THE EARTH OBSERVER

A Bimonthly EOS Publication

September/October, 1994 Vol. 6, No. 5

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Editor's Corner

Following the rebaselining of the EOS program this past summer, and with the full cooperation of the principal investigators and team leaders of all 18 EOS instrument science teams, I was able to establish viable multi-year science team budgets for all investigations through fiscal year 2000. These budgets have been communicated to all team leaders in guideline letters that further eliminate the heretofore barrier between science computing facility and algorithm development expenditures. Although the overall science budget for algorithm development has been reduced in accordance with the recommendations of the Payload Panel (*The Earth Observer*, Vol. 6, No. 4), it nevertheless has been possible to establish new funding lines for calibration and validation activities. In addition, funds have been identified to support the formation of some new Science Teams, such as those for Landsat-7 and the Dual Frequency Altimeter. Ghassem Asrar is currently working on an Announcement of Opportunity to be released in the Spring that will solicit proposals for these new teams, as well as a "young investigator" program, the replacement and/or augmentation of some existing facility science teams (where gaps have been identified), and a correlative measurement (validation) program.

The Payload Panel Report recommended a reduction in algorithm development funding, as well as support for a revised mission profile capable of accommodating the EOS budget reduction (see recent issues of *The Earth Observer*). Additionally, the Report recommended that

NASA explore the feasibility of accommodating the EOS Color instrument on the Landsat-7 spacecraft, thereby saving the Nation the cost of a spacecraft and launch. Chuck McClain, SeaWiFS (Sea-viewing Wide Field-of-view Sensor) and Color Project Scientist, together with the SeaWiFS and Landsat Project Managers at Goddard, studied this option extensively throughout the summer and recommended this implementation to NASA Headquarters on October 15.

Dr. Kennel, Associate Administrator for the Office of Mission to Planet Earth, awaited the conclusion of the Investigators Working Group meeting on October 21 (see article elsewhere in this issue) before making a decision on EOS Color, giving him ample opportunity to discuss various options with a number of key scientists in the Earth Science community. Based on these discussions, he decided not to proceed with flying Color on Landsat-7, due largely to the significant budget and launch schedule commitment that NASA has made to the Landsat-7 Program, and fear that integrating Color on Landsat-7 places the Color mission at risk if unforeseen budget and schedule problems arise.

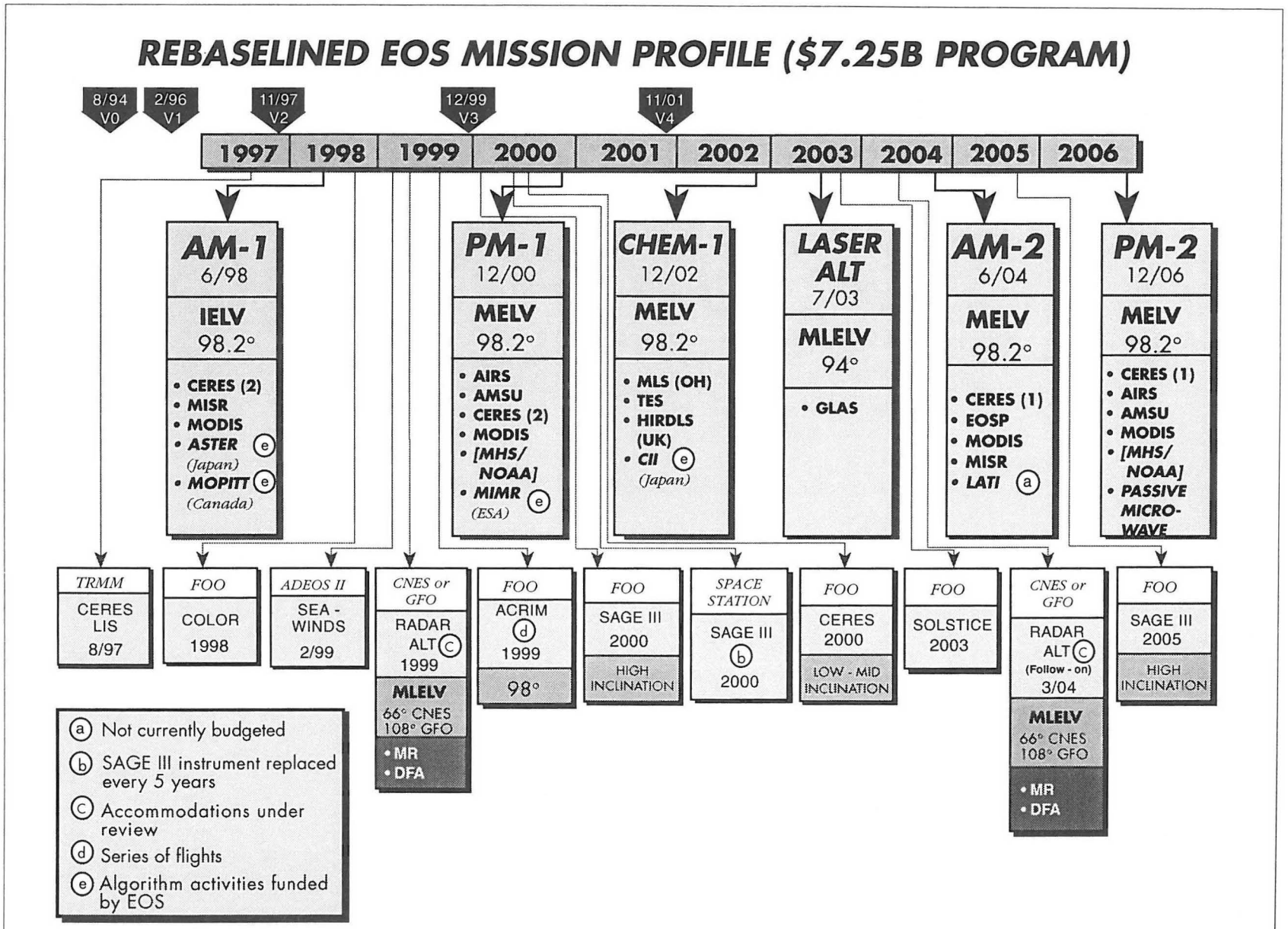
In lieu of integrating Color on Landsat-7, Dr. Kennel has asked the Mission to Planet Earth Office at Goddard to pursue other flight opportunities for the Color instrument, including development of a procurement package for the instrument to be released to industry. A procurement package will not be released, however, until an evaluation is made of the quality of data returned from SeaWiFS, now scheduled for launch in late May 1995. At that time, Dr. Kennel will once again consider the Color implementation, and decide either to proceed with a flight of opportunity, or to support an enhanced ocean color validation effort to maximize the value of the collective set of ocean color data being developed by NASA (SeaWiFS, MODIS), the European Space Agency (MERIS), and NASDA, the National Space Development Agency of Japan (OCTS). A two-day ocean color calibration/validation workshop is currently being organized for January. The workshop is to be hosted by the University of Miami and will aid in the development of a costed validation program for ocean color science.

Also, following completion of the program rebaselining this past summer, Goddard began updating the EOS Execution Phase Project Plan, which is the top-level program description and agreement between the Office of Mission to Planet Earth and Goddard Space Flight Center. This new version of the Project Plan, to be updated annually, includes updates to the mission profile, budget implications of the rebaselined program, and revised data product specifications.

Payload Panel Reports, the EOS Reference Handbook, issues of *The Earth Observer* since December 1992, MTPE Fact Sheets, and much more, can be found in the EOS Project Science Office homepage on the World Wide Web (URL http://spso.gsfc.nasa.gov/spso_homepage.html). The rebaselined EOS mission profile (shown on page 3) is also available on this server along with other spacecraft and airborne schedules and information.

Finally, an EOS Science Executive Committee (SEC) meeting was held in Baltimore on the evening of October 21. At that meeting, Michael Freilich of Oregon State University agreed to chair the new Data Quality Panel, which replaces the former Calibration/Validation Panel. Freilich will work closely with the EOS Project Science Office in the next few months to formulate a vital and significant effort in the area of EOS data quality.

—Michael King
EOS Senior Project Scientist



- Spacecraft reflights continue beyond 2006 to support generation of the 15-year science data set
- *Italics denote elements not funded by the EOS program*

The Ninth EOS Investigators Working Group Meeting

October 19-21, Hunt Valley, Maryland

—**Renny Greenstone** (renny@ltpsun.gsfc.nasa.gov) and **Bill Bandeen**, Hughes STX Corp.

The Investigators Working Group (IWG) of the Earth Observing System (EOS) met for three days at Marriott's Hunt Valley Inn in Hunt Valley, Maryland.

Wednesday Morning, October 19, 1994

Ghassem Asrar, EOS Program Scientist, gave a welcoming address. He pointed out that representatives from the Department of Energy's Atmospheric Radiation Measurement (ARM) Program were with us for the first time and he expressed his hope that we would establish a fruitful dialog with them.

The next speaker was **Charles Kennel**, NASA Associate Administrator for Mission to Planet Earth (MTPE), discussing the EOS rebaselining process. He began by summarizing the budget changes that have beset EOS since the 1990 "new start." Despite the cutbacks, the core science requirements for climate change studies have been preserved, as has the interdisciplinary science approach. The diversity of the EOS spacecraft missions has increased while their payloads and, consequently, their sizes have diminished. Even with the changes, it has been necessary to drop just one instrument, the High Resolution Imaging Spectrometer (HIRIS).

Kennel affirmed that we now have "the right set of measurements." He felt assured that there would be no more cutting of the program, and he urged that we must learn to depend more on our foreign partners. We should be increasingly aware of their complementary activities.

The current rebaselining effort has been planned so as to preserve the launch dates for the AM-1 and PM-1 spacecraft. In making the mission changes to accommodate the overall reduction in funds up to 2000, it was also necessary to adhere to year-to-year budgetary guidelines set by the Administration.

Kennel described some of the planning steps that led to the new rebaselined program. By late July of this year the EOS Payload Panel was asked to review 26 "strawman" options that had been agreed on by Headquarters and GSFC personnel and, establishing a precedent, the Panel was given information on the costs and cost profiles for each of the proposed options. Almost all of the Payload Panel recommendations were accepted.

The Payload Panel was asked to consider the future of Landsat. The response was that Landsat is important to climate change research and that the AM-2 mission should incorporate Landsat-8. There would be savings by combining the Landsat users group with the AM-2 science support group.

The new, rebaselined EOS mission profile shows that we will maintain the original schedule for AM-1, PM-1, and Chem-1, but place their follow-ons on six-year centers. SAGE III, SOLSTICE II, and ACRIM have all been dropped from the Chem-1 mission and are planned for flights of opportunity. The Tropospheric Emissions Spectrometer (TES) will be put in their place. We are looking to the Russians to provide a flight for SAGE III. The Microwave Limb Sounder (MLS) is to have a new channel for detection of the OH radical. Schedule changes will advance the radar altimetry mission (ALT-R) by three years and delay the laser altimetry mission (ALT-L) by one year.

In addition to the changes outlined above, there is to be a cost saving achieved by delaying the availability of selected data products. Some high-priority science

items have been added to the program in addition to those just cited. One example is a proposed new SAGE III flight in 2000.

Kennel anticipates that NASA will be operating on a fixed budget for years to come, but with pressure to do more. Congress and the Administration have shown their confidence in MTPE by adding $25 M to the EOS budget and $10 M to the EOSDIS budget.

Finally, Kennel asked all EOS participants to support MTPE, saying: "together we can meet the challenge."

Berrien Moore, chair of the Payload Panel, gave an overview of the Panel's findings. The Panel adopted as a high priority the charge not to slip the AM-1 and PM-1 missions—avoid the space station syndrome! They accepted the idea that the follow-on missions would be on six-year centers. The Panel recommended, at least temporarily, that the two-scanner CERES configuration be maintained for the PM-1 mission. They asked that the Atmospheres Panel review the value of the second CERES scanner and report back before March 1, 1995. The recommendation that NOAA be asked to fund an MHS instrument for PM-1 is still an open issue.

