of the insurers.

Michaels gave some interesting insights about the functioning of the catastrophic insurance organizations. In their risk considerations, the catastrophic insurers assume that there will be only two major events per year. A loss of $100 B is regarded as the canonical loss. The total capital of the entire insurance industry is only $250 B.

Jim Yoder (NASA Headquarters) presented "Early Results from the OCTS Mission." OCTS is the Ocean Color and Temperature Scanner and is now operating on board the ADEOS spacecraft along with POLDER.

Yoder gave a brief listing of related missions and instruments: NSCAT (on ADEOS) is providing ocean surface winds; AVHRR Pathfinder is providing SSTs; POLDER provides aerosols plus global ocean chlorophyll (started in November 1996); and SeaWiFS (projected to be launched in 1997) will provide global high-resolution chlorophyll measurements.

Yoder explained that the usefulness of ocean color lies in the fact that chlorophyll reflects green light, and thus its signal can be used to estimate plant life in the ocean, ocean productivity, and nutrient uptake. The key remote-sensing problem is that atmospheric corrections are needed since 90% of the signal reaching the satellite comes from the atmosphere.

Yoder listed some of the characteristics of POLDER and OCTS. POLDER has 8-km spatial resolution whereas OCTS has ~1-km resolution. He also noted that there has been a 10-year data gap from the last satellite-based ocean color measurements until now.

POLDER and OCTS are now still in their calibration/ validation (cal/val) stage. The SeaWiFS and MODIS science teams are assisting with cal/val for both POLDER and OCTS. They use buoys for this support activity. Global products from the two instruments should be available by the summer or fall of this year.

Yoder wryly pointed out that SeaWiFS activities have now gone on for ten years with the first flight yet to come. The SIMBIOS project has been formed by NASA to provide for the smooth merging of data from the sensors previously mentioned plus future sensors that may come along. Also, a new coordinating committee has been set up to provide an agreed Internet program for ocean color with the intent of reducing redundancy.

Ghassem Asrar (NASA Headquarters) presented "Direct Broadcast of EOS Data." He reviewed some of the technical aspects of direct broadcast (DB), saying, however, that DB is lagging behind other aspects of the EOS program. On AM-1 only MODIS will have the DB capability, whereas on PM-1 all the instruments will have the capability. Landsat's capability will be more like Direct Downlink, in that it will require pointing.

Peter Mouginis-Mark, University of Hawaii, has adopted a DB receiving system that should be widely usable because of its relatively low cost. A 5-m programmable tracking antenna is used along with special software to process the downlinked data. The U of H antenna costs about $650 K, including the dish, the pedestal, and ingest capability. It is estimated that about 100 users of the system will be in place around the world. There will be a planning meeting on April 14-17 at the University of Hawaii.

A comment from the audience was that the system can handle 150 Mb/s. Also, to save money it would be possible to go to a 3-m dish that would still be adequate to receive the MODIS signal, and then the system cost would be about $450 K. Operating costs would be about $100 K/yr.

With this final presentation the meeting was adjourned.

China Dimensions World Wide Web Site

— Mitchell Hobish, mkh@sciential.com

CIESIN and its Socioeconomic Data and Applications Center (SEDAC) are pleased to announce on-line availability of the China Dimensions World Wide Web site. This site offers access to a unique data collection that has been designed to facilitate a wide range of natural science and socioeconomic research and educational activities. It enables both researchers and the general public to obtain accurate and timely information on the world's most populous country. The China Dimensions URL is:

http://plue.sedac.ciesin.org/china

Highlights of the China Dimensions WWW site include the following data resources:

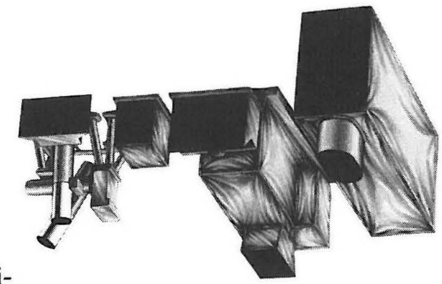
(1) China Administrative Regions GIS Data: 1:1M, County Level, 1990.
(2) GB (Guo Biao — National Standard) Codes for the Administrative Divisions of the People's Republic of China.
(3) Fundamental GIS: Digital Chart of China, 1:1M, Version 1. Includes layers for roads, railroads, drainage system, contours, populated places and urbanized areas.
(4) Interactive access to the China Census of Population, 1% Sample, 1982.
(5) County-Level Data on Population and Agriculture, 1990: Keyed to 1:1M GIS Map.
(6) County-Level Data on Provincial Economic Yearbooks, 1990-91: Keyed to 1:1M GIS Map.
(7) Agricultural Statistics of the People's Republic of China, 1949-94.
(8) County-Level Data on Hospitals and Epidemiology Stations, 1950-85.
(9) Priority Program for China's Agenda 21.

In addition, nation-level statistics on China are available through interactive access to the World Bank's Social Indicators of Development, Trends in Developing Economies and Monitoring Environmental Progress, and World Resources Institute's World Resources 1996-97.

For more information, please contact CIESIN User Services by e-mail at ciesin.info@ciesin.org or by telephone at (517) 797-2727.

The 12th Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Science Team Meeting

— Toru Kawakami (kawakami@ersdac.or.jp), ERSDAC (Earth Remote Sensing Data Analysis Center)



ASTER Instrument

The 12th ASTER Science Team Meeting was held December 3 - 6, 1996, at the Pacifico Yokohama Conference Center in Yokohama, Kanagawa, Japan. There were approximately 100 participants representing the ASTER Science Team, the Jet Propulsion Laboratory (JPL) ASTER Science Project, the Goddard Space Flight Center (GSFC), the Earth Remote Sensing Data Analysis Center (ERSDAC), the Japan Resources Observation Systems Organization (JAROS), the ASTER Ground Data System (GDS) Project, the instrument vendors, and the Japanese algorithm development contractors. The four-day meeting was composed of two plenary sessions and several individual Working Group meetings.

Plenary Session I, Tuesday Morning, December 3

H. Tsu (ERSDAC), ASTER Science Team Leader, welcomed the participants and opened the Plenary Session. Tsu reported that the Memorandum of Understanding (MOU) was concluded between MITI (Japan) and NASA (USA) on November 7, 1996. He discussed the ASTER Science Team current status and the Future Tasks schedule. There were six topics:

- Algorithm and Science Software Development (Standard Data Products)
- Requirements of the ASTER GDS and EOSDIS Designs
- Analysis of Instrument Proto Flight Model (PFM) Test Data
- Calibration/Validation Activities
- Mission Operations
- ASTER Announcement of Opportunity (AO) Plan

S. Lambros (NASA/GSFC) reported on EOS AM-1 news and status. His presentation included:

    - AM-1 is on schedule for a June 1998 launch
    - ASTER MOU is signed
    - Last instrument accommodation meeting (October 1996)
  - Operations Interface Control Document (OICD) is in draft form; target for signature is mid-January 1997
- Mission Operations Review (November 20-21, 1996)
- Master Schedule for the EOS AM-1 spacecraft

H. Watanabe (ERSDAC) presented an update of the ASTER GDS Development Status. He presented the major milestones achieved during FY 1995 and 1996 and talked about major issues and decisions reached: single xAR Data Base, use of the EOSDIS Core System/ Instrument Support Terminal (ECS/IST), use of the IWRS (Instrument-stick World Reference System), etc. He reported on delivery of the science software: Atmospheric Correction, Decorrelation Stretch, etc., from the U.S. Science Team; Level 1, Temperature-Emissivity Separation (TES), Digital Elevation Model (DEM), and Level 3 software from the Japanese Science Team. He explained the ASTER gateway architecture overview and the WWW browser service of the Information Management System (IMS). He also explained the Level 1 product status.

M. Pniel presented EOSDIS replanning and its impact on ASTER. The distribution of data products by EOSDIS may start 6 months after the launch in June 1998, because the development schedule of EOSDIS was delayed about 5 months. However, an interface test between EOSDIS and ASTER GDS will be carried out on schedule. He explained that the delivery schedule of Science Software version 2.0 will be postponed to January 1998.

A. Kahle summarized the discussions of the SWAMP Meeting that was held in October 1996 including:

- Lunar Calibration Plan
- Necessity of presenting early results of ASTER products after launch
- Rejection of more-frequent orbit corrections

Y. Yamaguchi (Nagoya University) summarized the Operations and Mission Planning Working Group (OMPWG) *ad hoc* meeting that was held October 30 - November 1, 1996, at ERSDAC in Tokyo. The main topics of the meeting included:

- xAR allocation and tracking (xAR is generic for any data acquisition request)
- Data Acquisition Request/Science Team Acquisition Request (DAR/STAR) cut-off
- Prioritization function
- Running simulation
- Mission analysis
- Prioritization of Level 1B processing
- Map projection vs. Path oriented
- LTIP (Long-Term Instrument Plan)
- Instrument Support Terminal (IST) development
- Revised AO plan

M. Pniel reported on the action items of the OMP WG *ad hoc* meeting.

H. Fujisada (Electrotechnical Laboratory [ETL]) reported on the Level 1 ATBD Update (V. 3) at the "EOS ATBD Review" in December 1996, and he presented the ASTER Level 1 algorithm and software development status. His presentation included:

- Delivery of the V. 2 algorithm (document) to the ASTER GDS (end of December 1996)
- Delivery of the V. 2 software to ASTER GDS (end of March 1997)
- ATBD (V.3) status
- Issuance of Level 1 data products specification (V. 2) (September 5, 1996)

S. Tsuchida, Geological Survey of Japan (GSJ) and T. Matsunaga (GSJ) reported on the results of measurements of the EOS Field Campaign, May 28 - June 9, 1996, at the Lunar Lake, Railroad Valley, and Cuprite sites, Nevada, U.S.

Y. Yamaguchi reported on the update of the ASTER Announcement of Opportunity (AO). The first preliminary investigation under the ASTER AO will begin in April 1997, and a full announcement may be made after completion of the preliminary investigation.

Y. Yamaguchi reported on the development and update of the Global Data Set Prioritization Map (Ver. 2). He announced that any Working Group (WG) is permitted to draw its additional requested area on this version of the Global Prioritization Map during this meeting. He reported that the final version of this map will be forwarded to the ASTER GDS by the end of March 1997.

G. Geller (JPL) reported on the Quality Assessment (QA) information for each ASTER Higher-Level Data Product (HLDP). He announced that Working Group co-chairs should present the summary of their discussions at the HLDPWG session, and raise any issues that are of interest to a wider group. He also announced to each WG that unless the WGs provided updated information, only the QA shown here will be coded at JPL, and noted that if there are issues that linger after this meeting (action items, etc.), any resulting changes must be received no later than February 28 to guarantee inclusion in the launch version of the U.S. software.

D. Noss (Arizona State University) reported on his DAR (Data Acquisition Request) entry tool in detail. He announced that his tool is available now on his web site.

H. Tsu asked each working group to discuss the following issues:

- The process for the map-oriented products
- Requirements for ASTER GDS and EOSDIS designs
- Plan for the updates of Calibration/Validation Plan documents
- Plan for STAR and population of the xAR data base

A. Kahle also announced the following topics:

- QA wrap-up
- Regional monitoring candidates

G. Geller (JPL) presented Quality Assessment (QA) close-out. He told the WGs that a goal of QA activities for this meeting is to close all remaining issues in the QA definition area. The deadline for any changes or additions to the launch version of U.S. software and the definition of metadata is February 28, 1997.

M. Kudoh (JAROS) reported on the Development of the ASTER Instrument Project. He said that the results of the PFM Test for ASTER subsystems showed no problems, and the ASTER System Test is still checking out detail. The ASTER instrument will be delivered to the U.S. by the end of January 1997.

The first plenary session was followed by a short tour to observe the ASTER instrument at the NEC Yokohama Factory on December 3.

On December 4, demonstrations of the ASTER (GDS) scheduler and the IST (Instrument Support Terminal) were given at the Information and Mathematical Science Laboratory, Inc., in Ikebukuro, Tokyo.

Plenary Session II, Friday Afternoon, December 6

K. Arai (Saga University) reported that the Radiometric Calibration Working Group (CAL WG) plans the next vicarious calibration activity at the Lunar Lake/ Railroad Valley areas as an EOS Field Campaign, accompanied by airborne data acquisition during June 16-20, 1997.

H. Fujisada (ETL) summarized the Geometric Validation Plan, the Ground Control Point (GCP), and the Level 3 (Ortho image) Product on behalf of the Geometric/Level 1 Working Group. His presentation included:

- Geometric Validation Plan of U.S. and Japan
- GCP Preparation Plan of U.S. and Japan
- Level 3 (Ortho image)
- ATBD update
- Development Status of Level 1 algorithm/software
- Level 1 Data Product specification (V. 2)
- Level 1B parameters (default, constraint)

Y. Yamaguchi reported on the discussions of the OMPWG in the meeting. His presentation included:

- Long-Term Instrument Plan (LTIP) to be finalized in February 1997
- Instrument Support Terminal (IST) and Scheduler demonstration
    - Comments to GDS by December 20, 1996
    - GDS will respond to the comments and questions by January 31,1997
- Global mapping update
    - Concept of Parameter Layer agreed upon
- Resource allocation and tracking
    - DAR/STAR definition discussed (DAR-Local, STAR-Local, STAR-Regional and STAR-Global)
- Alpha Version Priority Function
    - Function form and subfunctions proposed (data collection category, user category, clouds, urgency, etc.)
- File format for Scheduler
- Initial checkout concept
- Scheduler performance
- DAR/STAR database population
    - All ASTER members are encouraged to access Noss's xAR editor and to input DAR/STAR
- Use of cloud simulation by Scheduler

H. Murakami (Geographical Survey Institute) summarized DEM-related activities and Validation Sites.

F. Palluconi (JPL) presented the agenda and a summary of the Atmospheric Correction Working Group meeting. The topics included:

- ATBD Reviews (August 1996 Revision of ATBDs)
    - Surface radiance/reflectance
    - Polar cloud mask
- Algorithm development and schedules
    - V. 2 editions to be delivered in January 1997
    - Refined development of Adjacency Effect is underway
    - Adding Doubling Method to be used in Japan
- Field Campaign results
    - Difference between groups in the top-of-atmosphere radiance greater than 5% at all wavelengths (VNIR/SWIR)
    - Calibration of TIMS on U.S. Department of Energy Cessna Citation is altitude dependent (2 K; 2-8 km) (TIR)
- Alternate method for deriving surface temperature
    - An alternate method of obtaining surface temperature using ASTER data only is being developed. (Method depends on identifying

  - and using gray pixels at different temperatures within a scene)
- Quality Assurance
  - Questions were raised about the handling of "Alerts"(e.g., trigger on bad pixels and failed pixels)

S. Rokugawa (University of Tokyo) presented the agenda and a summary of the Temperature-Emissivity Separation (TES) Working Group meeting. The topics included:

- The result of the ATBD for T/E Separation
  - Available on the home page, August 16, 1996
- The current update of the TES code and the simultaneous estimation of atmospheric correction and TES parameters
  - Updated algorithm will be provided to GDS by the end of December 1996 Action Items (A/I)
  - Prototype TES code (final version) will be provided by the end of March 1997 (A/I)
- TES code status
  - Coding (for QA and spatial cases), complete in June 1997
- The current status of cloud classification algorithm
  - Testing under several conditions and no major change in code
- The clarification of input uncertainties and the visual effects of the uncertainties on TIMS data
  - Further discussion is required for the 2nd QA plane of surface kinetic temperature
  - Comments on visual effects of uncertainty (noise handling, etc.)
- Bit assignments and the definition of each bit were fixed
- Japanese request to U.S. team
  - Transfer "Fine Cloud Classifier" to Japanese team

S. Rokugawa (University of Tokyo) presented the agenda and a summary of the Airborne Working Group meeting. The topics included:

- Summary of an ASTER Airborne Flight in Nevada
- The TIMS flight in 1996, and MASTER update
- The five-year aircraft plan for validation
  - Flight campaign twice a year
- Thermal Emission and Analysis Software Environment (TEASE)

T. Schmugge (USDA Hydrology Laboratory) presented the agenda and a summary of the Ecosystem Working Group meeting. The presentation included:

- Global wetland mapping
- Scaling Vegetation-Soil-Water (VSW) index between ASTER and MODIS
- Arid-land vegetation coverage
- Agricultural land use mapping
- ASTER coral reef data product and remote sensing
- Coral reef database
- Some results of the Jornada Field Experiment
- Regional monitoring sites in U.S., Australia, and Japan
- Need criteria for procedures for evaluating regional monitoring sites
- QA—add flag for water vapor amount to indicate magnitude of atmospheric correction in TIR radiance product

M. Kishino (The Institute of Physical and Chemical Research) presented the agenda and a summary of the Oceanography Working Group meeting. The presentation included:

- The upcoming ERIM talk in March in Florida at the Marine and Coastal Environment Meeting
- Validation and DAR inputs
- Turbidity analysis by Landsat/TM
- 1995/96 sea-truth campaigns in Lake Shinji, Japan
- Present status of Satellite Oceanography in Japan
- QA number of cloud pixels for the Polar Cloud product

M. Urai (GSJ) presented the agenda and a summary of the Geology Working Group meeting. The presentation included:

- Global mapping prioritization update
- Regional mapping plans for volcanoes, glaciers, fluvial effects, and landslides
- Research plan with ASTER (Spectrum)
- xAR input for Scheduler
- Validation plans
- ASTER simulation datasets
- QA-related items

G. Geller (JPL) reported on the agenda and gave a summary of the Higher Level Data Product Working

Group (HLDPWG) meeting. The presentation included:

- Generic Header
  - Work needed to complete definition; discussed Generic Header off-line
- Validation and Test Site plans (overview and discussion)
  - By next Team meeting, need to have validation campaign schedule with specific dates for aircraft support
- Quality Assessment Close-out reports
  - TES WG finalized structure of second QA plan; added 4 items of metadata, and defined 3 alerts
  - Atmospheric Correction WG defined 2 types of alerts; user and algorithm developer
  - DEM WG reported no change for QA items
  - Geology WG reported no change for a D-stretch product, and more work planned for Cloud product
- Dummy pixels added to the first QA data plane
- Overview of U.S. HLDP QA processing procedures

Y. Ninomiya (GSJ) reported on the agenda and summarized the Spectral Library Committee meeting. The presentation included:

- Japanese status of Spectral Data Base architecture
- Discussion of the Spectral Library Page in JPL's new ASTER Web Site
- Research activities of the collaborative 1996 Australian Field Campaign by CSIRO and GSJ

M. Pniel invited the attendees to the next ASTER Science Team meeting scheduled to be held May 20-23, 1997, at the EROS Data Center in Sioux Falls, South Dakota, U.S.A.

The meeting was closed by A. Kahle, who called this a significant and productive meeting in which many issues were resolved in off-line splinter meetings as well as in the scheduled on-line meeting.

Joint NOAA-NASA GEWEX Continental Scale International Project (GCIP) and Interdisciplinary Studies in the Global Energy and Water Cycle

Release Date: on or about April 14, 1997

The National Oceanic and Atmospheric Administration (NOAA) Office of Global Programs and the National Aeronautics and Space Administration (NASA) announce the joint solicitation of proposals for scientific investigations to be carried out in support of GCIP and for interdisciplinary studies focusing on continental-scale land-atmosphere interaction in the GEWEX context.

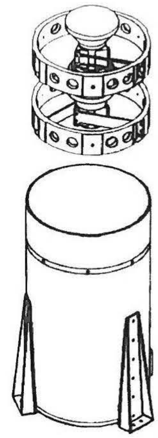
This solicitation will be available electronically on the release date via the Internet at the Mission to Planet Earth Home Page at http://www.hq.nasa.gov/office/mtpe/ under "MTPE Research Announcements" or via anonymous ftp at ftp.hq.nasa.gov/pub/mtpe. It is also being released by NOAA from the Office of Global Programs.

Paper copies of the NRA will be available to those who do not have access to the Internet by calling (202) 358-3552 and leaving a voice mail message. Please leave your full name and address, including zip code, and telephone number including area code.

Questions regarding this NRA can be addressed to:
NASA Headquarters, Code YS
Washington, DC 20546
Attn: Dr. James Arnold
Telephone (202) 358-0540; Fax (202) 358-2770
E-mail: jim.arnold@hq.nasa.gov.

Lightning Imaging Sensor (LIS) Science Team Meeting

— Steven Goodman (steven.goodman@msfc.nasa.gov), Marshall Space Flight Center



LIS Instrument

The Lightning Imaging Sensor (LIS) Science Team Meeting was held at the Global Hydrology and Climate Center (GHCC) in Huntsville, Alabama, on March 13-14, 1997. The primary objectives of the meeting were to review the status of LIS, discuss the status and results from the Optical Transient Detector (OTD) experiment (a LIS prototype in orbit since April 1995), review and update the LIS on-orbit calibration and validation plans, discuss the opportunities for participating in community field campaigns, review the opportunities for a geostationary lightning sensor, and conduct a "hands-on" demonstration to answer questions and provide a tutorial on the use and interpretation of OTD data and science products.

Hugh Christian (LIS PI) also reviewed the results from the lightning workshop held on March 11-12 (immediately prior to the LIS meeting) at Guntersville State Park, Alabama. The workshop was convened at the request of Robert Harriss, Chief of the Mission To Planet Earth (MTPE) Science Division, to discuss the contribution of lightning studies to the science goals of MTPE and the U. S. Weather Research Program (USWRP). The results of this workshop were presented at NASA Headquarters to Harriss and other program managers in the Science Division on March 27.

Lightning Imaging Sensor Status

The LIS has been integrated on the Tropical Rainfall Measuring Mission (TRMM) satellite, and the testing continues. The first end-to-end mission simulation was conducted successfully in November 1996. The launch-minus-8-month (L-8) LIS production software delivery was made to the MSFC Distributed Active Archive Center (DAAC) in March 1997. This LIS software release will be used for the second TRMM End-to-End Simulation scheduled for May.

A Memorandum of Agreement for LIS data delivery to the Japanese partners on TRMM has been completed. LIS data will be available to the science community monthly, once the data have been released by the quality assurance team. Near-real-time, geolocated browse imagery will be available for download from the LIS web page on a daily basis. Special browse products will be provided to support field campaigns on request. This approach worked well in providing OTD imagery in support of the PEM (Pacific Exploratory Mission) Tropics chemistry mission. Daily OTD browse imagery and data are already being provided to Ken Pickering and Anne Thompson (GSFC) in support of the forthcoming (summer 1997) SASS (Subsonic Assessment) Ozone and Nitrogen Experiment (SONEX).

Optical Transient Detector Status

The OTD mission began in April 1995. The OTD, an early prototype of LIS, was flight qualified and launched as a scientific payload on the Microlab-1 satellite in a 70-degree-inclination orbit at an altitude of 750 km. The OTD data have been quality assured, reprocessed, and released to the science community.

Some of the key scientific results from the OTD mission are:

- Produced the most complete and detailed maps of the global lightning distribution ever assembled.
- The global flash rate is estimated to be 40 flashes per second, less than half of the widely accepted estimate of 100 flashes per second, which dates back to 1925.
- Discovered lightning flash-rate signature as possible aid in tornadic and hazardous storm warnings.

- Discovered potential lightning-duration signature for continuing current discharges to ground, a key factor for the ignition of forest and wildland fires.

Two Ph.D. candidates supported by the LIS science team have recently graduated (Dennis Boccippio, MIT; Robert Solomon, U. of Washington). Boccippio joined the LIS science team in Huntsville, where he is analyzing the OTD data and performing on-orbit calibration and validation studies. Solomon is headed to France to collaborate on cloud electrification modeling studies.

Science Computing Facility (SCF)

The LIS, OTD, and ancillary data previously archived at the MSFC DAAC will continue to be available from the LIS SCF through the new Global Hydrology Resource Center (GHRC). The GHRC is collocated with the Global Hydrology and Climate Center (GHCC) in Huntsville, AL.

In addition to its current role in algorithm development, the LIS SCF will now operate as a PI-led source for the data production, archiving, and distribution system (formerly DAAC roles) for lightning data collected by the EOS lightning sensors, LIS, and the OTD. Airborne and ground-based lightning calibration and validation datasets, as well as weather radar and SSM/I brightness temperatures (used by the LIS Science Team for convective storm identification and for algorithm development and validation), will continue to be available for distribution from the LIS SCF through the GHRC. All datasets will still be accessible through EOSDIS, since all data providers are interoperable with EOSDIS.

MTPE/USWRP Lightning Workshop

Hugh Christian reviewed the results from the MTPE/USWRP lightning workshop. The charge to the 14 attendees was to discuss specific contributions of lightning observations and research to the MTPE and USWRP science goals, discuss science issues that lightning studies (space and ground based) can help address, describe their current research, describe the research that is enabled with the aid of a lightning sensor in geostationary orbit, and evaluate potential field campaigns to support LIS/OTD calibration and validation.

The attendees thought there was growing evidence that lightning is related to intense convection and the structure of the mixed-phase region of clouds, perhaps serving as a proxy variable for updraft strength or as an updraft velocity threshold; rainfall regimes; and latent heating.

Scientists have observed a number of relationships between rainfall and lightning from tropical monsoon environments to extratropical continental environments. There is some evidence for interesting changes in the amount of rainfall per flash in different and changing environments. Steve Rutledge (CSU) proposed that rainfall per flash could serve as an index to define these different and changing environments. Such changes were observed in association with wave oscillations, such as the Madden Julian Oscillation, and in moving from moist tropical to arid environments.

Jim Dye (NCAR) reported on the strong interest within the atmospheric chemistry community for better understanding of the contribution of lightning as a major natural source (of uncertainty) of NO_x. There is still a large uncertainty in the production rate per flash, the vertical distribution of the NO_x produced by lightning, and the interannual variability. There is new interest in the effects that thunderstorms appear to be having on the chemistry of the tropopause and lower stratosphere.

Marcia Baker (U. of Washington), John Latham (UMIST/NCAR), and Jim Weinman (GSFC) showed how lightning proxies for heating, water flux, and ice flux in clouds could be valuable as inputs to cloud and mesoscale models (MM). Weinman showed an example of an MM5 mesoscale model run for the March 13, 1993, "Storm of the Century" in which the lightning observed over the data-sparse (i.e., no radar coverage) Gulf of Mexico was merged with SSM/I and GOES-IR data to produce an improved heating rate in the model. The resulting data assimilation with the lightning data produced a better storm track and intensity forecast than was achieved using 12-hourly SSM/I and 3-hourly GOES data alone.

The group came up with a list of science issues and potential algorithms that might result from on-going lightning studies and future studies enabled by a geostationary sensor as follows:

- Exploit appropriate lightning/rainfall correlations for heavy convective rain and flash flood events. Use the lightning to aid in the identification and separation of convective and stratiform precipitation areas.

- Use the lightning as gap-filling observations for improved and continuous sampling of storms in mountainous areas.

- Use lightning observations in combination with satellite and radar to describe the structure, variability, and life-cycle of mesoscale weather systems.

- Determine the nature of land vs. oceanic convection, and with respect to changing intensity of tropical storms.

- Characterize winter storms, with and without lightning, to improve understanding of the nature of embedded convection in snow storms.

- Improve forest and wildland fire predictability and understanding by exploiting the flash duration and amplitude as indicators of the continuing currents that ignite fires.

- Improve interpretations of storm structure, morphology, and hazardous weather from observing storms with extreme intracloud flash rates, and storms with and without ground discharges.

The observing strategy recommendations from this group are to continue the OTD observations into the TRMM time frame. These data continue to be valuable since these are the only observations of boreal forests in the northern hemisphere. During the LIS mission, efforts should include supporting the TRMM calibration and validation field campaigns, supporting the NASA chemistry field campaigns not part of TRMM, explore the lightning "proxy variable" concept with the combined TRMM sensors and ground-based systems, and reach out to the modeling community to test the proxy concepts using merged data sources and model assimilation. The development of the geostationary concepts should be continued and the applicability of the data assessed. The Lightning Mapper Sensor pilot study, taking place in collaboration with Lincoln Labs at the NWS office in Melbourne, FL, addresses some of these proxy variable issues. Steve Goodman summarized the initial results from this project during the LIS meeting. As a community we need to refine and validate the proposed proxies for storm hazards, NO_x production, and cloud variables.

Field Campaigns

The team reviewed current plans and opportunities for participating in field experiments during the TRMM mission. Otto Thiele (TRMM Office) presented the status and plans for TRMM ground validation. Ed Zipser reported on the plans for airplane measurements during TRMM. Rich Blakeslee summarized the LIS calibration/validation plans. There are four primary campaign sites for focused LIS on-orbit calibration and algorithm validation:

- TExas-FLorida Gulf Coast UNderflight experiment (TEFLUN), spring 1998
- Brazil-Rondonia during LBA, January-February 1999
- Kwajalein, summer 1999
- Darwin, ongoing since November 1995

The TEFLUN experiment would extend the area of observations currently under study by the LIS team. A comprehensive set of WSR88D radar and lightning observations is now being made in central Florida at the TRMM ground truth site in the environs of the Kennedy Space Center. The LIS Science Team is developing a Memorandum of Agreement with Brazilian scientists to deploy and operate a small lightning network in Rondonia during the TRMM mission. It is hoped that measurements can begin by January 1998, and thus provide some early understanding of the characteristics of thunderstorms in that region. This operation would be similar to the ongoing LIS measurement program at Darwin, Australia.