The Panel's other recommendations included: fly Chem-1 on schedule in 2002; add OH capability to MLS (this has strong support from the atmosphere community); and move TES to Chem-1 (this allows the AM-2 mission to accommodate Landsat-8). The Panel said that it would make sense for ACRIM to fly on its own small spacecraft and said that it was absolutely unwilling to drop any instruments at this stage of its deliberations. The Panel recommended canceling the ocean Color mission as such, but correspondingly recommended flying the Color instrument on Landsat-7. Color measurements are particularly needed for determinations of the carbon cycle in tropical regions.

The Panel's recommendations on altimetry included delaying the ALT-L mission, but with a request that this be reviewed by the Cryosphere and Atmospheres Panels, with a report to be made by July 1, 1995. The Panel also asked that the cloud lidar option be reviewed.

The Panel made several recommendations that would reduce data processing costs:

- merge ASTER and Landsat science teams;
- reduce the total cost of algorithm development;
- consolidate and phase the implementation of the Distributed Active Archive Centers (DAACs);
- delay some processing and archiving of EOS standard products; and
- reduce the ASTER standard product demand assumptions.

The Panel noted some difficulties that still may have to be faced. Among these are the possible loss of one CERES scanner and the possibility that the MHS instrument will not be funded. There are concerns with gaps caused by scheduling six-year (instead of five) repeats of some of the missions. SOLSTICE II is likely to suffer a delay as a result of being dropped from the Chem-1 mission. It isn't clear whether it will be acceptable to have the Color instrument fly with Landsat-7.

Moore said that there will be a need for the program to focus more on issues of calibration and validation.

Gary Rottman, PI for SOLSTICE II, addressed the need to maintain the planned measurements for this instrument on the original schedule. The UV measurements from SOLSTICE were planned to occur during the solar maximum of the current solar cycle along with the flight of the Chem mission.

Ghassem Asrar, EOS Program Scientist, provided an EOS "Program Update," starting with the remark that the launch plans are "on track." He then gave the status of the Global Change Fellowship Program. At this time 160 students are funded.

A new Announcement of Opportunity for participation in EOS is being prepared, with the first draft due for internal NASA review in late December. There are to be opportunities for team members and team leaders for existing instrument science teams as well as for ALT-R, Landsat, Color, and ozone measurement (based on the instrument that has been termed "chemistry international"). There are also to be new (complementary) IDS studies that will be focused

investigations, funded in the form of small grants to last up to three years. Research activities will be undertaken to support calibration and validation. Funds for all these new activities will have to come from the existing budget.

The Program Science Office is developing collaborative programs to conduct coordinated field experiments such as GEWEX, LAMBADA, and PEM; to participate in field programs such as ARM and Long Term Ecological Research (LTER); and to share in international space-based missions such as ADEOS and TRMM.

The next biannual review of the IDS investigations is to take place in 1995. As a consequence of this review there could be some turnover of the existing investigations.

Asrar listed the accomplishments of the EOS Data and Information System (EOSDIS) since the last IWG meeting. The alternative architecture studies have been completed. The Version 0 (V0) system is now online, and the Pathfinder data sets are now available. There is to be a NASA Research Announcement (NRA) soliciting concepts for using the Pathfinder data.

Progress on the EOS AM-1 flight mission continues unabated; the funding has been preserved; and the Atlas IIAS launch vehicle has been selected. There is concern about the possible unavailability of the MHS and MIMR instruments for the PM space flight mission.

Drew Rothrock has convened a special review group from the larger community of Earth scientists to review the possible choices for the ALT-R mission. The choices are to adopt either the U.S. Navy's Geosat Follow-On (GFO) or the French TOPEX/Poseidon Follow-on (TPFO), where the Centre National d'Etudes Spatiales (CNES) is the lead agency.

There is a concern with defining the overall mission objectives for ALT-L. Vegetation and cloud measurements are secondary objectives for the mission, and may be pursued only as funding is available. There are programmatic issues that may stand in the way of flying the Color instrument on Landsat-7.

Restructuring of the Chem-1 mission to include TES has the advantage of allowing the performance of integrated tropospheric/stratospheric science. Headquarters is trying to find a flight vehicle for SOLSTICE II. There is a special difficulty with accommodating the boom required for pointing.

Preliminary studies are now being conducted for a Landsat Advanced Technology Instrument (LATI) that could fly on the AM-2 mission, but there is no funding for such an instrument at this time.

Among recommendations that have been made regarding EOSDIS, only the suggestion that one or more of the DAACs would be eliminated has been dropped from current considerations. Actions that are being taken include elimination of the quick-look capability, delay in processing and archiving of EOS standard products, and reduction in the ASTER standard product demand.

Michael King, EOS Senior Project Scientist, provided a "Project Science Office Update." His topics were mission profile and science budgets, peer review, the science plan, and Project Science Office activities. In reference to science budgets he said that budgets had been reserved for science teams for the dual-frequency altimeter (DFA), Landsat-7, Color, the Chemistry International Instrument (CII), and the Landsat Advanced Technology Instrument. An Announcement of Opportunity will be required to staff these teams. Calibration and Validation are two new line items in the science budget.

King described the Algorithm Theoretical Basis Document review activity and explained the grading system that had been applied to the algorithm documents. Algorithms categorized as A and/or B are regarded as acceptable for development, but needing either minor (A) or major (B) modifications. Algorithms in the C category are acceptable but are not regarded as standard products to be produced routinely by EOSDIS. "D" algorithms are to be dropped.

The Project Science Office has taken over responsibility for the EOS IWG e-mail distribution lists. Other Project Science Office achievements include the development of an Educators' Package and an EOS

science poster series to be distributed in February. Many of the Science Office documents are now available electronically through World Wide Web.

Diane Wickland, formerly the HIRIS Program scientist, led a discussion of the Accelerated Canopy Chemistry Program (ACCP). Nitrogen and lignin are the prime focus of the canopy chemistry studies. Wickland explained that the canopy chemistry program represented the final phase of studies that were originally part of the now-deselected HIRIS instrument program. She then introduced the talks by two of the members of the study team: John Aber and Alex Goetz.

John Aber (University of New Hampshire) gave the first of the two talks. The team has developed and analyzed both wet and dry leaf spectra at 2 nm resolution. The modeling and laboratory analyses that they have conducted tended to agree, and field calibrations were as good as laboratory calibrations. They found that, using the AVIRIS instrument, they can distinguish between forest species. Better spectrometers are needed for the field studies, but it is not clear whether good results can be obtained in sparsely vegetated areas.

Alex Goetz, former team leader for the HIRIS instrument, raised the question: Is there a simplified instrument that would have a subset of the HIRIS capabilities and could fly in the future as a lignin/nitrogen sensor? If 80-m resolution were adopted, as against the HIRIS 30-m specification, the instrument size would be reduced. Signal-to-noise ratio (SNR) is the key to instrument performance. The AVIRIS SNR that has been achieved in 1994 has not been adequate. Field investigations have shown that the desired detection and classification performance can be achieved when there are less than 2 cm of precipitable water in the field of view.

Wickland pointed to the unfortunate "complication" for this type of research that the AVIRIS aircraft flight program will probably be discontinued after 1995.

Tom Dunne (University of Washington) reported on the response of continental-scale river systems to large-scale environmental change. Dunne pointed out that there are many examples of responses of continental-scale river systems to large-scale environmental change, although he was emphasizing the Amazon. All of these are usually seen as isolated problems, but in fact may be connected through tectonic motions and human engineering activities, as well as general environmental changes.

Among objectives of the Amazon study are to map sediment concentrations along the river, to model flood-plain exchanges of nutrients, and to define the extent and timing of wetland inundation.

Jim Shuttleworth (University of Arizona) reviewed efforts in modeling land surface energy and water fluxes. He asserted that there are too many models of surface energy and water fluxes and gave some examples of these. Intercomparisons that have been performed for heat flux estimates show a wide scatter of results between models. Sadly, complexity doesn't guarantee performance. He discussed research on carbon exchange in tropical forests. It has been shown that there is a net input of carbon dioxide to forests in both wet and dry season campaigns. He raised the question as to whether there is a linkage between surface energy budgets and the variability of the global carbon dioxide budget.

Dennis Hartmann (University of Washington) discussed recent findings on the role of upper-tropospheric water vapor in climate sensitivity. Water vapor feedback has been shown to be responsible for more than half of the surface warming observed in doubled-CO_2 experiments. An important point to realize is that, in the upper troposphere, especially in the tropics, the observational quality of water vapor measurements decreases rapidly with altitude, but the importance for climate sensitivity does not.

Tim Liu (JPL) reviewed the relation between surface thermal forcing and sea surface temperature changes as observed by spaceborne sensors. He used AVHRR to get sea surface temperature estimates and ISCCP clouds to derive solar flux at the surface. He also used SSM/I to get wind speeds and humidity, which then made it possible to estimate latent heat flux. He concluded that the observations do not support hypotheses concerning natural Pacific Ocean thermostat effects.

Richard Alley (Penn State) discussed the problem of predicting sea level. Temperature vs. snowfall data do show that warm temperatures correlate with increased snowfall in the long run, but new results say that temperature is not the controlling factor for snowfall accumulation (at least in Greenland). Rather, it is the pattern of storm tracks that controls the accumulation. Ice sheets have a huge potential for sea level change but there is great uncertainty about how much and when.

Bob Dickinson (University of Arizona) gave an update on the Intergovernmental Panel on Climate Change assessments. He listed the chapters of the forthcoming 1995 report and noted that new material begins with Chapter 7, Observed Climate Variability and Change. The Intergovernmental Panel report authorship does not draw particularly upon the EOS scientists, and Dickinson urged that EOS scientists should offer their contributions. An especial concern for future years is the anticipated growth in aerosols as a result of increased coal firing and agricultural development in Asia.

Thursday, October 20, 1994

Berrien Moore (University of New Hampshire) gave some early results from a comparison of terrestrial models that was conducted at a Potsdam workshop under the auspices of the International Geosphere Biosphere Program (IGBP). Twelve models were identified for the intercomparison, and four of these were selected for the detailed comparison of this talk. Moore said that the models seem to agree at some latitudes but not at others, and they seem to have similar biases. In the northern hemisphere the models never have the full observed amplitude of carbon change, and they are almost always ahead of the observed phase of the carbon cycle. In the southern hemisphere there is a phase lag. The problems that have been encountered may be due in part to the effects of soil moisture and monsoon events.

Bill Parton (Colorado State University) presented a more-detailed study, using three of the models cited by Moore. Parton's study was restricted to the United States, and he was examining the effects of various climate change scenarios. The overall goal was to compare biogeochemical models of the United States at regional and continental scales in terms of their responses to climate change and in terms of vegetation redistribution. Some of Parton's findings were these:

- The models agree well with the "actual" E-T, but N-mineralization showed greater disagreement.
- The direct carbon dioxide effect on net primary production is small.
- The most significant differences among the models are in the *direct* response to increased carbon dioxide with a lesser response to climate change.

Peter Gleckler (Lawrence Livermore National Laboratory) followed the ecosystem modeling discussions with a comparison of 30 atmospheric general circulation models. He said that cloud-radiative effects are the key source of systematic errors in the models. He added that accurate representation of sea ice cover could be important.

Reinhard Beer (JPL) presented some spectral properties of wildfires obtained with the Airborne Emission Spectrometer (AES), based on measurements made in August 1994 from a DC-8 aircraft flying over brush fires in Central California. Ammonia gas was detected in the smoke and gas plumes from the fires. Plume temperatures appeared to be about 400 K. No nitric acid or nitrous oxide features were determined, although these were reported by ground workers. Beer hopes to correlate flame temperatures (found to be about 1500 K) with wind speeds and thereby determine fluxes of gases.

Farzad Mahootian (Gonzaga College High School in Washington, D.C.) described the "ECOLOGICA" program at the school. This has been a very successful program in getting the students involved in a "hands-on" manner with Earth science data and applying it in a team approach to pursue research objectives.

Richard Chappell (Globe Deputy Director) reported on the Global Learning and Observations to Benefit the Environment (GLOBE) education program. The three objectives of GLOBE are to enhance students' environmental awareness, to have the students acquire meaningful data, and to enhance students' interest in science and mathematics. A pilot-phase

project is to be ready by Earth Day 1995. About 100 U.S. schools are to be involved as well as about 100 other schools around the world

Carol Johnson (National Institute of Standards and Technology, NIST) discussed the role of NIST in the radiometric calibration of EOS sensors. She began by describing the NIST experience with the SeaWiFS instrument. NIST has provided a transportable SeaWiFS transfer radiometer (SXR) for verifying spectral radiance sources for ocean color measurements. Better than 1% accuracy is needed for this application. NIST has proposals to provide transfer radiometers for the visible, near-IR/shortwave, and IR.

John Dalton (Goddard Space Flight Center, [GSFC]) gave an update on EOSDIS. V0, the operational prototype for the ultimate EOSDIS system, now gives access to eight Distributed Active Archive Centers (DAACs) with about 190 datasets available. Browse capability is available from five of the DAACs.

Among the impacts of the rebaselining effort were the removal of the *hard* requirement for 24-hour production of data products and the deletion of the quick-look capability. The standard data product capability will be phased-in over time, reaching full capacity two years after launch.

Steve Wharton (GSFC) gave some science operations concepts for EOSDIS. He discussed a hypothetical EOSDIS capacity allocation scenario that would apply to the data from the TRMM mission and the EOS AM-1 mission. Capacities are to be allocated in terms of both processing load (MFLOPS) and data volume (GB/day). The next step is to ascertain with the instrument teams that the proposed allocation approach is reasonable.

Bruce Barkstrom (Langley Research Center) presented results from the *Ad Hoc* Working Group on Production. The *ad hoc* group had come together because of the gulf that had been developing between the EOS Project and the EOS science community. The group is striving to provide reliable production information to be available for the EOSDIS Core System. The group is also defining the data needs of the Interdisciplinary Science Teams to assist in planning network capacities.

Ken McDonald (GSFC) gave a demonstration of the Version 0 Information Management System. He used a computer-driven display to show the audience what would be available at their desk-top computers or work stations when they were connected to the V0 system.

Dixon Butler (NASA Headquarters) gave an overview of three independent alternative architecture studies of the EOSDIS Core System. The University of California approach was largely based on the use of Data Base Management Systems. The University of North Dakota described a system of Public Access Resource Centers that would focus on particular users. George Mason University proposed a "federated" client/server approach that would be "multi-layered."

Dave Glover (Woods Hole Oceanographic Institute) gave the EOSDIS Panel assessment of the three alternative architecture studies. The "watchword" is: don't process data if no one wants it! Wait for requests—then process! The Panel recommended that there should be a comparison of architectures and a network assessment, and that independent work should be continued.

Eric Barron (Penn State) discussed the issue of how to get new investigators into EOS and establish EOS as an open program. There have been various proposals on how to recompete the IDS investigations and how to improve upon the review process for the existing investigations. Non-EOS investigators should be brought into the review process.

Friday, October 21, 1994

Bryan Baum (Langley Research Center) led off a session on the various DAACs and the Pathfinder activities with a discussion of the status of the Langley DAAC. ERBE data are mostly on-line now. They have found that "subsetting" is very important to users.

Ron Weaver (National Snow and Ice Data Center) described the NSIDC and gave the status of the DAAC. NSIDC is the largest data resource providing ground truth on ice cover for passive microwave remote sensing purposes. Field campaign data, e.g.,

SHEBA, will be available at the DAAC. The DAAC *may* ingest DoD data that are currently classified.

John Townshend (University of Maryland) presented some results from the AVHRR Land Pathfinder and Global Land 1 km AVHRR data set. The primary intent of the activity is to provide"...well-documented data sets...that the scientific community can trust." The data he has worked with came from the GSFC DAAC. He discussed, primarily, the 8-km AVHRR five-channel data set coming from the NOAA PM satellites, NOAA 7, 9, and 11.

Dave Skole (University of New Hampshire) reported on results from the Landsat Pathfinder Program. The Landsat data of concern came from the Amazon basin plus central Africa and southeast Asia. Skole's group has used and processed abut 3000 Landsat scenes for analyses of deforestation in tropical regions. They have found that about 90% of biogenic carbon comes from tropical land clearing. They have also found that about 30% of deforested areas are now in secondary growth, but they don't know if the inventory of secondary growth is growing.

Peter Cornillon (University of Rhode Island) reported on successful results from the AVHRR Ocean Pathfinder Program, particularly the University of Rhode Island's Sea Surface Temperature (SST) Project using the AVHRR data. Problems encountered in their analyses could be attributed to the instrument, to the algorithms, and to the physics. Cloud detection turned out to be the single biggest problem. The Pathfinder algorithm fails in regions with relatively long periods of relatively uniform cloud cover, and this failure can be catastrophic.

Chris Neale (Utah State University) gave an overview of scientific applications of SSM/I Pathfinder data sets. The first SSM/I launch took place in June 1987. Among possible future products are surface moisture and snow-water equivalent. Results so far are site specific and need to be tested in many other parts of the world. Wind directions are not being produced because they would require passes from two satellites.

Bill Rossow (Goddard Institute for Space Studies) was the final scheduled speaker. His topic was research with the International Satellite Cloud Climatology Project (ISCCP) data sets. The group is now reprocessing the 10-year data set. The DX data will be at the pixel level. They have studied the variations in cloud droplet size as a function of land or ocean and northern or southern hemisphere. Rossow said that relative calibration (between satellites) and absolute calibration both require attention.

A key finding is that clouds *reinforce the atmospheric* heating/cooling pattern as against their *surface* cooling effect. Also, clouds are responsible for heating in the tropics and cooling at the higher latitudes.

Following the scheduled presentations, Charles Kennel gave a few concluding remarks. He said that things appear to be coming together, the science and the algorithms are developing well, and that EOS is now on a steady course. He said he will do his utmost to keep it that way. ■

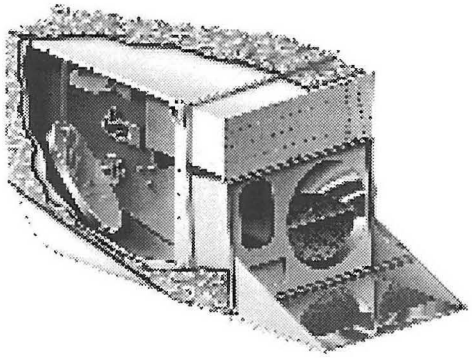
Steve Running (left) and Bill Parton (right)

Left to right, Peter Brewer, Jeff Dozier, Bruce Barkstrom, Mark Abbott, Dave Glover, seated

Left to right, Jim Gleason, Joe Zawodny, and John Gille

MODIS Science Team Meeting Summary

—**David Herring** (herring@ltpsun.gsfc.nasa.gov), MAST Technical Manager, Science Systems & Applications, Inc.



Opening Remarks

The MODIS Science Team Meeting was held in College Park, Maryland on October 12-14, 1994. It was chaired by Vince Salomonson, MODIS Team Leader. Salomonson announced that revisions of ATBDs receiving an A or B are due in November; those receiving a C are due by the end of December. Salomonson told the Team that Hughes Aircraft Company is considering relocating the Santa Barbara Research Center (SBRC) facilities and personnel to its El Segundo facility near Los Angeles Airport. The MODIS Team is very concerned that the reorganization may negatively impact MODIS development. At the suggestion of Chris Justice an action was taken to send a letter signed by Team Members to the upper management of Hughes expressing the Team's concerns.

Diane Wickland, MODIS co-program scientist, reported that there has been a third NASA HQ reorganization of Mission to Planet Earth in as many years. Salomonson introduced Robert Frouin, the new MODIS co-program scientist replacing Frank Muller-Karger.

Michael King, EOS Senior Project Scientist, gave an overview of the rebaselined EOS mission profile. He reported that science funding is no longer rigidly earmarked for research (algorithm development) or computing (science computing facility). Principal investigators may now allocate funding as they deem appropriate for algorithm development, science computing facilities, and scientific research. He told the Science Team that they should make their ATBDs available for anonymous ftp (file transfer protocol) from designated servers at their respective work sites.

EOSDIS Status Report

John Dalton, ESDIS Project Manager, listed the project's recent and upcoming milestones: the EOSDIS Core System (ECS) design review was held in June; the second release of the PGS (Product Generation System) Toolkit has been delivered to investigator teams; the EOS Data and Operations System (EDOS) contract was awarded to TRW, the EOS Communications (Ecom), which will provide communications links between DAACs (Distributed Active Archive Centers) is being developed in-house; the Preliminary Design Review is scheduled for January 1995; and beta delivery of software will be 2 years before launch, so that there will be an early warning if there are any problems. Regarding Independent Verification and Validation (IV&V), Dalton announced that the contract was awarded to Intermetrics in June. Dalton noted that ESDIS has decided to eliminate quick-look products. If the MODIS Team needs quick-look data, as well as health and safety data on the instrument, it can still rely on direct readout.

Steve Wharton, EOSDIS Project Scientist, reported that all data interdependency information has been submitted to EOSDIS, and the system is being modeled by Hughes. Wharton stated that EOSDIS needs to introduce evaluation criteria for reducing the com-

plexity and operational cost of standard data products. Then, resource allocations can be made and requirements can be managed within that capacity. He proposed that allocations be revisited on an annual basis because there will be changes in requirements and technology.

Science Data Support Team (SDST) Status Report

Ed Masuoka, SDST leader, announced that SDST has selected a new support contractor—GSC/SAIC. Masuoka reported the estimates for MODIS processing and storage requirements; the current estimates are 3.5 GFLOPS and 490 GB, respectively. Masuoka introduced Al Fleig, who summarized the Simulation Data Workshop at Flathead Lake, MT. At that meeting it was generally agreed to conduct two types of tests: tests for the scientific validation of algorithms and tests to ensure that the code is functioning correctly. SDST plans to use the SeaWiFS global data set to test MODIS' algorithms. Fleig told the Team that SDST will develop a MODIS Validation Plan. SDST needs to know from the Team members how they plan to validate their algorithms before launch and what kind(s) of test data they will need.

Masuoka reported that while the January 1994 beta software delivery consisted of one delivery of heritage code from each of the MODIS software developers, the second beta delivery, which began in October 1994, will consist of software to produce every science product. By June 1995, SDST hopes to have fully integrated MODIS beta software undergoing testing in preparation for the January 1996 beta delivery to EOSDIS. SDST has decided to use the ISCCP (International Satellite Cloud Climatology Project) grid for MODIS, which will be an 18 km grid for producing MODIS Level 3 products. Finer resolutions down to 250 m will be nested within each 18 km cell. Tools for converting this nested ISSCP grid to user-desired projections will be developed by MODIS or ESDIS and run at a DAAC or end-user site to produce the desired research product.

MODIS Project Reports

Richard Weber, MODIS Project Manager, reported that SBRC will have the MODIS Engineering Model (EM) built in 2 months. EM system-level tests will continue from January to March 1995. Weber stated that in terms of mass, power, and data rates, MODIS is well within specifications. Weber said stray light—scattered light off the mirrors, contamination, spectral band registration, and detector crosstalk—is still a concern. Tom Pagano (SBRC) added that most MODIS subassemblies are complete, and are being integrated and tested. SBRC received the prototype filters for the VIS and NIR bands and during analysis discovered some discrepancies in edge ranges and bandwidths of several filters (bands 13, 14, and 19). They asked NASA to relax the specifications for these filters.