Zen Kawasaki (Osaka University) discussed his results from recent field experiments and his role on the Japanese TRMM science team. He will continue collecting lightning data in Japan during the TRMM project and will continue collaborating in the LIS/OTD on-orbit calibration and algorithm validation.

At Kwajalein atoll, Aeromet has been responsible for a local-area lightning ground strike network. During

TRMM, we are examining the possibility of upgrading the magnetic direction finder technology at Kwajalein to time-of-arrival technology and possibly expanding the area of coverage. During the Brazil and Kwajalein experiments in 1999, we also plan on deploying a system to map total lightning activity within the clouds. The latter system is under development by Paul Krehbiel at New Mexico Tech. Brazil and Kwajalein, combined, would produce the most detailed lightning observations of tropical land and oceanic storms to date.

The next LIS Science Team Meeting is planned for March 1998.

Scientific Instrument Tested at University of Toronto Before Space Launch

— Andrew Yee (ayee@nova.astro.utoronto.ca), University of Toronto

A multimillion-dollar scientific instrument that will measure pollution in the Earth's troposphere during a collaborative Canadian, Japanese, and National Aeronautics and Space Administration mission will be rigorously tested at the University of Toronto. The testing will take place at a physics laboratory from April 15 to May 31.

The Canadian-built Measurements of Pollution in the Troposphere (MOPITT) instrument will be subjected to conditions similar to those it may find in space once it flies on board the first polar platform of NASA's Earth Observing System, to be launched in June 1998. In space, MOPITT will gauge the amount of carbon monoxide and methane over the entire globe for a period of five years as part of the Mission to Planet Earth program.

"MOPITT is part of a very significant international project," says Professor Drummond of the Department of Physics and the project's principal investigator.

"Canada and the Canadian Space Agency are contributing the instrument as part of the country's commitment to monitor the planet. We are testing it at U of T because we have built up a unique capability for testing and calibrating this type of instrumentation in a realistic environment."

The amount of carbon monoxide and methane is increasing at rates that scientists do not fully understand. Measuring these gases will help scientists better comprehend how the troposphere reacts to stimuli from Earth. These range from natural occurrences such as the growth of forests to catastrophic events like forest fires and human-induced phenomena such as agricultural emissions and combustion of fossil fuels for vehicles.

MOPITT was built by a consortium of Canadian companies led by COMDEV of Cambridge, Ont., BOMEM of Quebec City, Hughes-Leitz of Midland, Ont., and SED Systems of Saskatoon and is funded by the Canadian Space Agency's Space Science Program.

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Science Working Group for the AM Platform (SWAMP) Meeting Summary

— David Herring (dherring@pop900.gsfc.nasa.gov), EOS AM-1 Science Outreach Coordinator, Science Systems and Applications, Inc. (SSAI)

The April 3 - 4 SWAMP (Science Working Group for the AM Platform) Meeting was co-chaired by Yoram Kaufman, EOS AM Project Scientist, and Francesco Bordi, EOS AM System Scientist. Bordi presented the agenda for the meeting (the agenda and all attachments for this meeting are available at http://modarch.gsfc.nasa.gov/SWAMP).

EOS Project Status Report

Kevin Grady, EOS AM Deputy Project Manager, gave a brief overview of recent EOS AM-1 accomplishments. Grady congratulated the ASTER and CERES instrument teams for delivering their instruments on time—both instruments are at Valley Forge and both have undergone acceptance testing. He noted that CERES has already been integrated onto the spacecraft. The MODIS and MOPITT instruments are now assembled and are currently undergoing environmental testing. MISR assembly is nearing completion, but that team is having to correct some problems with the electronics. Overall, Grady stated that all five of the EOS instruments are in good shape.

He reported that much progress is being made on spacecraft integration. The power and Command and Data Handling subsystems have been integrated, the ground support equipment has been configured for spacecraft level testing, 98 percent of the spacecraft boxes have been fabricated, and the solar array is now proceeding through environmental tests. According to Grady, the solar array's harmonic drive failed its life test, so the EOS AM Project is having three new units built, and accelerated life tests will be run on these to determine if the problem was corrected. He also noted that the on-board solid state recorder had a few problems, making it and the solar array drive his current top two concerns.

Grady stated that near-term plans include the delivery of MISR, MODIS, and MOPITT to Valley Forge and completion of bench acceptance tests for all three. Also, delivery of the remaining spacecraft components—such as the S-band transponder and the equipment modules—are coming due. He hopes to complete the second spacecraft end-to-end test soon with the control center. Meanwhile, the launch vehicle (an ATLAS IIAS) is nearing completion.

EOS Instrument Team Reports

Robert Murphy, MODIS Project Scientist, gave a brief status report. He announced that MODIS is currently undergoing thermal vacuum testing, and things are going well with the instrument. Murphy noted that the sensor's nominal on-orbit temperature will be 10 K lower than was expected. However, the sensor is working well, and all major performance issues have been resolved. These include: low sensor background; useful SWIR behavior; reduced cross-talk; demonstration of the SRCA working as expected to provide useful spectral, spatial, and radiometric data; and virtually all signal-to-noise and dynamic range characteristics are within specifications.

Version 1 software testing is underway at the GSFC DAAC and is going smoothly. Specifically, software to generate 46 Version 1 MODIS products has been delivered by the Science Team—the remaining 4 products are expected this month. Integration and test activities on the Version 1 software using the pre-Release B testbed begins in May 1997. Murphy also presented a timeline for delivery and testing of Version 2 software. Testing in the Team Leader computing facility will be conducted from May to October 1997, and testing at the DAACs will be from February to March 1998.

Dave Diner, MISR Team Leader, gave status reports on MISR and AirMISR. Thermal vacuum testing was completed on MISR in December 1996. These tests were successful in verifying the instrument's thermal design. Some problems were identified in the camera power distribution system, leading to redesign and modification of that subsystem.

Diner reported that the flight system was successfully retested at ambient temperatures and that the second thermal vacuum test is planned for later this month. On March 29, a "MISRman" test was performed, which involved suspending a 10′ tall picture of a man above the instrument and then "viewing" it with MISR. Diner showed the resulting image—the first actual image data taken by the instrument.

Diner told the group that end-to-end tests of the PGE-1 (Product Generation Executables), which is Level 1 processing of the Level 0 data packets, is complete. This test was done by using Landsat Thematic Mapper (TM) data that was reverse processed back into the characteristics that will form data packets from MISR and put through Level 1 processing. These data will be registered in oblique Mercator projection.

On the AirMISR instrument, Diner reported that the camera has been radiometrically, geometrically, and spectrally calibrated. The ground data team is now in place for that instrument.

Diner's top 5 concerns are: 1) the scheduled completion and testing of the MISR instrument; 2) there is no identified funding for instrument engineering support during the mission—originally, the plan was to fund engineering support through the EOS AM-2 time frame; 3) reduction in planned science carry-over at the end of FY 97 adds risk to FY 98. Diner pointed out that the MISR Science Team ran out of funds in December 1996 because the new funds were not available to the team until 18 weeks into the fiscal year. He stated that, as a result of the funding delay, MISR's carry-forward funds were cut down to 7 or 8 weeks, and unless some measures are taken to prevent another delay this year, the MISR team may temporarily be "shut down;" 4) the MISR science software development schedule is tight, so MISR may not be able to accommodate any scope changes until after launch, which may affect the FPAR product that was recommended by the ATBD review board, and 5) the availability of EOSDIS at launch is a concern. Diner noted that the emergency plan allows for the processing of only 1 - 2 orbits per week.

Bruce Barkstrom, CERES Principal Investigator, reported that CERES was delivered to TRMM early last year. The instrument passed thermal vacuum, calibration, and shipment readiness review tests. Regarding algorithm development, everything is going smoothly and on schedule. He pointed out that, under the emergency back-up plan, the TRMM data processing system would be extended to handle CERES data, since CERES algorithms were designed to handle multiple instruments on multiple spacecraft. However, the shift in computing environments is a concern. He feels that on AM-1 the automated environment may not operate the shell scripts as well as on TRMM, so there may be some discontinuities between TRMM backups and AM-1.

Barkstrom announced that within the next month simulation tests on the TRMM spacecraft will be conducted with the instruments on board. Commands will be fed through the instruments, and feedback will be received at NASA LaRC. These simulation tests will be evaluated within a month after that.

Barkstrom stated emphatically that the CERES team continues to need a spacecraft pitch maneuver to view deep space—he said that the maneuver is "critical." His two other main concerns currently are EOSDIS and validation planning.

Scott Lambros, ASTER Instrument Manager, Code 421, delivered a status report on ASTER. He reported that the instrument was successfully delivered to Valley Forge, and it has successfully undergone bench acceptance testing. A data review was held in March to review the bench acceptance test results, and there are a couple of open items to resolve: 1) the Instrument Ground Support Equipment was registering thermal infrared data when no data were being sent; and 2) photodiode measurements of the visible/near infrared calibration lamp had a downward trend. The results of this measurement were within specifications, but the trend is being investigated further.

Lambros announced that current plans are to mechanically integrate ASTER onto the spacecraft in early May, with electrical integration completed by mid-May. The Direct Access System kick-off meeting was held recently to discuss plans for establishing a direct downlink site in Japan for capturing real-time ASTER data. The group is also considering capturing real-time MODIS data at that site.

Anne Kahle, ASTER U.S. Team Leader, presented an overview of the team's algorithm development status. The team has developed a visible, near infrared, and shortwave infrared atmospheric correction algorithm, adopting a look-up table approach based upon output from a radiative transfer code. Kahle said there is some concern in using Junge's aerosol size distribution and single scattering albedo. Based upon feedback from the ATBD review, ASTER has decided to change its look-up table to make better use of the inputs from the MISR and MODIS aerosol products. The goal is to maintain consistency with the aerosol parameters used to retrieve the inputs to the correction. However, strong emphasis will be placed on developing ASTER-only atmospheric correction and adjacency effect correction algorithms.

Kahle reported that the thermal infrared atmospheric correction algorithm development is proceeding. Version 0 will be a basic implementation of the algorithm; Version 1.1 will incorporate default atmospheric models and data quality indicators on a pixel-by-pixel basis; and Version 2, which will be ready at launch, will incorporate interfaces to instrument profile data from other EOS sensors and topographic databases.

Kahle announced that the temperature/emissivity separation algorithm is now complete and tested. The prototype of the daytime polar cloud mask is now available at JPL for product integration. She noted that the cloud mask runs with the Product Generation System (PGS) Toolkit on Landsat TM data.

Regarding ASTER science software, Version 1 is complete and was delivered to ESDIS in January 1997. Version 1.1 is in the final development stage and will be integrated in the ECS testbed beginning this June. Development of Version 2, the launch version, begins in June and is scheduled to be delivered in February 1998.

James Drummond, MOPITT Principal Investigator, reported that the instrument is presently at David Florida Laboratories in Ottawa, undergoing electromagnetic compatibility and vibration testing. Then it will be sent to the University of Toronto's calibration facility on April 15. Drummond stated that the test schedule is a concern in that it is marginal for effective instrument calibration. The remaining tests have been prioritized to maximize efficiency and the team is looking for ways to reduce the 45-day test schedule to fewer days. He stressed, however, that MOPITT's science objectives must be protected even under this heavy schedule pressure. He said the polarization test is proving to be a challenge, as is the spectral test. The team is attempting to speed up the field-of-view tests, which will take the longest time, but the scan mirror problems have slowed progress.

Drummond stated that MOPITT appears to be mostly "okay." There have been problems with the scan motors, but the problems were resolved. There were also problems with the port cover motors that have been resolved; however, Drummond feels that this increases the risk on orbit and now is very reluctant to re-close those doors once opened. Jim Butler asked if those doors will be closed during orbital maneuvers or left open. Drummond responded that the scan mirrors can be parked so that they are "looking" at the blackbody during maneuvers. Diner asked if there are thermal issues from leaving the covers open, especially concerning the system electronics should a maneuver bring the sun into the field of view. Drummond stated that if the mirrors are in park, he believes MOPITT can endure briefly pointing at the sun.

Jim Irons, Landsat-7 Deputy Project Scientist, Code 923, reported on the status of Landsat-7 on behalf of Phil Sabelhaus, Landsat-7 Project Manager. He told the group that Landsat-7 is a tri-agency group effort involving NASA, NOAA (for operations), and USGS (for data capture). Landsat-7 data will be archived and distributed from the EDC DAAC. Irons said that the platform is on schedule for a May 1998 launch—the schedule was reworked to accommodate late instrument delivery. An independent annual review and a Landsat Coordinating Group meeting were held in April at GSFC.

According to Irons, the Landsat-7 Project Office is supporting ESDIS' replan activities. He noted that full functionality of its data processing and distribution system will not be available until ECS Version B.1 becomes operational in January 1999. However, when Landsat-7 becomes operational 90 days after launch, NOAA will be able to archive and distribute Level 0R products; Level 1 products will not be distributed to EOS science users until January 1999. Irons stated that

Landsat-7 can capture 250 scenes per day and distribute to users a maximum of 100 Level 0R scenes per day. Kahle asked how much a scene will cost. Irons responded that at Level 0R a scene will cost up to $500. He noted that there is some discussion as to which agency owns the Level 1 data and who can set the price.

Spacecraft integration and testing of Landsat-7 has been underway since June 1996, with 46 of the 49 components already on board. The instrument integration and test, however, has encountered some substantial problems. The panchromatic band initially suffered from unacceptable noise. Efforts to reduce the noise led to recognition of poor electrical cable workmanship and to recognition of problems with the power supplies. Hopefully, these problems have been resolved so that the instrument can be reassembled and calibration testing can begin.

Regarding the Landsat-7 ground system, Irons reported that the flight operations team is now staffed and in place. The mission operations review was completed in January and the ground station delivery to EDC is scheduled for May 1997.

Irons announced that the next Landsat-7 meeting is scheduled for April 15 -17 at Valley Forge. He said that plans are still to fly the platform on loose formation with EOS AM-1—within 15 to 60 minutes.

EOS Calibration Update

Jim Butler, EOS Calibration Scientist, reported that the second ASTER radiometric comparison was held in December 1996 in Japan, in which a series of ultra-stable radiometers were used to make calibration measurements in the visible through the infrared. It was found that there was a 2-percent spread of preliminary visible/near infrared radiometric measurements, and a 5-percent spread of preliminary shortwave infrared radiometric measurements. A detailed article on this topic appeared in the last issue. He announced that the second MODIS radiometric measurement comparison is tentatively scheduled for early June 1997.

Butler reported that the bidirectional reflectance distribution function (BRDF) measurement validation round-robin is underway. Participating facilities include NIST, JPL, U. of Arizona, Hughes SBRS, and NASA's GSFC. The idea is, at each of these agencies, to make BRDF measurements on a common set of diffuse targets at a number of visible, near infrared, and shortwave infrared wavelengths and over a range of incident and scatter angles.