MODIS Characterization Support Team (MCST) Status Report

Bruce Guenther, MCST Leader, announced that MCST received positive feedback on its Calibration ATBD scenario at the Calibration Working Group Meeting. He discussed MCST's and SBRC's efforts to characterize the scattering/diffraction, ghosting, and optical and electronic crosstalk on MODIS, which could potentially limit radiometric accuracy in mixed cloud-cover scenes. SBRC is devising a strategy that includes design changes for the protoflight model (PFM) and detailed modeling of optical effects such as ghosting.

Guenther told the Team that MCST is restructuring its management approach to a smaller, more-skilled staff, and is about to move to a new support services contractor. Regarding beta-2 algorithm delivery, Guenther reported that the top-level design was frozen in July, with delivery scheduled for the end of October.

MCST is considering possibilities for maneuvering the AM spacecraft to view the moon—this maneuver is called a pitch-hold arrangement. A lunar view can be obtained with a 25-degree spacecraft roll, which has minimal risks. Guenther showed data which suggests that there is a 2 percent calibration difference across the GOES 8 imager mirror. This is a concern in that the design specifications for the GOES mirror are virtually the same as for MODIS. GOES validates its data by looking at cold space periodically; Guenther believes that this may be necessary for MODIS too.

MODIS Administrative Support Team (MAST) Reports

Locke Stuart, acting head of the MODIS Administrative Support Team (MAST), reported that Janine Harrison, former MAST head, resigned recently. David Herring, MAST Technical Manager, briefly summarized the results of Discipline Group discussions on the MODIS Document Archive (MODARCH). He stated that the Team would like a more-robust document distribution system to operate parallel to MODARCH. Herring introduced Michael Heney, MODARCH System Administrator, who presented the MODARCH status update. Heney announced that the document archive and retrieval software has been upgraded. The new version enables page range printing. He stated that MODARCH is also available as an ftp site, which the Team may use for submitting documents for distribution. Heney announced that MAST has established the MODIS Home Page on the WWW. The Uniform Resource Locator (URL) for the page is http://ltpwww.gsfc.nasa.gov/MODIS/MODIS.html.

Calibration Group Meeting Summary

Phil Slater summarized the Calibration Working Group's discussions. The Group feels that discussions on vicarious calibration, error budgets, and validation need to be included in the Calibration ATBD. Regarding the Engineering Model (EM) test plan and schedule, Slater said he is concerned that the far-field stray light will not be tested. The Calibration Group feels that there should be five temperature plateau levels for EM thermal vacuum testing, rather than two. Also, the Group is unsure of the effect on calibration accuracy of the new temperature maximum of 350 K (versus 380 K) for the onboard blackbody. The Group is concerned about the stray light modeling for MODIS, as well as the calibration and characterization equipment; they feel that more than one model should be used.

Atmosphere Group Meeting Summary

Yoram Kaufman summarized the deliberations of the Atmosphere Group. They discussed ATBD updates, integration of products, and delivery of beta software. For the validation of water vapor products, Kaufman said the Group plans to compare their results with those of the sun photometer network—specifically, they will intercompare near-infrared and infrared products. Regarding the MODIS fire algorithm, Kaufman stated that there is a problem simulating wildfires because they don't always look the same in the real world. The SCAR (Smoke, Clouds, and Radiation)-C campaign was a success in that it provided the Group with the aerosol database needed to make progress in this area. Kaufman said progress is also being made in developing the algorithm for aerosol correction over oceans.

Land Group Meeting Summary

Chris Justice summarized the Land Group Meeting. He reported that ATBD revision is underway—significant changes have been made based on the panel reviewers' comments. Products which need strengthening include Land Cover and LAI/FPAR. The Group is looking at ways to: 1) add new team members to augment ongoing activities on existing products, 2) subcontract specific short-term development tasks to "experts" within the community, and/or 3) build computing capacity within the team to develop suitable prototypes for the MODIS algorithm. Justice emphasized that adding new team members should not be at the expense of the resources needed for existing team members to fulfill their commitments.

Justice expressed concern from the Land Group about the planned reduction of the processing allocation for MODIS at-launch. Justice reported that Digital Elevation Models (DEMs) for EOS AM-1 instruments are being developed through an initiative headed by Martha Maiden at NASA HQ, with the Land Group playing an active role. He recommended holding a snow-ice meeting within the next 6 months. He suggested that the Land Group and SDST hold a meeting in the Spring of 1995 in Tucson to discuss various outstanding algorithm data processing issues including data interdependencies, Level 3 products, and gridding.

Ocean Group Meeting Summary

Wayne Esaias presented a summary overview of the Ocean Group Meeting. He pointed out that configura-

tion control on the data product numbers needs to be standardized. Esaias stated that the Group has major concerns regarding the suggested PGS allocations. He feels that the metric for the allocations is not rational. The numbers of products and flops required per product must balance with the services provided by EOSDIS. The process by which EOSDIS estimates cost per flop required is not clear. Esaias emphasized that research product generation and distribution must continue, both within MODIS and across all of EOS.

Esaias stated that the ISCCP grid is acceptable to the Ocean Group, but he recognized that it may not meet the Land Group's needs, so perhaps more than one gridding approach is needed. At the next meeting, Esaias would like discussions to be focused on key topics, rather than be discipline-centric. He feels MODIS will benefit from more cross-disciplinary interaction. The Ocean Group will meet Jan. 25 - 27, 1995, at a separate meeting to address discipline issues.

Closing Remarks

Salomonson announced that the next MODIS Science Team Meeting is scheduled May 3 - 5, 1995. The MODIS Calibration Working Group will meet May 2, 1995. ■

NASA Graduate Student Fellowships in Global Change Research

NASA announces graduate student training fellowships for persons pursuing a Ph.D. degree in aspects of global change research. These fellowships will be available for the 1995/1996 academic year. The purpose is to ensure a continued supply of high-quality scientists to support rapid growth in the study of Earth as a system. Over 270 fellowships have been awarded since the inception of the program in 1990. Up to 50 new fellowships will be awarded in 1995, subject to availability of funds.

Applications will be considered for research on climate and hydrologic systems, ecological systems and dynamics, biogeochemical dynamics, solid Earth processes, human interactions, solar influences, and data and information systems. Atmospheric chemistry and physics, ocean biology and physics, ecosystem dynamics, hydrology, cryospheric processes, geology, and geophysics are all acceptable areas of research, provided that the specific research topic is relevant to NASA's global change research efforts including the Earth Observing System and the Tropical Rainfall Measuring Mission which are a part of the Mission to Planet Earth. **THE DEADLINE FOR SUBMITTING APPLICATIONS IS March 15, 1995.**

For further information contact Dr. Ghassem Asrar, NASA Headquarters, Mail Code YS, Washington, DC 20546, gasrar@mtpe.hq.nasa.gov, phone (202) 358-2559; fax (202) 358-2770.

JPL Physical Oceanography DAAC Reprocesses Ten Years of Sea Surface Temperature Measurements from NOAA AVHRR

—**Jorge Vazquez** (jv@mst3k.jpl.nasa.gov), **Michael Hamilton, Andy Van Tran** (avt@pacific.jpl.nasa.gov), and **Rosanna M. Sumagaysay** (Jet Propulsion Laboratory)

(Reprint from the Science Information Systems Newsletter)

Introduction

In order to understand the processes involved in global climate change, many different scientific measurements are needed. A primary function of NASA's Earth Observing System (EOS), the centerpiece of NASA's Mission to Planet Earth, is to distribute such measurements to the scientific community in a form that will optimize their use by the research community. One of the parameters critical to understanding how the ocean affects climate on a global scale is sea surface temperature (SST).

An example of the importance of sea surface temperature determinations for climate studies is their use in the study of the western boundary currents of the world's oceans. The western boundary currents play an important role in the Earth's heat balance. They carry a tremendous amount of heat poleward from low-latitude regions (see Figure 1). Because the currents exhibit strong SST gradients, the SST measurements can be used to determine their displacements. Knowledge of the displacements, in turn, allows us to improve our understanding of ocean circulation and heat transport. Of course, SST measurements of themselves are important as determining factors in the transport of heat flux between the ocean and the atmosphere.

In an attempt to provide these important measurements to the scientific community, the Advanced Very High Resolution Radiometer (AVHRR) Global Area Coverage (GAC) Pathfinder Project has been charged with reprocessing and thus creating a new high-quality SST data set suitable for global studies. The joint NASA/NOAA Pathfinder Project was initiated in 1989. Once the reprocessing is completed, an SST data set of greater than 10-years length will be available to the scientific community.

New Algorithms for Cloud Detection

Because the time period of the data set (1981-present) spans several AVHRR instruments on board a series of NOAA satellites (NOAA-7/9/11), a major milestone of the reprocessing effort is in the inter-calibration of the satellites. The previous AVHRR SST (the multi-channel or MCSST) product was computed similarly, through a comparison of *in-situ* (buoy) surface temperature observations and channel radiances or "brightness temperatures." Simple linear coefficients were thus derived and used to estimate global SST. The current reprocessing effort has led to the development of a consistent set of calibration coefficients and non-linearity corrections that will produce a long-term SST data set. In addition to improving the overall accuracy of the estimates, an improved processing scheme has led to a more-sensitive cloud-clearing technique. This has improved the number of estimates per global image by nearly a factor of two, thus substantially increasing the retrieval of valid SST values. The Rosenstiel School of Marine and Atmospheric Sciences of the University of Miami has primary responsibility for algorithm development, with oversight by a science working group of remote-sensing and SST experts.

Ease of Access and Quality Assurance

Because of the tremendous amount of data involved in this project, a major responsibility of the JPL team, in conjunction with the Physical Oceanography Distributed Active Archive Center (PO.DAAC) at the Jet Propulsion Laboratory (JPL), will be to provide easy

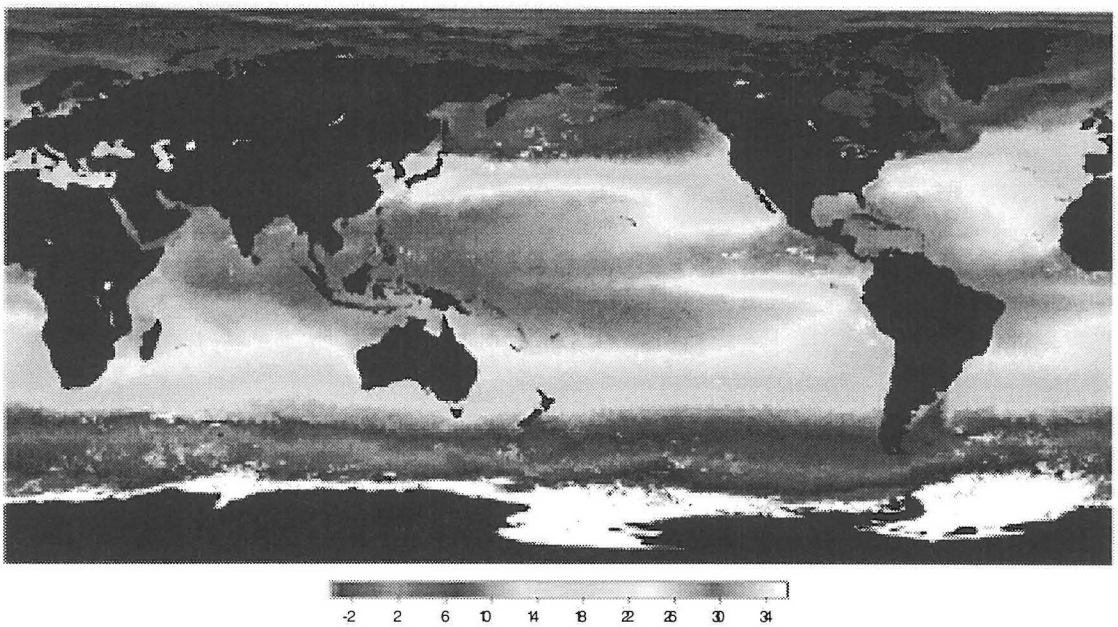


Figure 1. 1988 Days 150 - 180 Mean Composite of SST (° C)

access to the data and to ensure the highest possible quality data set. Several scenarios are planned to maximize the utilization of the data. Due to the enormity of the reprocessing task, a benchmark period consisting of years 1987 and 1988 has been established. These will be the first two years processed and quality checked by the JPL team. A significant part of the processing effort deals with regridding the data from an equal-area to equal-angle grid, thus making it more suitable for visualization and image manipulation. The equal-area scheme is not suitable for visualization because the number of SST values in a longitude band varies with latitude. The equal-angle grid has the same number of SST values in both latitude and longitude for the entire globe.

The data will be provided as a 9-km spatial resolution set of daily global images, where the image size is 4096x2048. These data will then be distributed in several formats including the Hierarchical Data Format developed by the National Center for Supercomputing Applications. This format allows data to be shared in a heterogeneous environment with portability across various hardware platforms. In addition, the data will be available in more-standard image formats. Incorporating binning procedures implemented by the JPL team, these daily images of sea surface temperature will be used to form weekly and monthly composites for distribution. Statistics and quality information dealing with the estimation of the sea surface temperature will also be distributed. Part of the quality control of the data consists of spatial and temporal tests as well as visual inspection of each daily global image by the JPL team. Due to size constraints, initial distribution will be through an FTP site, while the daily images must be sent out via tape.

How to Order

It is anticipated that by November 1994, two years of data from the benchmark period (1987 and 1988) will be available for distribution. Data may be ordered from the JPL Physical Oceanography DAAC. To access an electronic catalog of PO.DAAC products, open URL to http://seazar.jpl.nasa.gov. To access NOAA/NASA AVHRR Ocean Pathfinder, open URL to: http://sst-www.jpl.nasa.gov.

User Services Office, MS 300/320
JPL PO.DAAC
Jet Propulsion Laboratory
4800 Oak Grove Dr.
Pasadena, CA 91109, U.S.A.
Telephone: (818) 354-9890
FAX: (818) 393-2718

Using Artificial Intelligence to Understand EOS Data

—**Jarrett S. Cohen** (jcohen@jacks.gsfc.nasa.gov), Hughes STX Corp., High Performance Computing Branch, Goddard Space Flight Center

(Reprint from the *Science Information Systems Newsletter*)

This article is based on the paper "AI Challenges within NASA's Mission to Planet Earth," published in the notes of the AI Technologies for Environmental Applications Workshop of the Twelfth National Conference on Artificial Intelligence (AAAI '94).[1] *The work described here is funded by NASA Headquarters, Code X, Operations Technology Program.*

Beginning in the late 1990s, NASA Earth Observing System (EOS) satellites will pierce the skies, documenting global change and probing how the planet works as a dynamic system. Through observations of such phenomena as surface temperature, ozone depletion, greenhouse effects, ocean productivity, desert/vegetation patterns, and the extent of sea-ice, they will study the interrelationships among the Earth's geosphere (land), oceans, biosphere (where life exists), atmosphere, and cryosphere (ice, glaciers).

One of the greatest challenges of the EOS era will be processing and retrieving the enormous amounts of complex data these satellites will collect. Current estimates envision a collection rate of one terabyte (1012 billion bytes) per day with a total of 11,000 terabytes over the 15-year mission, the equivalent of 1000 times the holdings of the Library of Congress!

Building a robust EOS Data and Information System (EOSDIS) accessible to scientists and non-scientists alike is seen as crucial to the success of EOS. NASA's FY 95 budget request bears out this importance, with $455 million for EOS and $285 million for EOSDIS.

Since 1985, NASA/Goddard Space Flight Center's Information Science and Technology Branch (ISTB) has been exploring artificial intelligence (AI) techniques to further these ends. The centerpiece of ISTB efforts is the Intelligent Information Fusion System (IIFS), a scientific spatial database management system aimed at handling EOS-era data challenges.

Various components of the IIFS are currently being applied to the TIROS Operational Vertical Sounder Pathfinder dataset, the former International Data System Office's severe storms database, and the EOS Distributed Active Archive Center V0 Data Archive and Distribution System (DADS).

The IIFS

The IIFS is based on an object-oriented database used to store metadata, i.e., data in its highest or abstract form, about remotely-sensed images (see Figure 1). Its task is to transform raw sensor and ancillary data into working models of the whole-Earth system called *standard products.* [Editor's note: This is not the EOS definition of "standard products." See the EOS Reference Handbook.] Creating such models involves several levels of processing through a production pipeline, called the Product Generation Module (PGM). These levels basically involve data retrieval, preprocessing, and application-specific processing.

After the PGM processing is completed, the data are archived in the Archive/Retrieval Module (ARM) and made available for future reprocessing. The ARM includes a mechanism to locate the data efficiently based on numerous domain-specific search criteria. The metadata define parameters of the data, including information about the sensor that collected it, preprocessing parameters, and summary content information. Summary metadata, known as *browse products,*

[1] William J. Campbell, Robert F. Cromp, Nicholas M. Short, Jr., James C. Tilton, GSFC; George Fekete, Manohar Mareboyana, Hughes STX Corp.; Jacqueline L. LeMoigne, USRA/CESDIS; Nathan S. Netanyahu, National Research Council; and Keith Wichman, Clemson University. The group was originally called the Intelligent Data Management Group.

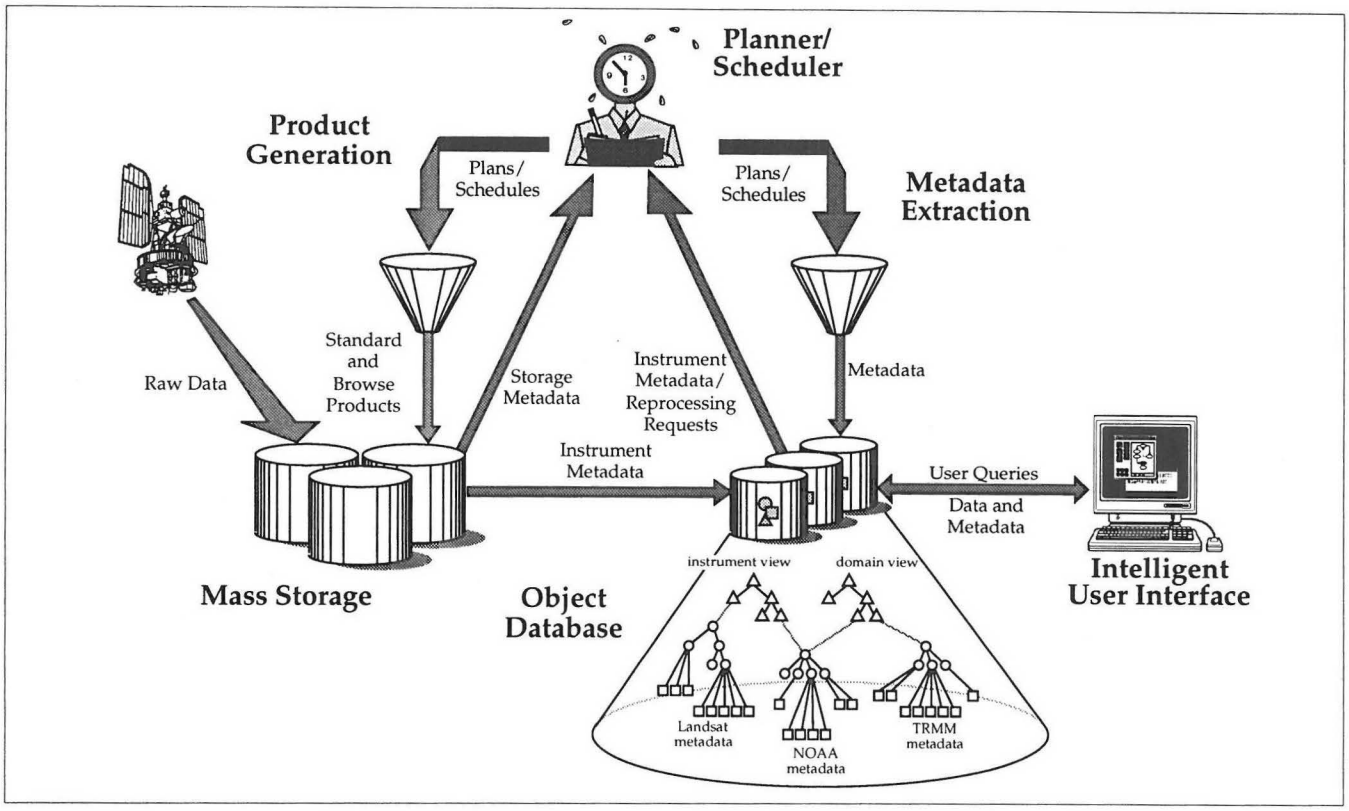


Figure 1.

provide a low-resolution, low-accuracy view of the data to assist in determining which data may be of interest to scientists. These metadata are stored in a metadatabase, or electronic "card catalog," and include interface software for novice users.

In the IIFS diagram, the PGM encompasses the top half and the ARM, the bottom half. As the ARM represents the user's perspective, it is considered first.

ARCHIVE/RETRIEVAL MODULE (ARM)

Mass Storage and Object-Oriented Database Management System

Similar to typical memory management between CPU and secondary storage devices, a hierarchical organization exists between the mass storage and the processing pipeline and user interfaces. In this arrangement, frequently requested products migrate to higher levels of storage, and less frequently requested products are swapped out. The data residing at the highest level are used for browse purposes. An object-oriented database management system (OODMS) organizes the metadata in terms of its presentation to the user, manages the production and analysis algorithms, and exploits the efficiency of the hardware environment.

Sphere Quadtrees: A New Data Structure

The choice for a particular data representation scheme is often strongly influenced by a scientist's preferences. The result is a sampling scheme very conducive to generating graphic renditions using specific projection methods. For example, there are formidable volumes of published Earth science data gridded along lines of latitude and longitude, making storage of data in tables of rows and columns very convenient. Unfortunately, any attempt at making digital flat maps from the sphere involves warping (stretching) and tearing followed by resampling (gridding).

To address such shortcomings, the IIFS uses a hierarchical spatial data structure called a *Sphere Quadtree* (SQT). An SQT can model a digital spherical image consisting of small triangular picture elements called

trixels that cover the sphere's surface (see Figure 2). This data structure has several desirable properties, including abstraction, topological consistency, variable and multiple resolution, rapid access to data, and the support of improved interactive browsing.

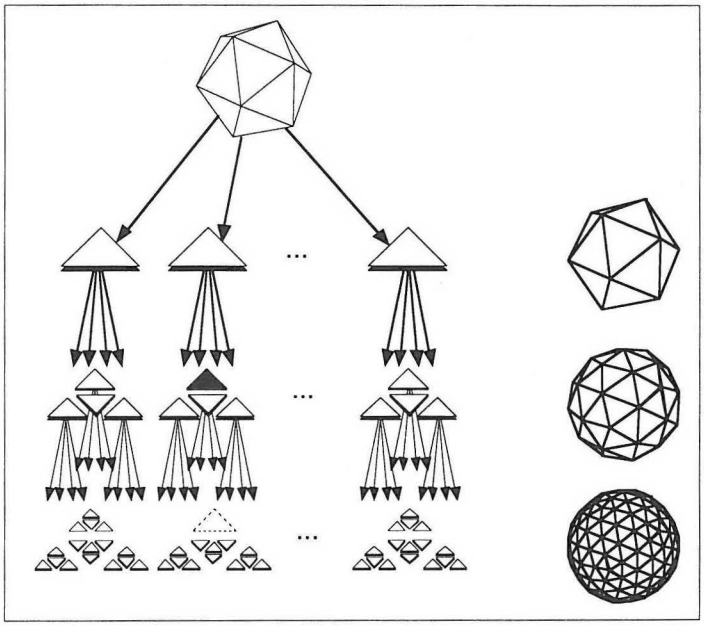


Figure 2.