Butler stated that the May 1996 vicarious calibration field campaign at Railroad Valley/Lunar Lake, NV, identified several areas that contribute to differences in participants' radiance and reflectance measurements. These areas included aerosol optical depth and size distribution, incident total solar irradiance (TSI), radiative transfer codes, atmospheric absorption, and surface reflectance. There will be additional campaigns in 1997 to compare reflectance measurements, visible/near infrared/shortwave infrared radiometers, and sun photometers. Butler plans to host a Calibration Panel Meeting July 8-10 at GSFC. Details on these and other calibration-related activities are available on the new Calibration Web page, at http://eospso.gsfc.nasa.gov/calibration/calpage.html.

EOS Validation Update

Dave Starr, EOS Validation Scientist, reminded everyone about the validation page—http://eospso.gsfc.nasa.gov/validation/valpage.html—a useful and evolving resource for validation information. He also reminded the group that the EOS Project Science Office supports the HITRAN database for use in EOS algorithm development and science data validation; Starr encouraged the instrument teams to utilize this resource.

Starr presented an overview of the PROVE (PROtotype Validation Exercise) campaign to be conducted May 20 - 30 at the USDA-ARS/LTER Jornada Experimental Range in New Mexico. This campaign is being organized primarily by the MODIS Land Discipline Group. During PROVE, the NASA ER-2 will conduct two flights with AVIRIS, AirMISR, and the MODIS Airborne Simulator on board.

Starr presented the validation schedules for the AM-1 and PM-1 mission time frames. He noted that the post-ATBD revised validation plans and summary charts are due July 11, 1997, from the AM-1 teams. Selection of the investigators for AM-1 validation will occur in

August. The final pre-launch validation plan is due from AM-1 teams in May 1998. Summary charts and draft plans for PM-1 validation are due August 15, 1997. Starr announced that there will be a PM-1 Validation Workshop in September 1997.

Starr told the group that according to Jim Huning, Airborne Program Manager at NASA HQ, the NASA WFF C-130Q will be grounded permanently at the end of this year and that the third ER-2 will soon be returned to the Air Force. Starr discussed the developing concept of a multi-agency national fleet of research aircraft that are available to NASA for research missions. He asked each team to promptly submit any flight requests for FY 98 (call will be released by HQ shortly) so that flight planning may be done more efficiently. He would also like to know the scope of the FY 99 flight plans (flight hours) for each group so that he can better characterize the "big picture" of EOS validation plans over the next several years.

Diner asked if the EOS Instrument Teams can respond to the Validation NRA. Starr responded that the NRA is open to anyone. However, he explained that the difficulty with teams proposing is that it would no longer be an open, fair competition. He also pointed out that each instrument team already has a funding mechanism in place to conduct validation efforts. He suggested that if a team feels it didn't scope its validation budget correctly and now feels it needs to do more activities, then it should address these concerns in its annual budget negotiations with the EOS Project Science Office.

Digital Elevation Model (DEM) Update

Nevin Bryant, chair of the DEM Science Working Group, stated that the goals of his group are: 1) to ensure that the required DEM datasets and their derivatives are available at launch in 1998; 2) to ensure the progress toward and availability of DEM access software; and 3) to support other Mission to Planet Earth (MTPE) activities requiring DEM and auxiliary dataset information. Bryant stated that his group's approach is to identify the required DEM resolutions (1 km and 100 m); identify the DEM producers, production schedules, and data availability; and identify and perform trade studies to refine requirements, formats, and derived DEM products for EOS instruments.

According to Bryant, EDC and MISR datasets containing DEM global coverage products at 1 km and 100 m were completed in 1996, and have been available to users since February 1997. The estimated accuracy of the two 1-km datasets is 41 m RMS. He expects them to be available in HDF-EOS GRID format by June 1997. Bryant noted that 35 percent of global land area will not be available at 100 m until after the year 2000.

Bryant stated that his group is currently working on six different trade studies. For instance, the Science Data Processing Toolkit calls for DEM datasets, so his group is working to identify the specific requirements. The DEM group is also evaluating the data access efficiency for raster tiling schemes. Bryant reported that the final DEM plan will be submitted to NASA in mid-1997 for signature.

Direct Broadcast Processing

William Campbell, head of NASA GSFC's Applied Information Sciences Branch, reported that Code 935 is working with U. of Maryland-Baltimore County, Clemson U., SW Louisiana U., and the U. of Hawaii to develop software and hardware for receiving direct broadcast data from MTPE platforms. The cooperative effort among these universities is an "open arrangement"—they must purchase and set up their own infrastructures. The prototype system has been up and working for the last 3 weeks, and Campbell acknowledged that the system has minor glitches, but it works.

He announced that his group is working to develop the tools to acquire and process data, and produce products, in an intelligent, affordable way. EOS AM-1 will be transmitting with a 52 MHz bandwidth. A cheap down converter was developed that will cover all of the X-band range. The entire system for processing data is run on a workstation—everything from deconvolution and decoding, to demodulating and frame synchronization, to remote sensing decoding and depacketizing, to raw data ingest and storage. He noted that today, the EOS ground system costs between $400 K and $600 K without remote sensing decoding and depacketizing capabilities. In the fall of 1997, the cost is expected to drop to about $150 K, including decoding and depacketizing capabilities.

EOS AM Science Outreach Coordinator

Kaufman introduced David Herring, newly-hired into the position of EOS AM science outreach coordinator. Herring will work with the EOS AM Project Science Office, the EOS AM principal investigators, and the EOS AM interdisciplinary investigators to help communicate the science results of the EOS AM-1 mission to the general public. Specifically, Herring is currently working on an EOS AM-1 brochure and is helping to scope an exhibit on EOS that will reside in the "Looking at Earth" gallery of the Smithsonian Air and Space Museum.

Global Gridded Products

Robert Wolfe, MODIS Science Data Support Team member, reported on MODIS' plans to use a nested, integerized sinusoidal grid for producing Levels 2g through Level 4 gridded products. He noted there is also a desire from the polar community to develop a polar grid in which to produce the sea ice product at 1.25 km to match the AVHRR grid. The temporal grid resolution includes daily, 8-day, 16-day, monthly, 96-day, and yearly data.

Regarding the MODIS Land Group's climate modeling grid (CMG) products, Wolfe stated that seven products will be produced at 1-degree resolution, as well as 0.25 and 0.5 degrees. The MODIS Ocean Group plans to use an integerized sinusoidal grid. The resolution is 4.6 km (2.5 arcmin) and the CMG is 1 degree. The temporal resolution is daily, weekly, and 3-weekly through Level 3 products; and yearly at Level 4. The Atmosphere Group plans to use a 1-day and monthly equal-area grid (Hammer-Aitoff). Their CMG is 1 degree and the temporal resolution is daily and monthly. Wolfe presented the projected processing loads for each discipline group.

Diner presented a status report on MISR's global gridded products. He stated that the MISR Team is currently producing the second draft of their Level 3 ATBD. He noted that the earliest inclusion of products is in their Version 2.1 software.

Barkstrom reported that all but one of CERES' gridded products are produced on a monthly average. There are four kinds of CERES gridded products: 1) ERBE-like (monthly average) in two formats, so regional information is available on all fields or all regions within a particular field; 2) surface radiation budget (monthly average), including top-of-atmosphere and Earth surface fields; 3) synoptic product with the same spatial grid; and 4) full radiation fields and clouds at a monthly average. Barkstrom noted that the CERES data product catalog is available on-line at the CERES Web site.

John Gille reported that there are currently no official gridded products for MOPITT. Techniques to create validation and research products are being developed. Gille stated that there are six fields that MOPITT would grid, if it chose to, using two methods. The first method is the Kalman/Cressman mapping method. Gille showed images illustrating the time effect that the setting sun has on atmospheric nitrogen oxide. The second gridding method is Advect and Update mapping. Under this method, the field is continuously advected and new measurements are combined with the field, according to variances. Using this method, however, map uncertainties grow with the time since the last data insertion.

Jim Stobie, of the Data Assimilation Office (DAO), reported that new gridded test datasets will be available by April 15 in the HDF-EOS GRID format. These data will also be COARDS compatible; however, if using the EOSDIS Toolkit, users won't see COARDS metadata, and if using the FERRET Toolkit, users won't see GRADS metadata.

Stobie stated that the DAO will provide hourly surface data every 3 hours, and 3-hourly upper air data every 6 hours. The sample data will be a 1-month sample from August 1996 in a 2°-by-2.5° lat-long grid. This dataset will not be moved to a 1-km grid until a year after launch; data will be available at 36 pressure levels. File specifications on this data set will be available soon.

EOSDIS Emergency Backup Update

Irons reported that the Landsat-7 Team is developing a new antenna at the Landsat Ground Station, from which data will be sent to the Landsat Processing System to produce Level 0R data in HDF format—this is reformatted raw data with no corrections or resampling. From there, the data will be sent to ECS. After launch, the operations of the processing system will be managed and paid for by NOAA through EDC, whereas ECS will be managed and paid for by ESDIS.

But, what happens if there is no ECS at launch? Irons stated that the first priority is to not drop any data. In an emergency system, there would be a tape system developed to capture data and create a backup tape archive for eventual transfer of data to ECS when it finally does come on line. During the orbital checkout period, the emergency system would enable the transfer of data from the temporary archive to an image assessment system for performance verification and calibration. After the 90-day check-out period, the system will be capable of transferring data to a Level 1 Product Generation System for the production of Level 1 ETM+ data products. This emergency system will have the capacity to archive 250 scenes per day and output up to 60 Level 0R and 25 Level 1 ETM+ scenes per day.

Regarding MODIS' emergency backup plans, Ed Masuoka, MODIS Science Data Support Team Leader, told the group that the MODIS Science Team is providing the software for the core system, and SDST is putting the processing and storage system together. The GSFC DAAC will handle distribution and ancillary data. The goal of the MODIS backup plan is to develop a computing system to support quality assurance, validation, and early science development of the algorithms.

Masuoka reported that on March 9, SDST made a demonstration to ESDIS Project personnel on the processing of MODIS products using the SeaWiFS processing framework. Since then, tiling has been added for processing Level 2G and Level 3 products. Current SDST activities include incorporating the Version 1 MODIS science software into the emergency backup processing framework, developing post-launch visualization tools, and prioritizing resource usage in the backup system. Data are now being collected at validation sites that will be used to tune the algorithms. After launch, initial emphasis will be on studying ocean/aerosol effects, ocean surface temperature, vegetation index availability, geolocation accuracy, and the instrument's 250-m registration.

Graham Bothwell, of the MISR Team, reported that the primary goal of MISR's emergency backup plan is for the MISR SCF to support all calibration/validation work, as well as all the early mission basic science goals. The DAAC will ingest, archive, distribute, and possibly provide some additional processing of Level 0 MISR data. It is possible that these data could be processed through Level 3 at the DAAC; however, details and potential capacity are yet to be determined. Bothwell said he is concerned that there may be some difficulty in obtaining appropriate new staff at JPL at short notice. Also, MISR is relying on the goodwill of the DAAC to make existing resources available, which adds risk should the DAAC encounter capacity, throughput, or staffing limitations.

Barkstrom presented an overview of CERES' emergency backup plans. He stated that CERES differs from other EOS instruments in that when it ran into the problem of producing a different release A from what is being produced for TRMM, it had to put together a plan for production with the DAAC. Consequently, a slightly modified proposal was produced, and accepted by ESDIS, for a computer system to extend the TRMM system that was being designed. The major changes for AM-1 are that more jobs and more data files are being produced. Barkstrom noted that AM-1 will provide data over the polar regions that TRMM can't provide.

Moshe Pniel presented an overview of the ASTER emergency plan, to be jointly executed by JPL ASTER and the EDC DAAC. The EDC DAAC will ingest Level 1 data tapes from Japan, create a database from Level 1 metadata to support rudimentary search and order capabilities, and distribute a small amount of data to the ASTER SCF. The ASTER SCF will select a limited set of Level 1 data, get the appropriate external datasets needed for Level 2 processing, produce Level 2 data, and distribute Level 2 scenes to ASTER principal investigators. Pniel stated that Japan will initially send two scenes per day and will eventually ramp up to 150 per day; four full Level 2 scenes per week will be produced at the SCF.

The MOPITT emergency backup plan was presented by Paul Bailey, of NCAR. He noted that MOPITT has only two at-launch standard products and three experimental products with relatively small computational resource requirements. Instrument activation and checkout will take 3 months, so the team's requirements for DAAC processing are quite low. Algorithm checkout will be done 3 to 5 months after launch with low DAAC utilization due to the need for high interactivity. MOPITT's approach will be to build on the SCF science data processing software testbed, which will be in place to support activation and checkout. The capability to capture and manage appropriate metadata during product generation will be added to this software. Bailey said MOPITT will rely on the LaRC DAAC for distribution to the user community.

In summary, Kaufman stated that the team's emergency plans are now defined and in place. So, even if ECS is not ready at launch, there will be some capacity for processing and distributing AM-1 data. The emergency systems will phase out as EOSDIS comes on line and they become redundant.

SWAMP Evaluation of EOSDIS Testing

Kaufman stated that the SWAMP group must evaluate the EOSDIS test plan and ensure that there is an adequate supply of test data to EOSDIS. Specifically, the SWAMP must evaluate the test results, report those results, and recommend actions to ESDIS.

Skip Reber told the group that the EOSDIS test will be demonstrations of some degree of usability and functionality of the system. These demonstrations will be held in May 1997, and again in August, and will include EOSDIS' ability to supply PGEs and test data. The test will be a demonstration of the basic push functionality of ECS using selected instrument teams' data and PGEs.

Data System Working Group Report

Reber reported that this group's only activity was a workshop to provide mutual understanding of how to implement metadata in preparation for the launch of Landsat-7, EOS AM-1, and SAGE III . He defined metadata as the information you need in order to get data out of the system in a useful and meaningful way. Users' ability to retrieve data depends upon the metadata; however, there is some confusion and misinterpretation about the term. Initially, 287 attributes were being suggested as inputs for metadata, which was an intimidating number.

Reber said that, as a result of the workshop, metadata will be divided into four broad categories: mandatory, science critical, science optional, and product-specific attributes. He stated that after launch there will be opportunity to insert new metadata items, but that opportunity decreases with time.

EOSDIS Update

Rick Obenschain, ESDIS Project Manager, presented an update on the status of EOSDIS, including a summary of the current system requirements. He raised the question: What happens if EOSDIS' core capabilities are not available at launch? Obenschain acknowledged that the instrument teams now have their emergency backup plans, which were initiated on March 17. But ESDIS also decided, while developing its software release B.0 capabilities, to set a milestone that it feels it can reach and that will provide basic EOSDIS functionality—called B.0' (prime). Release B.0' will have a critical subset of the capabilities of B.0, which in turn will be an incremental build toward B.1.