Automatic Data Characterization and Cataloging

One of the most challenging parts of the IIFS is the module responsible for automatically characterizing image content. As data holdings continue to grow, catalogs must be augmented with more semantically rich discriminators. Searches of data holdings based on image content need summaries of the substance of each image. Just as a postage stamp version of an image serves as a browse product of the full image, a *characterization vector* categorizes an image's features at a high level. Each sensor is designed to detect specific spectral features, and success depends on factors such as the time of observation, the pixel resolution, the frequency of observation, and viewing conditions. IIFS assumes that each sensor can detect a finite set of known spectral features and has characterization algorithms specific to each sensor. The algorithms produce characterization vectors that are then used to populate the object-oriented metadata-base. The choice of which characterization algorithm is applied to a given image is made by a planner/scheduler (detailed later), which makes its selection dependent on the level of accuracy required, the allotted processing time, the available computing and data resources, and the kinds of products that need to be generated using the image.

Image Compression

Image compression is a crucial component of the ARM. However, no single approach is likely to be appropriate for all aspects of the problem. Lossless compression is required for data archiving, while some degree of information loss may be allowable for video transmission. For browse, larger amounts of loss may actually be desirable, as a general overall impression of the data quality and content may be all that is necessary. The key task for lossy data compression in browsing is to preserve only the information required.

If a "progressive" data compression approach is used, browse data can also facilitate the distribution of the data from the ARM. Here, the image is compressed at various levels called a compression hierarchy. The first level of the hierarchy provides an initial rendition appropriate for browsing. The ensuing levels contain the details that are missing at earlier levels. Either a user or the planner/scheduler would inspect the browse data, and decide at "anytime" whether or not to inspect the data more closely. Under this scheme, the data distribution process is kept efficient since no redundant information is ever sent or used.

The ISTB scientists have concentrated on image segmentation and variations on Vector Quantization. These approaches are particularly suitable for data archives and distribution across computer network applications. They have developed a hierarchical data compression scheme based on segmentation produced by a version of the IPRG algorithm discussed below under image segmentation and applied it to AVHRR data.

PRODUCT GENERATION MODULE (PGM)

Multi-Sensor Data Registration

Prior to integrating multi-source information, correlation or registration must be performed on data taken

at the same or different times by identical or different sensors. The usual approach is to choose in both input image and reference image some well-defined ground control points (GCPs), usually characteristic features of the images, and then to compute the parameters of a deformation model that defines the transformation between reference image and input image. The main difficulty lies in the choice of the GCPs. Most commercial systems assume some interactive choice and are neither user-friendly nor well-suited for the automatic processing of a large volume of data. The Goddard team has proposed a registration method based on the use of Wavelet Transforms, which perform automatic extractions of the GCP.

The Wavelet Transform, with its similarity to the Fourier Transform, is very useful for image compression, browsing, and reconstruction. The multi-resolution scheme provided by the two-dimensional wavelet decomposition allows one to iteratively refine (from low to high resolution) the deformation model between input and reference images. The IIFS's algorithm, implemented on the massively parallel MasPar MP-2, has been tested on similar-resolution images. It is being generalized to data of very different resolution such as AVHRR (1 km resolution) and Landsat-TM (30 m resolution) data.

Image Segmentation

Image segmentation generates a spatial description of an image as a set of specific parts, regions, or objects. A region-based description of the image data can provide significant data compression for image transmission and storage and can also serve as input to image analysis routines.

Over the past several years, the team has investigated a powerful image segmentation approach called *Iterative Parallel Region Growing* (IPRG) and implemented it on a MasPar MP-2. The general principle of IRPG is to start with each pixel representing an individual region and then group two or more regions iteratively based on a uniformity criterion until no adjacent regions qualify for merging. At each iteration, one or several merges occur. IPRG performs the best merges in parallel on a set of well-defined subimages.

The successive iterations of a region growing process give rise to a hierarchy of segmentations from finer to coarser, and the main difficulty lies in the choice of a "stopping criterion." As an aid, the investigators have developed a Hierarchical Segmentation Exploration Tool (HSEGEXP) through which a user can manually interact with the hierarchical segmentation produced by the IPRG algorithm to select the needed level of segmentation detail.

Planning and Scheduling

The IIFS solution for managing the product generation side is to model modern-day manufacturing and production plants. Instead of processing from a supply-oriented production that has a tendency for mass production irrespective of scientific demand, this model takes a demand-driven approach in which the delivery of products occurs "just-in-time" for scientific needs and uses a minimal amount of inventory, i.e., intermediate data products.

Several techniques from the planning field are used to manage the generation of both standard and browse products. For standard products, classical approaches using hierarchical planning with deadlines are used. Here, an execution monitor interprets plans according to the run-time environment, assigns uncommitted tasks to processes, and collects statistics for the planner. For browse product generation, the demands of image processing require that plans be conditional; that is, each action is dependent on the outcome of previous actions.

Like planning, scheduling of both standard and browse product tasks is an iterative process where loose constraints must be tightened as more information about resources, responses from information retrieval, and products from other PGMs arrive. The ISTB is currently working with Honeywell Technology Center for the development of an ARM scheduler based upon the Time Map Manager.

CONCLUSION

The IIFS is the culmination of 10 years of research by the ISTB. It combines technologies from AI as well as conventional computer science to understand the

systemic properties of EOS. Unlike current systems analysis approaches that use top-down design, the AI paradigm for systems engineering is to have the system gradually evolve towards a solution. Because of the enormous size of EOS and other imminent missions, future systems must utilize the AI approach to meet the demands of changing requirements and new scientific knowledge. ■

Global Learning and Observations to Benefit the Environment (GLOBE): Announcement of Opportunity for Science/Education Teams

Technical Representative: Barrett Rock, (202) 395-7600.

The Government is interested in receiving proposals that address the development of services and materials to support scientific measurements, environmental education, teacher training, and program evaluation as part of the GLOBE Program. The GLOBE Program is an international education and science program that will involve students all over the Earth in measuring their local environment and creating a global set of data to be shared via the Internet, that will be used to create global environmental images for the students and for environmental scientists.

GLOBE is driven in part by the measurement needs of scientists and will be structured to teach students about the Earth's environment, thereby generating increased interest in science and awareness of the changing global environment.

A public briefing was held on November 3, 1994. The Announcement of Opportunity (AO), which contains a detailed description of the competition, has been released; deadline for receipt of proposals is December 15, 1994. Any award is subject to availability of funds. Proposals will be evaluated by a peer review panel, which will meet in January, 1995. Written requests for copies of the announcement should be directed to Dr. Barrett Rock, The GLOBE Program, 744 Jackson Place, N.W., Washington, D.C. 20503. The AO is available electronically through anonymous FTP from stis.nsf.gov. For further information contact: stis@nsf.gov (Internet), (703) 306-0214 (voice mail), or (703) 306-0090 (TDD). Information is also available on the Globe World Wide Web server accessed through URL http://www.whitehouse.gov in the Vice President's homepage. All proposals submitted by responsible sources will be considered.

LANDSAT ADVISORY PROCESS: REQUEST FOR PUBLIC ADVICE AND COMMENTS

The Landsat Program Management is seeking advice and comments from individuals regarding the status, effectiveness, and operation of the Landsat system. This request is issued pursuant to Public Law 102-555, the Land Remote Sensing Policy Act of 1992. Advice and comments are sought from a diversity of individuals who represent a broad range of public- and private-sector perspectives and a full spectrum of interests in the Landsat program and the data and services it provides. Those wishing to provide such advice and comments, via a survey that will be used as input for a report to Congress, can obtain further information on the Landsat advisory process and a copy of the survey questionnaire from:

George J. Komar
Landsat Advisory Process Coordinator
NASA Code YDO
300 E Street, SW
Washington, DC 20546
Fax: 202-358-3098

Requests received before January 1, 1995 will be honored.

Data Assimilation for EOS: Operational Support for NASA Campaigns

—**Michael Seablom, Richard Rood** (rood@dao.gsfc.nasa.gov), **David Lamich** (lamich@tyler.gsfc.nasa.gov), **Paul Newman** (newman@notus.gsfc.nasa.gov), Laboratory for Atmospheres, NASA Goddard Space Flight Center Greenbelt, MD 20771

Introduction

The Earth Observing System (EOS) will provide scientists with a comprehensive set of observations for studying the atmosphere. Beginning in the late 1990s, data will be collected from the EOS platforms providing a more-comprehensive view of the Earth system than the global set of conventional meteorological observations. The Data Assimilation Office (DAO) at the NASA Goddard Space Flight Center is tasked with production of assimilation analyses for general use by the Earth sciences community, as well as quantitative scientific interpretation of the observations. The current system, which consists of an 18-layer optimum interpolation analysis (Pfaendtner et al., 1994) and a 46-layer numerical model (Takacs et al., 1994), has been used extensively for examining meteorological case studies (e.g., Schubert et al., 1993). Under EOS, many new types of data are expected to increase the amount of data ingested by a factor of 10 or more over current standards.

Recently, the DAO has provided operational support for various NASA missions. These have included support for the Stratospheric Photochemistry Aerosols and Dynamics Experiment (SPADE), an aircraft experiment, and the Atmospheric Laboratory for Applications and Science (ATLAS), an experiment conducted from the space shuttle. In each of these cases, the assimilation system was operated in a real-time mode, in which data collection, data preprocessing, quality control, integration, and dataset distribution were involved. In this sense the assimilation system was operated in a mode that serves as a prototype for the EOS operational environment.

This article describes DAO support for the current Airborne Southern Hemisphere Ozone Hole Experiment/Measurements for Assessing the Effects of Stratospheric Aircraft (ASHOE/MAESA) field experiment. The DAO is providing meteorological analyses and 120-hour forecasts twice per day to the scientists involved with the mission. We describe the production environment for supporting such an effort and describe how prototype data sources are tested and verified during the mission.

The ASHOE/MAESA Experiment

The purpose of ASHOE/MAESA is to increase our understanding of the chemical and dynamical nature of the lower stratosphere, and to determine what effect aircraft exhaust of proposed high-speed civil transports will have on this region of the atmosphere. The experiment examines processes potentially affecting ozone and distributions of chemical tracers. In recent years the observed decline in total ozone over polar regions has raised concern about the effect of man-made emissions. This has led to significant research of the polar vortex, a region of strong winds which swirl around the high latitudes in the stratosphere during the winter months. Observations have also indicated decreasing ozone values in the mid-latitudes during winter; these mid-latitude ozone losses are poorly understood. It is a goal of ASHOE/MAESA to answer some of the questions scientists have raised about the chemistry of the stratosphere, and to provide governments with information useful for policy-making decisions on man-made emissions.

In situ chemical and dynamical measurements are being made by NASA's high-altitude ER-2 research aircraft. During the experiment most of the flights were conducted from Christchurch, New Zealand, thus providing access not only into the polar vortex edge but also into subtropical air. The mission is being divided into four deployments, which consist of approximately five eight-hour flights. The deploy-

ments are each designed to sample seasonal variability of the stratosphere. Deployment I was conducted in March, 1994 and Deployments II and III were conducted in June and July. The final deployment was completed in October. In nearly all cases flights were directed either due north or due south; the ER-2 has a range of 2400 km enabling flights from Christchurch to sample the latitudes 20 S to 65 S. Equatorward flights allow scientists to examine to what extent vortex "filaments" may be breaking away and penetrating the mid-latitudes, There is also an opportunity to examine tropical air in the stratosphere. Poleward flights enable examination of the polar vortex and the chemistry of the very cold air trapped inside.