Obenschain said that ESDIS has proposed several alternative architectures for EOSDIS in the PM-1 era and beyond that a committee of representatives from the user community, instrument teams, DAACs, ESSAAC, and the NRC can evaluate and select from. The idea is to evaluate all options in an intelligent manner and then build the best system possible.

Obenschain announced that within 9 months ESDIS must deliver release B.0, and so B.0' must be built in the interim. Release B.0 refers to the required functionality within EOSDIS for the period of launch through 6 months after launch. He stated that ESDIS can't change the basic architecture of release A, but it can add software demonstrations that will provide confidence in the system. The first demonstration will be in May 1997. A second demonstration is scheduled for August 1997. Obenschain said that ESDIS is currently on schedule to deliver the release B test bed, as well as to conduct the demos. However, if in August it appears that ESDIS cannot provide the B.0 capability at launch, then ESDIS will decide on a new course and will then increase the funding for the emergency backup plans.

Calibration Attitude Maneuvers

Joe Bolek, of the EOS AM Project, presented an overview of the two calibration attitude maneuvers (CAMs) being studied. One CAM being considered is a multiple rate pitch that allows for deep space viewing, as well as a slower rate for viewing the moon. The second is a constant pitch rate that views the moon and deep space at the same rate. Bolek then listed the specific requirements for each maneuver.

Grady told the group that Chris Scolese, EOS AM Project Manager, wants the capability to do the maneuver, but has not yet committed to when he would do it, so the maneuver is not in the spacecraft baseline plan yet. Murphy pointed out that the CAM must be planned before the early validation stage and cannot be delayed because a lot of datasets will be negatively impacted. Bill Barnes, MODIS Instrument Scientist, added that he would like to see the CAM done within the first 60 days after launch. He said that this is critical to MODIS' calibration and should already be part of the baseline plan. Kaufman pointed out that a memo explaining the need for the CAM was already sent to the EOS AM Project; he asked Grady when a response will be forthcoming. Grady answered that a letter from the EOS AM Project would come out in May, stating that the EOS AM Project will continue to go forward with its planning and analyses. [Note: According to Kaufman, subsequent to the SWAMP meeting, the EOS Project Management and Project Science Offices began working this issue and he feels they are nearing a satisfactory resolution.]

Ground Control Points

Bryan Bailey, Project Scientist of the Land Processes DAAC, announced that his team held its initial meeting in October 1996, at which they discussed requirements for ground control points (GCPs) and instrument team preferences. He noted that ASTER and Landsat-7, and MODIS and MISR, are natural pairings in their GCP requirements.

Bailey showed some sample images—such as the Salton Sea in California, and a road grid in northwestern Iowa farmland—which are candidates for "positional information image chips." He said the idea is to identify GCPs that can be shared by EOS instruments to reduce duplication of effort and cost in establishing them. Bailey briefly listed some candidate positional information sources.

Bailey reported that the remaining tasks facing his group are to complete the identification and selection of physical ground features, finish identifying and obtain the best imagery for creating image chips, finish identifying and obtaining the best positional information for GCPs, and then create the GCP chips.

Policy for Algorithm Modification

Kaufman stated that it is not clear when algorithms will be modified and when reprocessing will occur. He feels that a policy should be implemented to govern these two things. Kaufman suggested that in the first year after launch, the PIs can change their algorithms routinely, but they will be encouraged not to change them once the algorithms are mature. Also, quality control parameters can be developed to indicate whether an algorithm was not changed, was modified slightly, or changed significantly prohibiting a time series. Reber took an action to summarize the policy whereby PIs record changes in their algorithms. He asked the PIs to send him their recommendations on how changes should be made and when a freeze should be implemented.

EOS AM-2 Planning

Ray Taylor, of the EOS AM Project, presented an overview of options for the EOS AM-2 payload. Taylor assumes that Landsat and EOS AM missions will merge after Landsat-7 and EOS AM-1, incorporating lessons learned from those missions. He reported that the baseline plan is to launch AM-2 in 2004 with a measurement complement that encompasses the measurements of MODIS, MISR, ETM+, CERES, and EOSP. The idea is to incorporate new and advanced technologies for improved system performance while reducing the weight and volume of the spacecraft and continuing to support the MTPE science research objectives.

Taylor said there are four options for EOS AM-2: 1) fly copies of existing instruments and spacecraft, 2) fly evolutionary instruments and spacecraft, 3) develop completely new designs, and 4) rely on other providers. Taylor recommends option #3.

He said that AM-2 will be significantly smaller than AM-1, and will go from using an ATLAS rocket to a Taurus. He is also exploring possibilities for formation flying with other platforms. Specifically, Taylor is considering grouping three spacecraft and is developing requirements for navigation and geolocation knowledge for position and attitude knowledge. He said the goal is to get within 0.10 pixel pointing knowledge. He added that for cloud studies, the spacecraft must be within 1 minute of one another, so that requirement would drive the formation plans.

Next SWAMP Meeting and Action Item Review

The next SWAMP Meeting is tentatively scheduled for the second week in September 1997 at Lockheed Martin Missiles and Space, King of Prussia, Pennsylvania.

EOS PM-1 Advanced Microwave Scanning Radiometer (AMSR-E) 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 homepage: wwwghcc.msfc.nasa.gov/AMSR

The US EOS PM-1 AMSR-E Science Team had a meeting on March 11, 1997 at Goddard Space Flight Center. This half-day meeting featured discussions of various topics: integrated team algorithm, two deliverables, ADEOS II AMSR data transfer, validation campaigns, and the ER-2 flight plans. (The PM-1 AMSR was named "AMSR-E" by the Ministry of Finance of Japan.)

This was an unusually short meeting because the ATBD Peer Reviews were taking place the following day. Roy Spencer, Team Leader, opened the meeting by going over the agenda. The meeting started with a PM Project Office report. Bernie Graf, PM Project AMSR-E Instrument Manager, reported on the EOS PM-1 AMSR hardware status. The interface hardware issues are all resolved and documentation is being completed. Paul Hwang, PM Project Office, updated the team on the NASDA-NASA Memorandum of Understanding (MOU).

D. Conway, AMSR-E Software Integrator, discussed the team integrated software driver, plans for development, and issues connected with this development. The simple flow diagram for this driver initiated discussions with all team members on what order the different algorithms should be called into execution, which algorithms need inputs from others, and who will write out the final products. The team decided that, for AMSR-E, a granule will consist of data in one full orbit starting and ending at the South Pole.

The team discussed several other miscellaneous topics:

- Software Management Plan and Science Data Validation Plan outlines;
- Metadata updates;
- ER-2 flight plans for different field experiments and the specific rainfall over the ocean field experiment idea (in collaboration with G. Petty, Purdue University); and
- ADEOS II AMSR data transfer from Japan, in collaboration with the JPL SeaWinds team.

The Team was updated on the communications with S. Gunter (SeaWinds Project, Ground Data Systems) and the agreed-upon proposed data transfer format and flow. S. Sobue (NASDA Earth Observation Information System Associate Senior Engineer, representative to ESDIS project) brought up several issues in connection with this data transfer: the sensor provider has the responsibility for Level 1 processing and there is no Level 1c requirement for ADEOS II (the AMSR-E Science Team will process the remapped Level 1b data and call it a *Level 2* product); metadata format compatibility and toolkit use; and two modes of ADEOS II data flow operation: mode 1 - through a data relay satellite (90% of the time), and mode 2 directly to an X-band ground station (the remaining 10%).

The next AMSR meeting will take place at the Hydrology and Climate Center, Huntsville, AL, June 10-11, 1997.

The International Land Surface Temperature Workshop

— William Snyder (will@icess.ucsb.edu), University of California, Santa Barbara
— Mervyn Lynch (lynch_mj@cc.curtin.edu.au), Curtin University of Technology, Australia
— Zhengming Wan (wan@icess.ucsb.edu), University of California, Santa Barbara

Introduction

The International Land-Surface Temperature Workshop was held on September 17-19, 1996, at the University of California at Santa Barbara. Jeff Dozier, Dean of the UCSB School of Environmental Science and Management, welcomed the participants. Twenty-five participants from USA, France, Australia, and Japan attended the workshop. Twenty presentations were followed by two discussion sessions. It was a successful and productive workshop. The important findings of the workshop are outlined below together with the recommendations for further actions.

Workshop Objectives

The workshop was part of a continuing effort to maintain contact among members of the EOS community that are concerned with the improvement of land-surface temperature (LST) algorithms, the definition of procedures for validation of LST, and the identification of the sources and the magnitude of measurement uncertainties. The specific goals of the Workshop were to clarify the present state of the art in LST estimation from spaceborne sensors and to identify future directions including issues requiring further research effort. A subsidiary goal was to establish a closer relationship between LST algorithm designers and the LST user community.

Overview of Scientific Presentations

The importance of accurately determining LST to support an improved understanding of land surface processes, including land surface forcing, and the correlation of LST with the enhanced greenhouse effect were some of the issues identified by Z. Wan in an overview paper titled "Challenges and opportunities for LST." The prospect of suitable datasets for LST research is soon to be enhanced by the impressive range of on-orbit sensors to be launched over the next few years. To advance the science, algorithm developers need to improve validation programs, collaborate more in the development and refinement of LST and land surface emissivity (LSE) algorithms, undertake comprehensive and coordinated field campaigns, and forge closer relationships with GCM (General Circulation Model) scientists.

The technical aspects of the MODIS instrument design, and key role that it plays in the provision of accurately calibrated shortwave (SWIR) and longwave (LWIR) infrared radiances for LST research, was reviewed by C. Schueler of SBRS (Hughes) in a paper "Technologies for temperature sensing from space." The specific algorithm proposed for application to MODIS to derive LST was presented in a paper, "MODIS Generalized split-window LST algorithm," by Z. Wan and J. Dozier, who outlined the theoretical basis of the approach, the sensitivity and error analysis, and the results from validation campaigns conducted at Railroad Valley Playa, Nevada, with the MODIS Airborne Simulator (MAS). The algorithm assumed that the band emissivities for the surface under investigation were well characterized. According to simulations in wide ranges of atmospheric and surface conditions, the rms errors in retrieved LST were typically 0.7 K. A follow-on paper, "MODIS day/night LST algorithm for retrieving land-surface temperature and emissivity," by Z. Wan and Z-L. Li, proposed a MODIS day/night algorithm that has the ability to reduce the atmospheric effects caused by the uncertainties in atmospheric temperature and water vapor profiles in the process of simultaneous retrieval of surface temperature and band emissivities. Validation data over Railroad Valley Playa, Nevada showed retrievals from MAS had an accuracy of 1 K, but there is a significant difference between the retrieved emissivities and those measured from samples in the laboratory. A paper titled, "Thermal infrared surface radiance and its validation," was presented by F. Palluconi and addressed the role of ASTER in surface radiance measurement. The approach adopted applied radiative transfer methods to determine the radiance at the satellite. A sensitivity study, concerning the impact of atmospheric temperature, water vapor, ozone, and visibility on the radiance, was presented. Also described was a validation program which was conducted over instrumented lakes in California and Nevada.

A. Gillespie, T. Matsunaga, S. Rokugawa, and S. Hook, in a paper titled, "Temperature and emissivity separation from Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) images," provided a description of a temperature and emissivity algorithm (TES) ultimately designed for application to ASTER. The approach involved an iterative scheme to remove the effect of downwelling sky irradiance reflected by the surface. From the validation data presented, it appeared that the scheme worked well over a variety of land surface cover types. Further, the derived spectral variation in emissivity compared well with *in situ* data acquired at the Railroad Valley Playa, Nevada, test site.

D. Ellement, M. Lynch, B. White, and I. Tapley presented "Land surface temperature estimation with AVHRR and numerical models applied to Western Australian field sites." With preset emissivities split-window LST algorithms were developed that are accurate to about 1 K over several instrumented test sites. A model of the diurnal LST cycle was being evaluated and applied to a remote region in the north of Western Australia. T. Schmugge and C. Coll's paper, "Application of the TES algorithm to TIMS data from HAPEX-Sahel," described the application of the TES scheme to TIMS imagery. The emissivity normalization derivation performed well but required a reasonably good first guess; whereas, for the emissivity min-max difference approach, the performance was comparable, but there was much less sensitivity to the first guess. Some difficulty was encountered for application to gray bodies.

A paper by M. Moriyama, "Error analysis of ASTER T/E Separation," described an implicit scheme which employed the covariance of the observations to estimate uncertainty in the retrieved surface variables. "Simultaneous determination of atmospheric correction parameters, LST and spectral emissivity from TIR multispectral data over land," by H. Tonooka, used a multi-pixel method, based on scene modeling, to estimate sky radiance and the surface parameters. The scheme was applied to TIMS data, and the performance and limitations were discussed.

The important information content in high spectral resolution infrared radiometry was the key point of the of the paper "Land surface temperature and emissivity estimation with high spectral/high spatial resolution sensors," by H. E. Revercomb, M. J. Lynch , L. E. Gumley, K. I. Strabala, and P. F. W. van Delst. High spectral resolution radiometry allowed the sampling of spectral regions in between atmospheric emission lines, where the atmosphere is highly transparent, and the downwelling thermal radiance is negligibly small. This approach permits a separation of the surface temperature and the spectral emissivity. "Validating remotely sensed land surface temperatures for surface radiation studies" by A. J. Prata, R. P. Cechet, I. F. Grant, and G. F. Rutter outlined an impressive program that continued the development of a network of ground-truthing stations spanning the Australian continent designed to support validation and modeling studies using satellite data. The comprehensive datasets being acquired at existing sites were described. Finally, the additional information gained using ATSR (Along-Track Scanning Radiometer) to evaluate LST was discussed and illustrated with examples using ATSR imagery over an Australian field site. S. N. Goward, R. O. Dubayah, K. P. Czajkowski, A. Waltz, and S. Liang in a paper, "Validation of the split-window land surface temperature algorithms," outlined activities in the AVHRR Pathfinder program and the studies that they were undertaking in global primary production and modeling the surface energy budget. They compared the results of an analysis of the performance of 12 split-window algorithms applied to datasets from BOREAS, FIFE, and HAPEX-Sahel, and undertook an estimation of the sources of error in the resulting LST products. The paper concluded with a discussion of the role of spatial scaling of datasets when statistics derived from a sensor of one spatial scale are compared with those derived from a sensor operating at a different spatial sampling scale (e.g., AVHRR and Landsat TM).