The Production Environment

During ASHOE/MAESA the DAO provided the analyses and forecasts for flight planning, initialization of trajectory models, and benchmarking the stratospheric portion of the system. An analyst is present in the field to maintain the production schedule and to interpret the assimilation product. One of the most important aspects of the mission is planning precise flight paths that will result in the desired dynamical and chemical measurements. Flights are initiated between 7:00 and 9:00, New Zealand Standard Time, and return between 15:00 and 17:00. The production schedule, shown in Figure 1, is designed to accommodate flight operations. The analyses use data from the four "synoptic times," which are the international standard times for reporting weather observations. Each assimilation suite consists of analyses produced at 18:00 Greenwich Mean Time (GMT) on the previous day, followed by 0:00 GMT, 6:00 GMT, and 12:00 GMT on the current day, and linked in between by six-hour forecasts. A five-day global forecast is then executed based upon the analysis from 12:00 GMT. Output from the analyses and forecasts consist of heights, temperatures, winds, moisture, sea-level pressure, and sea-level winds. All of the output quantities are gridded with a horizontal resolution of 2 degrees north-south by 2.5 degrees east-west. A large number of model diagnostic quantities, such as precipitation and diabatic heating terms, are also available.

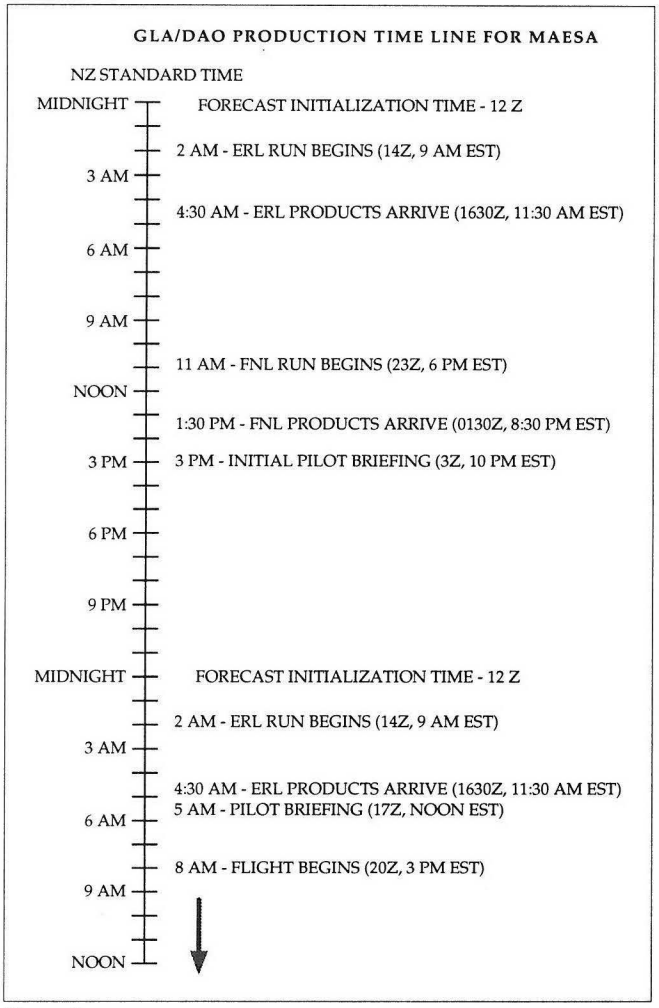


Figure 1.

Assimilation production consists of data collection, preprocessing, reformatting, analyzing, and storage. Collecting and preparing the global meteorological datasets for analysis is as time-consuming a task as performing the analysis itself. Input data collection is accomplished via a DAAC-funded electronic link between the National Meteorological Center (NMC) and the Earth Sciences Directorate at NASA Goddard. Prior to analysis the raw data must be checked for quality and consistency; duplicated observations must also be removed. Those data passing the initial quality checks must be placed into a format usable by the analysis. As the analysis is initiated, the data are passed through a more-comprehensive quality control which compares the observations with the model's first guess quantities (Seablom, 1990). Following the analysis, the output is saved and the five-day forecast is begun. These procedures are implemented twice

per day; at 12:00 GMT, when only a subset of the global observations are available from NMC, preliminary (or early) assimilations and forecasts are executed (marked ERL in Figure 1). Later in the day, at about 0:00 GMT, a more-complete set of observations is available and the assimilation and forecast are executed again. These products are referred to as "final," and are marked FNL in Figure 1. This allows for flight support utilizing information as up to date as possible.

Both the assimilations and forecasts execute on Goddard's Cray C98 computer, and the output datasets are permanently archived on the Unitree mass storage system. The Cray computer and the mass storage system are operated by the NASA Center for Computational Sciences (NCCS) and require special execution procedures. Data collection and preprocessing require about 30 minutes of computer time, with the analysis taking about 40 minutes, and the forecast taking about 25 minutes. The output datasets which are needed in the field are transmitted via the Internet. Because of the complex network routing between Washington, D.C. and Christchurch, transmission may take up to several hours. The entire process, from collection of the data to storage of results, is automated and ideally does not require human intervention. However, the nature of collecting a global dataset of weather observations, the linking together of workstations and supercomputers, and the sometimes difficult task of objective quality control often does require human intervention. Hence, a minimum of one person providing full-time support is needed. The NCCS also provides 24-hour support in the event of computer or networking problems.

Validation of the Assimilations and Forecasts

Providing good data analyses and accurate forecasts for the ASHOE/MAESA experiment is a challenging task. Because the ER-2 aircraft was deployed in a relatively data-sparse region of the South Pacific, it was frequently difficult to obtain the amount of observations required to produce high-confidence meteorological analyses. Should the analyses be in error, it was not possible for subsequent forecasts to be reliable. The problem stems from an inherent lack of rawinsonde data ("weather balloons"), which are the single most reliable source for obtaining informa-

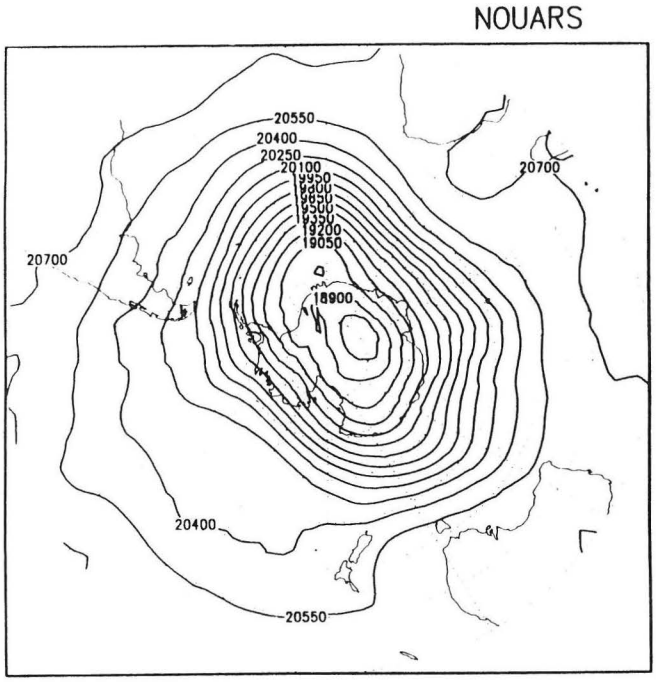


Figure 2. 50 hPa height analysis for June 2, 1994, 0.00 GMT. Analysis utilized standard satellite retrievals and available conventional data.

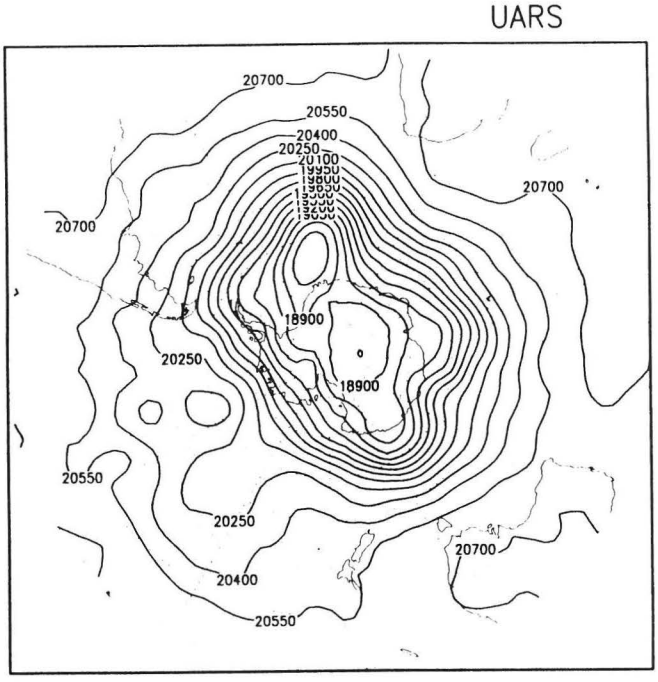


Figure 3. 50 hPa height analysis for June 2, 1994, 0.00 GMT. Analysis utilized data as in Figure 2, with the addition of UARS retrievals.

tion about temperatures and winds in the lower and middle atmosphere. Instead, the analyses relied heavily on the less-accurate, but ubiquitous, polar-orbiting-satellite measurements of temperatures from TOVS. During the field experiment various methods of incorporating new, unconventional data types into the analyses were attempted in an effort to improve the products. These data types included temperature profiles obtained from ER-2 measurements, Special Sensor Microwave/Imager (SSM/I) surface winds, and temperature profiles of the middle and upper stratosphere obtained from the Upper Atmosphere Research Satellite (UARS).

ASHOE/MAESA data provide a method for validating the analyses and the impact of the addition of new data types. This demonstrates the type of validation exercise needed when developing assimilation systems for more general applications than numerical weather prediction. By using the highly accurate dynamical and chemical measurements made by the instruments on board the aircraft, we were able to obtain a reliable estimate of the analysis error for a limited region. As an example we present the case of June 1, 1994 in which the ER-2 aircraft flew into the polar vortex. The 50 hPa analysis of geopotential heights for 0:00 GMT is shown in Figure 2. The aircraft track extended in a line from the south island of New Zealand south-southwestward to a location near 65 degrees south latitude and 152 degrees east longitude. A second assimilation cycle, which utilized Microwave Limb Sounder temperatures from UARS in the middle stratosphere, was executed for this period and the resulting 50 hPa heights are shown in Figure 3. Note the large change in the structure of the polar vortex. Without the inclusion of the UARS retrievals the vortex was analyzed with a lower wavenumber solution and the features were significantly smoother than the analysis which included the UARS data. Without independent data sources it is difficult to determine which solution is more reasonable.

Figure 4 displays nitrous oxide (N_2O) measurements made by the ATLAS instrument (Loewenstein et al., 1989) on board the ER-2. Note the sharp decline measured at approximately 21:40 GMT (78,000 seconds GMT). This signature is typical of vortex penetration; the low values represent nitrous oxide which has descended from aloft. The tight gradient in the height field (Figure 3) agrees more favorably with the location and magnitude of the sudden drop in N_2O. The temperatures in the UARS analysis also appear to be more reasonable given the presence of polar stratospheric clouds. In general, the assimilation with UARS data provides an analysis more consistent with chemical observations from the aircraft.