"MODIS and MAS LST field campaigns" by W. Snyder, Z. Wan, Y. Zhang, and Y. Feng, described field work conducted at Railroad Valley Playa on June 4, 1996, and outlined activities planned for a further BOREAS experiment later in 1996. These field campaigns were part of preparations for validation underflights of MODIS with MAS. Their error analysis showed that contributions of 0.3 K, 1.0 K, and 0.3 K were assignable to temporal, spatial, and calibration sources respectively, giving an accumulated error of 1.09 K. The analysis of the error budget for vicarious calibration of TIR sensors was addressed in a paper, "Selecting appropriate sites for calibration of TIR sensors," by Z . Wan. Associated modeling studies, which assumed realistic uncertainties in the knowledge of the atmospheric state (3 K in temperature, 30% in water vapor profiles, 10% in water vapor absorption coefficients), were presented. For successful vicarious calibration, the sources of uncertainties (radiative transfer ~0.2%, surface emissivity ~0.003, measured LST ~0.88%, calculated radiances at the top of the atmosphere ~0.37 %, ~0.71% and ~0.65%, for MODIS bands 29, 31, and 32, respectively) were expected to produce radiance rms errors 1.01%, 0.79%, and 0.74%, in these three MODIS TIR bands. A dry region in midwestern Tibet, and possibly in Bolivia, is the area where it is expected that these vicarious calibration accuracy requirements could be achieved.

The sole paper on the role of microwave radiometry, "Surface temperature estimation over land using satellite microwave radiometry," was presented by E. G. Njoku. After reviewing the key issues of concern in surface sensing (including surface soil moisture, soil/vegetation temperature, surface reflectance, vegetation canopy opacity and fractional cover, atmospheric opacity and mean temperature, and polarization) the performance of regression and non-linear iterative retrieval methods for temperature were presented. For a large simulated dataset, with multichannel measurements and homogeneous conditions, these two methods can retrieve surface temperatures with RMS errors of 2.1 K and 0.4 K, respectively, for assumed radiometric noise of 0.2 K. However, the effects of modeling error and sub-pixel heterogeneity can be expected to increase the retrieval error significantly.

R. Dickinson, M. Jin, and X. Zeng, in a paper titled, "A dataset of land surface temperature diurnal cycle from MODIS data and CCM/BATS," and a related presentation by Zeng and Dickinson titled, "How to use skin temperature in land surface modeling - the consideration of surface sublayer," described the coupling of satellite skin temperature with the NCAR CCM (Community Climate Model) coupled with the Biosphere-Atmosphere Transfer Scheme (BATS) over various land-cover classes in the model. The performance of the model-estimated skin temperature for the FIFE dataset (July 1987) was presented. The measurement error in skin temperature ratioed to the skin - air temperature difference was identified as a key requirement for accurate model performance, including flux estimation.

"TIR BRDF measurements and modeling" by W. Snyder and Z. Wan outlined laboratory facilities suitable for making measurements on samples collected in the field. The importance of translating the laboratory measurements on components to MODIS scene parameters was illustrated with a discussion of BRDF kernels and emissivity anisotropy as a function of zenith angle. A related paper by Y. Feng, Y. Zhang, and Z. Wan, "Measurement of the thermal infrared spectral emissivity of foliage," described improvements made to laboratory instrumentation and measurement procedures. The data were recorded over the 3-14 μm range but the band-averaged emissivities of vegetation canopies, for MODIS bands 31 and 32, showed that expected scene emissivities will vary over a very narrow range.

The meeting concluded with two review sessions chaired by S. N. Goward and F. Becker. The conclusions and recommendations are summarized below.

Findings

The prime task of the LST algorithms is to accurately correct both the atmospheric and emissivity effects in the TIR data for recovering LST. For land covers with high and stable emissivities, such as lake surfaces, snow, ice, and vegetation, split-window LST methods can be used to retrieve LST with surface emissivities estimated from ancillary information or prior knowledge. The coefficients of the split-window algorithm are derived from model simulations or field measurements conducted under certain atmospheric conditions. In high-humidity conditions the accuracy of split-window methods can be improved by adjusting these coefficients based on viewing angle and external assessment of the ranges of the atmospheric water vapor and temperature from satellite sounding, radiosonde, or meteorological analysis. Vegetation has a high value of and little angular variation in its emissivity in the split-window range (10-13 μm) because the component emissivity of vegetation is already high and is increased further by its structural properties. In semi-arid and arid regions, the surface emissivity varies over a wide range. This can result in a significant error in LST retrieved by the split-window method. Several multi-band and/or multi-temporal methods have been developed for retrieving surface temperature and emissivity simultaneously.

These methods utilize the special capabilities of specific sensors in remote sensing of the surface TIR status. For example, ASTER has five bands in the 8-12 μm range, MODIS has three bands in the 3.5-4.2 μm range and four bands in the 8-13.5 μm range, and HIS (High resolution Interferometer Sounder) and AERI (Atmospheric Emitted Radiance Interferometer) provide high spectral resolution interferometric data in the 590-2750 cm^{-1} range. The benefit of high spectral resolution of the latter sensors does permit a separation of the reflected atmospheric downwelling radiance from the surface emitted radiance because the atmospheric emission line structure is resolved. This will be a benefit for validation but it will be some time before this capability exists on orbit (AIRS on PM-1). With the advances in TIR sensor technology and in LST algorithms, and the synergism between LST products generated from data of different satellite sensors with mixed characteristics in spatial, temporal, and spectral resolutions, it is possible to provide LST products for global and regional studies.

It is essential to make comprehensive error and sensitivity analyses of LST algorithms over wide ranges of atmospheric and surface conditions. A common source of error occurs when the resampling or mapping is made to obtain LST values at geolocated grids from the LST field that is retrieved from airborne or satellite data by whatever LST algorithms. In most applications, LST values are required at geolocated grids for temporal analysis and for uses combined with other data. The size of this error depends on the gradient in the retrieved LST field and it may be significantly larger near boundary areas. In such areas, mis-registration of day and night data would increase the error of the MODIS day/night LST algorithm. Numerical simulations of the mis-registration in areas where pixels are mixed with two components with different emissivities and at different temperatures show that the MODIS day/night LST algorithm still works well (the RMS error in retrieved LST values over wide ranges of conditions is smaller than or near 1K) as long as the uncertainty in registration does not exceed 20 percent. Therefore, it is proposed to use the MODIS day/night LST algorithm to retrieve surface temperatures and band emissivities initially at 5-km resolution (the resolution used in the MODIS product of atmospheric temperature and water vapor profiles is five by five 1-km pixels).

A clearer understanding of the applications of LST is needed. For instance, the LST accuracy needed in climate models is not a constant but a function of the surface-to-air temperature difference. More study is required regarding the relation between the LST retrieved from TIR data, and the LST and the lower boundary fluxes in climate models. Also, spatial scaling plays an important role in global climate modeling. Study is ongoing as to how LST scales and the impact on climate modeling. Further, polar satellite LST provides 'snapshots' during the diurnal cycle that must be incorporated into climate modeling.

There is a need for more conclusive *in situ* validation and accurate field measurement data that address sampling and instrumentation issues properly. Sampling a dynamic and spatially-varying view-angle dependent temperature field is often a dominant source of error. We need to consider combined use of radiometric and kinetic surface sensors and their placement. It is obvious that accurate field validation of LST can be made only over large flat uniform test sites and that comprehensive numerical simulations are needed to validate the inherent capability of LST algorithms in dealing with pixels mixed by components with different emissivities and at different temperatures. Significant improvement would result from the use of airborne sounders which are nadir-looking coincident with a scanner. There is also a need for long-term sites to establish accuracy under varying conditions and to provide data to a larger community.

More attention is needed for cirrus clouds and aerosols. For instance, the capability of cirrus detection at night may be questionable. Although aerosols play only a small role under normal conditions, there are certain areas with regularly high aerosol values which will bias the retrieved LST. The aerosol parameters in most atmospheric transmittance models may be not satisfactory and require improvement via controlled field experiments.

There is continued potential for new and better LST algorithms. These algorithms will motivate and follow the development of cheaper and better instruments, for instance, high-spectral and high-temporal resolution sensors. For self-contained algorithms, an increase in the number of bands will allow better estimates of the atmospheric characteristics and possibly reduce the sensitivity to land-surface spectral emissivity if the signal-to-noise ratio of observation data is large enough.

Improvements for external methods will consist of the incorporation of assimilation data over time. Also, it is expected that sounder data will become more common and more accurate. This will provide the atmospheric profiles of temperature and water vapor needed for LST recovery. Passive microwave instruments provide a valuable, independent assessment to incorporate into LST algorithms. But it is important to understand the physical difference between the surface "skin" temperature measured by TIR sensors and microwave-measured temperature in real applications. The accuracy of LST estimated from microwave data is limited by the uncertainties in surface emissivity, which is affected by surface moisture variations. This would be improved with longer wavelength channels in future instruments.

The accuracy and role of geostationary sensors for providing higher temporal sampling of land temperature should be investigated. Such sensors offer a higher probability of achieving cloud-free conditions for a given location and also would provide datasets at times more appropriate for model assimilation.

Recommendations

1. Make intercomparisons of different LST algorithms in their accuracy and sensitivity with real data in well-characterized surface conditions, and with numerical simulations in wide ranges of atmospheric and surface conditions.

2. Study the dependence of LST on solar and view angles, and the impact on LST applications through *in situ* measurements and modeling.

3. Enhance the relation between land-surface temperature/emissivity and atmospheric profile products.

4. Land-surface temperature currently is an output of numerical models. But the temperature normally introduced in models is an aerodynamic temperature which cannot be measured from space. It would be, therefore, important to improve our knowledge on the relationships between the radiative and the aerodynamic temperatures so that LST measured from space can be used to validate the model outputs. Encouragement should be given for the conduct of numerical simulation experiments which assimilate LST measured from space and determine the level of impact on the forecast.

5. Conduct a field campaign workshop to continue the study of the requirements and implementation of field LST validation.

6. Conduct an air/satellite field validation campaign using a combination of high-spectral and high-spatial-resolution airborne sensors as well as the polar and geostationary satellites. Diagnose the techniques for validation with a relatively easy target in a low-humidity atmosphere. Translate these to more critical high-humidity conditions in later experiments. Examine the viability of TIR vicarious calibration.

7. Re-examine the optimal bands for multi-band LST for future instruments.

8. There is a need to establish a set of permanently instrumented field sites so that algorithms can be tested over the full range of meteorological and surface conditions that occur at a given location.

Report of the EOS Data Quality Assurance (QA) Workshop

— Bob Lutz (rlutz@ltpmail.gsfc.nasa.gov), Hughes STX

On November 6, 1996, an EOS Data Quality Assurance (QA) Workshop was convened at the Goddard Space Flight Center. Approximately 60 people attended, including Principal Investigators (PIs) or their representatives from Instrument Teams (ITs) of the AM-1 and PM-1 platforms, SAGE-III, and TRMM; representatives from the DAACs and several Interdisciplinary Science (IDS) Teams; and numerous Earth Science Data and Information System (ESDIS), EOS Project, and NASA Headquarters personnel. The Workshop continued an effort that the QA Scientist (Bob Lutz) had been pursuing for the past two years under the auspices of the ESDIS Science Office (H. K. Ramapriyan).

Bob Lutz opened the meeting, welcomed the participants, and provided logistical information.

Skip Reber (EOS Deputy Senior Project Scientist and Acting Earth Observing System Data and Information System [EOSDIS] Project Scientist) spoke next, defining the following goals for the workshop:

- to have each Instrument Team (IT) present its QA methodologies;
- to share thoughts among the Project, ITs, and EOSDIS Core System (ECS) on QA;
- to agree that data need to be published with error assessments; and
- to agree to some form of common nomenclature and format.

H. K. Ramapriyan followed Reber's introductory remarks. He stated that while it is understood that quality assessment of data products is the responsibility of the respective instrument teams, the QA planning is being coordinated by the ESDIS Science Office to ensure that:

- the ESDIS Project understands the requirements that the ITs have on EOSDIS;
- the IT requirements are provided by the ITs in time to meet the overall schedules of the system development;
- the QA Plans of each of the ITs are made available to the others and to the other users of EOSDIS; and
- EOSDIS is developed to provide the services needed to meet the ITs' QA needs.

Bob Lutz then presented the agenda of the workshop. He also explained that prior to the workshop, each AM-1 team had been provided copies of the QA Plans that had been received by the ESDIS Project from the other teams and E-mailed a list of questions/issues that they were requested to cover in their presentations. In addition, all IDS teams had been solicited through a questionnaire (one-third responded) for their desired requirements on QA parameters from the AM-1 teams.

The morning session and a portion of the afternoon discussion were devoted to instrument team QA presentations. (It will be noted in the following report, that the instrument teams are using different terminology for the same functions. The issue of developing a common nomenclature is still being resolved.)

Erika Geier presented the CERES QA Plan, which had been submitted to ESDIS prior to the Workshop. The CERES QA plan is divided into automated QA done at the DAAC and manual QA done at the Scientific Computing Facilities (SCFs). Automated QA is performed by the production software. Errors will be handled in 2 ways: 1) A flag is set when problems occur. 2) In the case of a fatal error, "alarm scenarios" are activated. Every granule of an archival data product will have associated with it at least one Quality Control (QC) report. Manual QA is performed by the Data Management and Science Team, and the QA method is based on that used for the Earth Radiation Budget Experiment (ERBE). They have alarm/stop conditions if they do not want data production to continue. CERES expects metadata support for the Science Product Access Code.

Paul Bailey summarized the MOPITT QA Plan, which also had been supplied for review before the workshop. MOPITT QA activities are limited to what can be done operationally as the data products are produced. QA Analysis components include DAAC Product Generation Executive (PGE) components and SCF components. DAAC PGE components include on-line checks and Exception Logs, post processing of Exception Logs, and Data Product (DP) Summaries. SCF components include manual granule review, retrieval of Exception Logs and DP granules, and the transmission of the Granule Accessibility Code and metadata to the DAACs. Bailey indicated that there will be no QA functions performed by DAAC personnel, and he provided estimates of SCF staffing.

The MODIS QA Plan consists of four separate QA Plans coordinated by Al Fleig (not present at the workshop). The four plans are for Level 1B, Land, Atmosphere, and Ocean products. (Note : though a representative from Level 1B was not at the workshop, a detailed QA Plan for Level 1B had been provided to ESDIS for distribution and review.)

David Roy discussed the MODIS Land (MODLAND) QA Plan, which was distributed at the meeting. QA Activities are to be performed at the proposed MODLAND data processing facility (Land Data Product Evaluation—LDOPE facility). QA procedures which are used by algorithm developers, DAAC personnel, and data product users are executed at run and post-run time. For science data run time, QA information is stored in mandatory and optional QA planes. MODLAND said that product metadata summaries are stored in the mandatory QA plane and core metadata are stored in the mandatory ECS QA flags. Post-run-time QA will be applied to each product. Estimates of data volume QA-ed and staffing were also provided.

The MODIS Atmosphere QA Plan was presented by Allen Chun. MODIS Level 2 atmospheric products, spatial resolution, and run-time QA flags were presented. (This Draft QA Plan was submitted to ESDIS in March 1997.)

Bob Evans reviewed the MODIS Oceans QA Plan. The MODIS Oceans QA methodology is based on a series of steps that include use of engineering data and flags from the Level 1 product to determine if a pixel is suitable for processing (i.e., sensor and ancillary data valid). Level 2 flags are in part shared between Sea Surface Temperature (SST) and color (observation geometry, spatial/spectral cross-talk, polarization angle, and mirror incidence angle), together with state of the atmosphere. Evans reported that each ocean product will use the first flag set to determine product-specific flags. The Level 3 processing is conducted separately for each ocean product and uses a binning scheme, which preferentially keeps the highest quality data. At Level 3 the flags are combined into 4 quality levels.

Ralph Kahn and Barbara Weymann discussed the MISR QA Plan, which was received by ESDIS in January 1997. Prior to the Workshop, an article had been published (*The EarthObserver*, January/February 1996), describing their methodology. Science QA parameters are developed in concert with data product generation. Errors in the PGE processing result in "fatal alarms." DAAC operators monitor these alarms and may examine images. They contact the SCF on any anomalies found. Activities required are currently being negotiated between the LaRC DAAC and MISR and will be documented in the MISR Operations Agreement. MISR has also developed error-processing scenarios. They will use the "pull scenario" for data to be sent to the SCF for evaluation. Data transfer rates were also provided.

Craig Leff summarized the ASTER QA Plan, which was submitted in advance of the workshop. ASTER performs automated QA within the PGEs at the DAAC during production, and manual QA of every nth product (TBD) at the SCF. Future plans may include participation of the DAAC staff in science QA. A flowchart was presented depicting ASTER QA operations. Alert information is generated, if necessary, for every PGE, with the alert log periodically archived for Science Team review. Each output pixel range is to be checked, and bad data will not be replaced with marker values. QA data planes will only be used for data products at Level 2 and above. Estimated ASTER data flows between the DAAC and the SCF, and the staffing required, were discussed.

Jim Stobie described the Data Assimilation Office (DAO) QA approach. A formal QA Plan will be submitted at a future date. DAO uses instrument data (including information about the instrument errors) to produce its assimilated products. The assimilation process is a series of cycles. Each cycle involves:

1. Running a model-generated forecast based on the output from the previous cycle. This results in a first guess.

2. The first guess is then compared with observations and adjusted accordingly. The amount of adjustment depends on the quality and quantity of the observations. High-quality observations receive more weight than low-quality observations. The assimilation process depends on accurate error statistics for both the observations and the first-guess model. DAO also reported that important by-products of the assimilation process are updates to the model and instrument error statistics.

Concluding the instrument team presentations, Vanessa Griffin (speaking for Steve Goodman) reviewed TRMM-LIS QA methodology.

LIS QA parameters will include: false alarm rate, event probability, and summary statistics. For manual QA, errors are flagged for improper dataset assembly or problems with the science data or platform time/ephemeris. LIS processing will be performed by the LIS SCF operations team.

Laurie Glaze, a representative of the Volcanology IDS Team, discussed the team's QA information needs. The Volcanology Team uses datasets from several instrument teams (ASTER, MODIS, and MISR) and will need to understand QA parameters from each IT. This team's minimum requirements for QA data include QA data parameters for each scene and QA parameters per pixel, with a major concern being the flagging of bad, missing, or interpolated data. The team is also concerned with how much confidence there is in radiance data. The Volcanology Team concluded that they would like to have access to QA Plans, as they are developed, and instrument team test datasets, with QA parameters included, to modify their algorithms. (A general area of concern was voiced during this presentation. Realizing that some AM-1 products may have as many as 20 QA parameters, IDS teams that use numerous products may face a considerable task of interpreting hundreds of QA parameters.)

ECS support for QA activities was then reviewed by Karl Cox. General services provided by ECS for QA include:

- ability to acquire data and information for QA;
- accept and store QA information;
- update QA metadata attributes; and
- ability to alert operational staff to suspend operations when QA failure occurs

The Science Data Model QA attributes were then described. They represent the metadata in the inventory tables. There are separate Automatic, Operational, and Science QA flags for each granule, with explanation fields associated with each. The Automatic Flags are set by the PGE, and the Science flag is set by the SCF. Comments from members of the ITs during this discussion indicated that additional QA support is needed from ECS. Specifically, this includes a method for batch updates by the SCFs of QA metadata and the allowance of multiple sets of flags/statistics per granule for different parameters. (Note: ECS has agreed to fulfill both of these requirements.) It was recognized during this session that a more-effective dialogue needs to be established between ECS and the ITs concerning QA requirements.

Bob Lutz and Skip Reber led a discussion on QA data dependencies amongst the AM-1 teams. Each team provided material on what information is needed from another IT for its dataset production. A conclusion was reached that identification of specific QA parameters was needed from the data producers before the final B.0 QA Plans are due. A subsequent discussion was then held to come to an agreement on definitions of content, structure, and code QA parameter descriptions, so that appropriate dates could be set for the delivery of these parameters.

At the conclusion of the meeting, an Action Item list was generated. The most important of these Action Items was:

- An interactive dialogue between ECS and the ITs needs to be established to communicate IT QA requirements.

To work this issue and several of the issues below, a small QA Working Group has been formed. The group includes representatives from the ITs, ECS, ESDIS, and the DAACs. To specifically address this issue, all ITs were requested to scrub their requirements (ECS functions and services) needed for QA. These requirements were compiled and forwarded to ECS. ECS has since provided a response to these requirements, which was communicated to the ITs via the QA Working Group. A QA Working Group meeting has been scheduled for the summer of 1997 to discuss these ECS responses, any unresolved QA Workshop Action Items, and B.0 QA operational scenarios.

Other Action Items included :

- The ability of the SCF Metadata Update Tool to identify granules is limited. ECS needs to provide granule identification within the tool and to allow this tool to function in concert with the Subscription and Data Ordering Tools (i.e., linked functionality of the tools). (ECS has conceptually agreed to fulfill this requirement. The QA Working Group will provide guidance to ECS on this issue.)

- IDS teams, ITs, and non-ECS users need a tool to view and display QA information in a convenient and user-friendly manner. (A Tiger team of the Client Design Working Group has been working the general issue of the displaying [and grouping] of core and product-specific metadata on the Client.)

- The QA Working Group will address and come to closure on a common method of presenting and publishing QA information/terminology amongst the ITs, i.e., common nomenclature. (This issue will be discussed and resolved at the QA Working Group meeting).

- A QA Home Page will be developed by the ESDIS Science Office to allow easy access to IT Draft QA plans and QA information. (This has been established—see end of article.)

- All instrument teams will supply information on QA parameters that are prioritized in terms of content by March 20, 1997. Code parameters will be delivered by July 1, 1997. The collection of these parameters will be disseminated to all ITs, via the Working Group, for comment. (As this information is known, it will be disseminated. This is an ongoing Action Item.)

- Though it is realized that Science QA is an Instrument Team responsibility, some ITs have indicated that they will negotiate with their DAACs to share QA responsibilities. Agreements are needed on the division of these DAAC/SCF QA functions. (This item is in the process of being completed by the ITs and their respective DAACs and will be discussed at the QA Working Group Meeting.)

Several issues, such as the interaction of validation on QA activities, were not discussed during the workshop due to time constraints. A follow-on workshop is expected to be conducted during the winter of 1997-1998, after the ITs develop their final B.0 QA Plans, to address these and other QA issues that may arise.

The workshop agenda, minutes, and action items are found within the ESDIS Science Homepage (http://spsosun.gsfc.nasa.gov/Science/QA_Nindex. html) under the heading Quality Assurance. For additional information regarding the topic of Quality Assurance, please contact the author (rlutz@ltpmail.gsfc.nasa.gov).

Landsat 7 Comments Solicited

NASA is soliciting comments on Landsat 7 and user needs for Landsat 7 ETM+ data. Interested parties are invited to complete a questionnaire available on the Internet or via printed copy.

The Internet address for the questionnaire is: http://geo.arc.nasa.gov/sge/landsat/newsurvey.html.

To receive a printed copy, send your request to:

E. Sheffner
MS 242-4
Ames Research Center
Moffett Field, California 94035
Fax: (415) 604-4680.

Results of the MTPE Education NRA

— Stephanie Stockman (stockman@denali.gsfc.nasa.gov), MTPE Education Program

Last fall, NASA's Mission to Planet Earth (MTPE) Program announced its first National Research Announcement specifically focused on education, NRA-96-MTPE-07, "Opportunities to Participate in NASA's Mission to Planet Earth Education Program." This announcement, developed in conjunction with the NASA Education Division, sought to round out and strengthen the MTPE Education Program by soliciting unique and innovative proposals from a broad range of education and research professionals to address two specific areas. Those two areas were Earth system science education for the pre-service teaching community, and support of undergraduate student research opportunities in Earth system science.

A total of 61 proposals were received from over 50 different institutions in response to this NRA. Using a peer review process that included both science and education professionals, 18 proposals were selected for funding at a level of nearly $700,000 per year for the next 3 years. This group includes 12 pre-service teaching proposals and 6 undergraduate student support proposals as listed below.

Pre-Service Teacher Enhancement

Planet Earth Workshops for Teachers of Physical Science
PI - Dr. John J. Sullivan
University of New Orleans, New Orleans, LA 70148-2840

CISAT Pre-Service Teacher Enhancement Workshop
PI - Dr. James L. Barnes
James Madison University, Harrisonburg, VA 22807

Umass Planet Earth Education Program (Planet Earth)
PI - Dr. Morton M. Sternheim
University of Massachusetts, Amherst, Amherst, MA 01003

Introductory Training for Pre-Service Teachers in Earth System Science
PI - Dr. Vicki Harder
University of Texas, El Paso, El Paso, TX 79968

Earthworks: Educating Teachers in Earth System Science
PI - Dr. Hartmut Spetzler
University of Colorado, Boulder, Boulder, CO 80309-0216

Pre-Service K-12 Teacher Workshops for Earth Systems Science and Policy
PI - Dr. Jack F. Paris
California State University, Monterey Bay, Seaside, CA 93955-8001

Mission Possible: Earth System Science, the Curriculum, and You
PI - Dr. Valerie K. Olness
Augustana College, Sioux Falls, SD 57197

Concepts and Pedagogical Strategies in Earth System Science Education for K-12 Teachers of Science and Environmental Education
PI - Dr. Richard Busch
West Chester University, West Chester, PA 19383

Pre-Service Earth Science Training Opportunity (PESTO)
PI - Dr. John Katzenberger
Aspen Global Change Institute, Aspen, CO 81611

A Cross-Disciplinary Literacy Course on Earth System Science for Teachers in the 21st Century
PI - Dr. Assad A. Panah
University of Pittsburgh, Bradford, PA 16701-2898

Pre-Service and In-Service Teacher Enhancement Using a Space Camera
PI - Dr. Wallace Fowler
University of Texas Austin, Austin, TX 78759-5321

A Summer of Seasons
PI - Dr. S. Raj Chaudhury
Norfolk State University
Norfolk, VA 23504

Higher Education Student Support

Advanced Undergraduate Research Using Optical Radiation in the Atmosphere (AURORA)
PI - Dr. Doyle A. Temple
Hampton University, Hampton, VA 23668

UCSB Earth System Science Undergraduate Summer Research Program
PI - Dr. Catherine Gautier
University of California, Santa Barbara, Santa Barbara, CA 93106

Undergraduate Internships in Earth System Research at Biosphere 2 Center
PI - Dr. W. S. Broecker
Columbia University, Palisades, NY 10964
Oricle, AZ 85623

Earth Systems Field Research Experience for Undergraduates
Foundation for Glacier and Environmental Research
PI - Dr. Maynard M. Miller
University of Idaho, Moscow, ID 83844

OUR Earth: Opportunities for Undergraduate Research in Earth System Science
PI - Dr. Janice DeCosmo
University of Washington, Seattle, WA 98195

Research Experience in Earth System Science
PI - Dr. Waldo J. Rodriguez
Norfolk State University, Norfolk, VA 23504

EOSDIS Metadata Workshop of April 1-2, 1997

— H. K. Ramapriyan (rama@ulabsgi.gsfc.nasa.gov), ESDIS Project, Code 505, NASA Goddard Space Flight Center, Greenbelt, MD 20771

One of the issues discussed at the meeting of the EOSDIS Panel (a.k.a. the Data Panel) February 12-14, 1997, was the "tension between at least two communities in the EOSDIS world" (see David Glover, "Minutes of the EOSDIS Panel Meeting," *The Earth Observer*: Jan/Feb 1997, vol. 9, No. 1, pp. 3-6). It was recommended by the Panel that a "metadata workshop be held or better yet a series of metadata workshops," where "the users and implementers of the metadata" were to be "brought together for an open exchange of ideas." Skip Reber (Deputy Senior EOS Project Scientist and Acting Project Scientist for EOSDIS) volunteered to start the workshop series under the auspices of the Data System Working Group, which he chairs.

The first workshop in the series, called "Pre-Launch Metadata Workshop," was held at the George Mason University in Arlington, VA, during April 1 and 2, 1997. Moshe Pniel from the ASTER team chaired the workshop. Participants included data producers from each of the AM-1 and SAGE III instrument teams, end-user representatives from the Data Panel, the DAACs, the ESDIS Project, and ECS staff.

The primary purpose of the workshop was to expedite the development of metadata in the ECS for data production and distribution prior to the launches of Landsat-7, AM-1, and SAGE III, and to ensure a clear understanding of the roles and responsibilities of the Instrument Teams, DAACs, ESDIS Project, and ECS in the provision of metadata. There were discussions of how metadata are created and used as well as the metadata needs of both the instrument teams and end-users. While changes to the metadata model for B.0 (the release of ECS ready for the launch of Landsat-7, AM-1, and SAGE-III) are very limited, and only minor changes can be accommodated to B.1 (the release to be delivered in January 1999), ways were discussed to simplify the metadata input process for the instrument teams while satisfying the needs of the end-users.

The format of the meeting included plenary sessions in the morning, which allowed for some training on the purpose and design of the metadata model and allowed for open discussion of issues and concerns regarding the model. Afternoon breakout sessions for each of the AM-1, Landsat-7, and SAGE-III instrument teams allowed for discussion and resolution of their specific concerns and needs. Each team included representatives from the ESDIS Project and ECS to answer detailed questions. In addition, ECS experts floated from team to team in order to answer detailed questions regarding the data model and the system.

Results of the meeting were very positive. Several instrument team representatives thought that significant progress was made in understanding of the data model and ECS issues and recommended that another metadata workshop be convened to discuss the Release B.1 metadata model. Issues identified are being worked by the ESDIS Project and ECS, and feedback on their resolutions will be provided to the concerned groups. Currently, the ESDIS Project and ECS are pulling together all of the information from the workshop to put on a web page. As soon as this is available we will send out a notification.

Japanese Advanced Earth Observing Satellite (ADEOS) WWW On-line Services

— Shinichi Sobue (sobue@eos.nasa.gov), NASDA Liaison to Earth Science Data and Information System (ESDIS) Project
— Mathew Schwaller (matt@ulabsgi.gsfc.nasa.gov), NASA ESDIS Project, NASA Goddard Space Flight Center

The National Space Development Agency of Japan (NASDA) is pleased to inform you of Advanced Earth Observing Satellite (ADEOS) on-line services available via the World Wide Web (WWW). In August, 1996, at the Tanegashima Space Center in the southern part of Japan, NASDA successfully launched this new Earth observation satellite, which was developed through international collaboration. NASDA has begun operating ADEOS in its standard observation mode, and the NASDA Earth Observation Center (NASDA/EOC) is working with NASA and other sensor providers [Centre National d'Etudes Spatiales (CNES) of France, and the Environment Agency (EA) and Ministry of International Trade and Industry (MITI) of Japan] to receive, process, archive, and deliver ADEOS standard product data and related information. All ADEOS raw and Level 0 data as well as Advanced Visible and Near Infrared Radiometer (AVNIR) and Ocean Color Temperature Scanner (OCTS) standard products are archived at the NASDA/EOC and each sensor's data are also archived by the sensor provider.

In collaboration with ADEOS sensor providers, NASDA has established a virtual on-line ADEOS data and information system to promote ADEOS data utilization for global change study over the Internet via the WWW.

Now, Earth scientists have world wide access to ADEOS data and related information with the following URLs:

1. NASDA home page for ADEOS: http://yyy.tksc.nasda.go.jp/Home/This/This-e/adeos_e.html

2. NASDA on-line information service pages for ADEOS
   (a) ADEOS first images. (NASDA worked with NASA, CNES, MITI, and EA to provide the first ADEOS image from each sensor) http://www.eoc.nasda.go.jp/guide/guide/satellite/satdata/adeos_first_index_e.html

   (b) Browse service [OCTS, NASA Scatterometer (NSCAT), and Total Ozone Mapping Spectrometer (TOMS)]
   http://www.eoc.nasda.go.jp/guide/www/index_e.html
   http://seawifs.gsfc.nasa.gov/seawifs_scripts/octs_browse.pl

   (c) Intensive Local Area Coverage (LAC) (OCTS Level 3 Chlorophyll-a, SST) http://www.eorc.nasda.go.jp/ADEOS/ILAC/RtcL3p.html

3. ADEOS sensor provider home pages
   (a) EA: http://www-ilas.nies.go.jp
   (b) MITI: http://img.ersdac.or.jp
   (c) NASA/JPL NSCAT: http://www.jpl.nasa.gov/winds
   (d) NASA/GSFC TOMS: http://jwocky.gsfc.nasa.gov
   (e) NASDA/TEDA (Technical Data Acquisition): http://akebono.tksc.nasda.go.jp

NASDA is prototyping a Web Gateway to its Earth Observation data and Information System (EOIS), which will provide access to ADEOS data catalogue services under the Global Observation Information Network (GOIN) initiative. NASDA will demonstrate the first prototype Web Gateway access in June 1997 at the GOIN workshop in Boulder.

In addition, NASDA is working together with NASA, NOAA, ESA, and the European community to develop an on-line OCTS Intensive Local Area Coverage (ILAC) system to provide OCTS data via the Internet.

Teams Selected for Studies of Potential Partnership with NASA to Develop New Earth Imaging Radar System

—Douglas Isbell, NASA Headquarters, Washington, DC, (Phone: 202/358-1547)
—Mary Hardin, Jet Propulsion Laboratory, Pasadena, CA, (Phone: 818/354-5011)

Four industry teams have been selected to study potential partnering arrangements to implement LightSAR, a proposed new Earth-imaging satellite system that would use advanced technologies to reduce the cost and enhance the quality of radar-based information for scientific research, commercial remote-sensing and emergency management applications.

LightSAR's synthetic-aperture radar measurements would provide high-resolution images on a nearly continuous basis, giving the project considerable capability to map changes in land cover, generate topographic maps and provide long-term mapping of natural hazards such as earthquakes, floods and volcanoes.

"With LightSAR we are attempting an innovative teaming arrangement between government and industry to develop a mission that meets both NASA's science objectives and industry's commercial objectives," said Dr. Steven Bard, LightSAR pre-project manager at NASA's Jet Propulsion Laboratory (JPL), Pasadena, CA. "This unique teaming approach includes having industry share in the cost of the mission, beginning with these studies.

Potential commercial applications of LightSAR data include mapping and cartography, crop monitoring and health assessment, forestry management, resource exploration, and environmental monitoring, including oil spills and coastal zone monitoring.

"The results of these studies, especially as they relate to proposed teaming and cost-sharing arrangements for the follow-on phases, will help establish an appropriate implementation approach, should NASA decide to proceed further with a LightSAR mission," said William Townsend, acting Associate Administrator for NASA's Office of Mission to Planet Earth, Washington, DC.

Results from the studies, valued at $700,000 each, are due in November 1997. Members of the four selected study teams, each headed by a prime contractor, are:

- DBA Systems Inc., Melbourne, FL (prime), and CTA Space Systems, McLean, VA.

- Lockheed Martin Astronautics, Denver, CO (prime); Space Imaging EOSAT, Lanham, MD; Autometric Inc., Alexandria, VA; Earth Satellite Corp., Rockville, MD; ERDAS Inc., Atlanta, GA; Environmental Research Institute of Michigan (ERIM), Ann Arbor, MI; Observera Inc., Alexandria, VA; Pacific Meridian Resources, Portland, OR; User Systems, Inc., Chesapeake Beach, MD; University of Michigan Radiation Laboratory, Ann Arbor, MI; and Lockheed Martin Tactical Defense Systems, Phoenix, AZ.

- Research & Development Laboratories (RDL), Culver City, CA (prime); Spectrum Astro, Gilbert, AZ; Environmental Research Institute of Michigan (ERIM), Ann Arbor, MI; Harris Corp., Melbourne, FL; Alenia Spazio, Rome, Italy; and Georgia Tech Research Institute, Atlanta, GA.

- Vexcel Corp., Boulder, CO (prime); Ball Aerospace & Technologies Corp., Boulder, CO; EarthWatch, Inc., Longmont, CO; SpaceTec, Hampton, VA; and South Dakota Space Technology Group, Rapid City, SD. Affiliate members include ERDAS Inc., Atlanta, GA; University of Michigan Radiation Laboratory, Ann Arbor, MI; Bechtel, San Francisco, CA; Dynamics Technology Inc., Torrance, CA; Cargill, Minnetonka, MN; Georgia-Pacific Corp., Atlanta, GA; and CAL-FED Bay-Delta Program, Sacramento, CA.

NASA's Stennis Space Center Commercial Remote Sensing Program (CRSP) is managing the commercial applications development effort for the LightSAR project, and will assist the industry teams in conducting pilot applications projects.

JPL is managing the pre-project development of the LightSAR mission for the Office of Mission to Planet Earth.

New Wind Data Improving Accuracy of Weather Forecasts

— Douglas Isbell, NASA Headquarters, Washington, DC. (Phone: 202/358-1753)
— Mary A. Hardin, Jet Propulsion Laboratory, Pasadena, CA. (Phone: 818/354-5011)
— Allen Kenitzer, Goddard Space Flight Center, Greenbelt, MD. (Phone: 301/286-2806)
— Stephanie Kenitzer, NOAA National Weather Service, Silver Spring, MD. (Phone: 301/713-0622)

NASA scientists using weather forecast models with newly incorporated data from the wind-measuring NASA Scatterometer (NSCAT) instrument on board Japan's Advanced Earth Observing Satellite (ADEOS) are seeing significant improvements in their ability to analyze weather patterns and generate more accurate forecasts, especially in the Southern Hemisphere.

"Initial experiments with the wind measurements taken by the scatterometer indicate the potential to extend the useful range of weather forecasts in the Southern Hemisphere by about 24 hours," said Dr. Robert Atlas, an NSCAT science team member from the Goddard Space Flight Center, Greenbelt, MD. "We have also seen improvement in early analyses and forecasts of storms in the Northern Hemisphere. Specifically, NSCAT appears to more accurately locate both cyclones and fronts, and to improve the forecasts of their location by as much as several hundred kilometers."

Such information should assist meteorologists at the National Oceanic and Atmospheric Administration's Marine Prediction Center, Camp Springs, MD, to issue more accurate warnings that could help reduce the loss of life and property at sea and along the U.S. coastline.

Accurate measurements of wind velocity in the Southern Hemisphere have been virtually non-existent due to the vastness of the southern ocean. The scatterometer takes 190,000 wind measurements per day, mapping more than 90 percent of the world's ice-free oceans every two days. The instrument is giving scientists more than 100 times the amount of ocean wind information than is available from ship reports or buoys. Because the scatterometer is a radar instrument, it operates 24 hours a day, collecting data day and night, regardless of sunlight or weather conditions.

"Since the August launch, we've set a new standard in terms of how quickly we have been able to calibrate and validate our instrument and get the data into the hands of the people who are using it," said Jim Graf, NSCAT Project Manager at NASA's Jet Propulsion Laboratory, Pasadena, CA.

"Weather forecasters will be able to use these data to better predict the evolution of fronts and storms over the oceans and track them as they approach land and major population centers. The maritime industry will benefit by steering ships away from storms and toward areas with favorable tailwinds," Graf said. "By combining the scatterometer wind data with ocean height data from the TOPEX/Poseidon mission, Earth scientists are getting a first hand look at the forcing function, the winds, and the ocean's response, ocean height and waves, or the *yin* and *yang* that control much of our planet's weather and climate change."

The NSCAT project also is making the wind images available to the public via the Internet at the following address: http://www.jpl.nasa.gov/winds.

"Each day, we provide a 'daily wind movie' of the Pacific Ocean that allows people to see the last 26 hours of NSCAT wind data. Anyone who has an interest in what the winds are doing — weather forecasters, scientists, boaters, surfers, fishermen — can log on and get an up-to-date picture from NSCAT," Graf said. Data of the Atlantic Ocean and other oceans will be on-line in a few weeks.

The scatterometer uses an array of stick-like antennas that radiate microwave pulses in the Ku-band across broad regions of the Earth's surface. A small fraction of the energy in the radar pulses is reflected back and captured by NSCAT's antennas. At any given time NSCAT's array of six dual-beam antennas scans two swaths of ocean — one on either side of the satellite's near-polar, sun-synchronous 500-mile orbit. Each swath is 375 miles wide. The swaths are separated by a gap of about 215 miles directly below the satellite where no data collection is possible.

The NSCAT instrument was launched August 16, 1996, on Japan's ADEOS. ADEOS includes instruments from the United States, Japan, and France, with investigators from many other countries. The satellite is a key part of an international environmental research effort that includes NASA's Mission to Planet Earth (MTPE).

The Jet Propulsion Laboratory developed, built, and manages the NSCAT instrument for NASA's Office of Mission to Planet Earth, Washington, DC.

Science Calendar

June 11-12	SAGE III Science Team Meeting, Hampton University, Hampton, Virginia. Contact Sandra Smalley, tel. (757) 864-6211, e-mail: s.e.smalley@larc.nasa.gov.
June 10-11	AMSR Science Team Meeting, Global Hydrology and Climate Center, Huntsville, Alabama. Contact: Elena Lobl, (205) 922-5912, e-mail: elena.lobl@msfc.nasa.gov.
June 11-13	TES Science Team Meeting, Harvard University. Contact: Reinhard Beer, e-mail: beer@caesar.jpl.nasa.gov.
June 16-17	NSIDC DAAC User Working Group (PoDAG), Boulder, Colorado. Contact: Ron Weaver, (303) 492-7624, e-mail: weaver@kryos.colorado.edu.
July 8-10	Calibration Panel Meeting, Goddard Space Flight Center, Greenbelt, Maryland. Contact: Jim Butler, (301) 286-4606, e-mail: james.j.butler@ gsfc.nasa.gov.
July 10-11	User Working Group for the Biogeochemical Dynamics DAAC (Oak Ridge National Laboratory), Oak Ridge, Tennessee. Contact: Robert B. Cook, (423) 574-7319, e-mail: cookrb@ornl.gov.
July 15-17	AIRS Team Meeting, World Weather Building, Camp Springs, Maryland. Contact: George Aumann, e-mail: hha@williwaw.jpl.nasa.gov.

Global Change Calendar

June 12-13	The International Climate Change Conference and Technologies Exhibition, Baltimore, MD. Contact: Exhibition office, tel. (301) 695-3762, Fax (301) 295-0175.
July 1-9	IAMAS/IAPSO Joint Assemblies, Earth, Ocean, Atmosphere: Forces of Change. Melbourne, Australia. e-mail: mscarlett@peg.apc.org, WWW URL: http://www.dar.csiro.au/pub/events/assemblies.
July 7-10	Third International Airborne Remote Sensing Conference, Copenhagen, Denmark. Contact: ERIM/Airborne Conference, P.O. Box 134001, Ann Arbor, MI 48113-4001. Tel. (313) 994-1200, ext. 3234; Fax: (313) 994-5123; e-mail: wallman@erim.org; WWW URL: http://www.erim.org/CONF/conf.html.
July 21-23	2nd International Symposium on "Reducing the Cost of Spacecraft Ground Systems and Operations," Keble College, Oxford University, UK. Contact: Richard Holdaway, Rutherford Appleton Laboratory, tel. +44(0) 1235 445527, Fax: +44(0) 1235 445848, e-mail: r.holdaway@rl.ac.uk.
July 27-August 1	SPIE 1997 International Symposium, San Diego, CA. Contact: Roberta Hart (360) 676-3290.
August 4-8	1997 International Geoscience and Remote Sensing Symposium, Singapore. For more information contact IEEE/GRSS, 2610 Lakeway Drive, Seabrook, TX 77586. e-mail: tstein@phoenix.net, tel. (713) 291-9222; Fax: (713) 291-9224.
September 8-12	WMO Fifth International Carbon Dioxide Conference, Cairns, Queensland, Australia, e-mail: 97CO2@dar.csiro.au; WWW URL: http://www.dar.csiro.au/pub/events/co2_conf/index.html.
September 22-26	Conference on Sensors, Systems and Next Generation Satellites III, London, England. 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, 560-1785, Fax (203) 560-2915, e-mail: ruaafeng@rusys.EG.net, or Nader Nada, tel. (730) 993-1626, Fax (703) 993-3729, e-mail: nnada@osf1.gmu.edu. Internet: http://www.frcu.eun.eg/www/conference/aast.html, or http://www.ceosr.gmu.edu/neews.html.
October 20-23	Geological Society of America 1997 Annual Meeting, Salt Lake City, UT. Tel. (303) 447-2020 or 1-800-472-1988, Fax (303) 447-0648, e-mail: meetings@geosociety.org, WWW URL: www.geosociety.org.

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