Chemical measurements from satellites, which provide more extensive coverage but at lower hori-

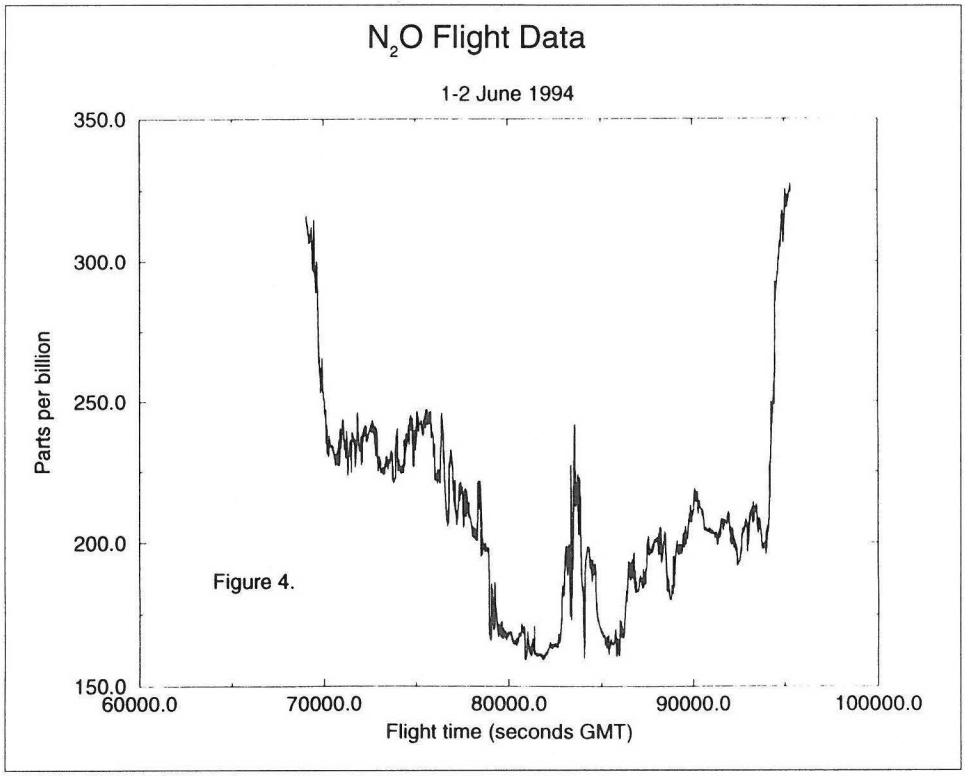


Figure 4.

zontal resolution, are also useful for validation of the analyses. The general shape of the vortex has a strong signal not only in N_2O measurements, but also in measurements of ozone and methane. Following the last ASHOE/MAESA deployment the Data Assimilation Office will continue to assess the quality of the analyses and forecasts by utilizing a wide range of chemical and dynamical observations. The efforts of the ASHOE/MAESA science team will provide a broad based evaluation of the assimilation capabilities, revealing both strengths and weaknesses.

Summary

Meteorological support for operational missions such as ASHOE/MAESA require a significant commitment in terms of rote production efforts as well as continuous monitoring of the products. Use of the assimilation system in the field has significantly enhanced the ability of scientists to sample and understand the stratosphere efficiently. Improvements to the system must be performed iteratively with validation efforts. At the conclusion of ASHOE/MAESA we expect to have a significantly large database containing *in situ* measurements, both chemical and dynamical, which we hope will improve our understanding of the lower and middle stratosphere of the South Pacific. This, *in turn*, will allow us to modify the analysis accordingly and make the necessary changes to assimilate new data types. We expect to extend our capabilities to other applications. This includes a reanalysis of the TOGA/COARE period using unconventional data types as well as participation in future campaigns to study the climatological system. The flexibility of the DAO to use nonstandard data and customize production schedules allows us to address the special problems of the campaigns.

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DAO Data Products

The Data Assimilation Office supports a variety of assimilated datasets for use by the scientific research community.
For more information contact:

Distributed Active Archive Center, NASA/GSFC
Reassimilation for period 1985-1990

data@dao.gsfc.nasa.gov
Three-hourly, daily, and monthly marine surface datasets for 1985-1990

Stratospheric assimilation for 1994

Other information may be obtained via Mosaic on the World Wide Web at the URL:
http://dao.gsfc.nasa.gov/dao.home_page.html

The Data Assimilation Office will conduct a seminar at Goddard Space Fl;ight Center, entitled "Results from the GEOS-1 Five Year Assimilation" March 6-8, 1995. Please send inquiries to: schubert@dao.gsfc.nasa.gov

SatView Visualization Software Available

—**Dennis L. Hartmann** (dennis@atmos.washington.edu), **S.L. Katz**, and **G.C. Gudmundson** (gcg@atmos.washington.edu), Department of Atmospheric Sciences, University of Washington

Introduction

SatView is a versatile, interactive tool for displaying satellite images and weather data. It was developed in conjunction with a program of scientific research conducted under a NASA Earth Observing System Interdisciplinary Science Investigation at the Department of Atmospheric Sciences at the University of Washington.

View Images Easily

SatView enables the user to look at satellite images, line contours, vector fields, and filled contours quickly and easily. The images can be viewed side-by-side, superimposed or in sequence, zoomed in, zoomed out, highlighted, and annotated, in nearly any map projection. SatView runs under X windows, and was designed to be simple enough to let the user get started quickly, and powerful enough to produce clear, informative images of publication quality.

With SatView's point-and-click interface, it is easy to explore. The users are given the option of setting a wide variety of parameters; however, each parameter has a reasonable default. With SatView, the users can determine the complexity of their operating environment: from preset and simple to customized and very detailed.

SatView can display several types of data fields: scanned data, such as *satellite images* (which are rasterized images with latitude and longitude information); gridded data, such as *contours* (filled, or as line overlays), *vectors*, or *pixels*; and sparse data, such as *vectors, text values*, or *markers*. SatView comes with tools to help the users put data in SatView's format so that they can quickly begin looking at their data. If the data is already in standard meteorological netCDF format, the users can view it instantly.

Menu and Mouse Driven

SatView is not for people who enjoy typing lengthy, arcane commands. The graphical user interface lets the user control the program simply and intuitively, without a lot of typing or memorizing cryptic sequences. If the user wants to highlight a range of data values, pointing of the cursor is all that is needed. Through menu selection, the user can change the map projection, print a hard copy, or loop through the images with the click of a button.

SatView supports panning and zooming using a quick, mouse-driven interface. To zoom in, the user drags a rectangle and clicks a button. Dragging the mouse scrolls the image. The user then selects a menu item to zoom the image back out.

Keeping Track

SatView makes it easy to inspect the value and position of any data point in an image. A mouse click within the color bar highlights that value in the whole image, or a click of the mouse on the image highlights that value in the color bar. Moving the cursor causes it to read its new geographic coordinates, which are always displayed on the screen.

SatView remembers where the user was the last time the program was used. Users can save their sessions anytime to pick up later, right where they left off. Users can store preferences for viewing options, so SatView will come up with the size, colors, and map projection preferred every time.

Publication-Quality Output

There are some features that are not used much, but are handy when it is time to produce a high-quality final image. For instance, users can import color

tables, choose fonts, and annotate an image within SatView. Once the image is ready, the user can send it to a PostScript printer, or write it to a PostScript or XWD file.

How to Obtain SatView

SatView is free to the research community and is available via anonymous ftp from **eos.atmos.washington.edu.** Log in as anonymous and enter your internet address as the password. Type `binary`, then at the next prompt type `mget pub/satview`. Answer yes to any prompts, then quit ftp. The complete SatView manual and instructions may be obtained via Mosaic: http://www.atmos.washington.edu. To build SatView you will need NCAR Graphics, XView, FORTRAN, and C.

Closure on The Global Carbon Cycle

A Description of The U.S. Department of Energy Ocean Margins Research Program

The Department of Energy's Ocean Margins Program (OMP) is designed to quantitatively assess the importance of coastal ocean systems in the global carbon cycle. Since the beginning of the Industrial Revolution, human energy-related activities have dramatically altered the global carbon cycle, and, consequently, this cycle is not presently in a steady state. To reduce major uncertainties in predicting future global environmental quality, it is imperative to understand the sources and sinks of atmospheric CO_2, the role of anthropogenic activities in disrupting the natural carbon cycle, and the effects of, and feedbacks between, these activities and the natural carbon cycle. Due to continuously increased loading of nutrients to the margins, which, globally, is related to the rate of human population growth and high population densities in coastal states, biological carbon fixation has been stimulated. Depending on the fate of the fixed carbon, this stimulation has the potential to mitigate the effects of anthropogenically derived CO_2. Determining the factors that control the magnitude of carbon exchanges between the ocean margins and the atmosphere, and the subsequent fate of this carbon, is crucial to predicting the strength and capacity of the oceans to absorb excess anthropogenic atmospheric CO_2.

The first phase of the OMP broadly examines the continental margin of the western North Atlantic Ocean, which adjoins the east coast of the United States, focusing primarily on the southern portion of the Mid-Atlantic Bight between Cape Hatteras and Chesapeake Bay. In this region, a large flux of freshwater and particulate organic carbon flows to the North Atlantic Ocean. An interdisciplinary research team, using state-of-the-art physical, chemical, biological, and molecular tools, will trace and quantify the fluxes and fate of carbon in the coastal ocean. The program elements, which include geochemical tracers, physical circulation, biological and molecular ecological processes, will be used to understand if, and how, the continental margin serves as a conduit to transfer atmospheric CO_2 to the deep ocean and sea floor. In addition to providing information that is necessary for assessing the importance of coastal-ocean systems in the global carbon cycle, this program will help provide the scientific framework necessary for managing coastal ecosystems and energy resources. As a result, research efforts within DOE's OMP involve several Subcommittees of the National Science and Technology Council's (NSTC) Committee on Environment and Natural Resources (CENR), including Global Change, Water Resources, Coastal and Marine Environment, Biodiversity and Ecosystem Research, Resource Use and Depletion Research, and Global Observations.

Further information on the OMP can be obtained from:
Dr. Curtis Olsen, Ecological Research Division Office of Health and Environmental Research
U.S. Dept. of Energy, Washington, D.C. 20545
fax: (301) 903-8519

—Paul Falkowski

Meeting On At-Launch Digital Elevation Model (DEM) Requirements For The EOS AM Platform

NASA HQ, Washington, DC.

October 6-7, 1994

—Chris Justice (justice@kratmos.gsfc.nasa.gov)

Martha Maiden (NASA HQ) held an ad-hoc meeting to address EOS instrument topographic data requirements. Specifically, the focus of the meeting was the generation of a global DEM product for EOS AM-1 and TRMM at-launch processing. The critical needs for DEMs by the satellite land community include: path length determination for atmospheric correction, geometric and geolocation requirements (for navigation, the use of DEMs is not optional), and radiometric requirements (e.g. slope aspect correction, shadowing, Bidirectional Reflectance Distribution (BRDF)). DEMs are currently being used in Landsat and Advanced Very High Resolution Radiometer (AVHRR) processing at local and global scales. Regional DEM data set preparation is already underway in several places and at Distributed Active Archive Centers (DAACs), there is now the need for a concerted effort to meet the global instrument needs.

Chris Justice (UMD) chaired the meeting and summarized the meeting goals as being: to clearly state and justify the instrument DEM requirements, to develop tight specifications for a global DEM product, to identify and assess current activities which can be coordinated and built upon, to develop an implementation design for a product that will meet the product specifications, and to identify activities needed for DEM product generation.

Presentations were given on the DEM requirements and activities for various EOS instruments: Mike McCumber (GSFC) for TRMM, Jan Peter Muller (UCL) and Robert Wolfe (Hughes STX) for MODIS, Frank Palluconi (JPL) for ASTER, Ken Jones (JPL/Caltech) and Nevin Bryant (JPL) for MISR, and Jim Irons (GSFC) for Landsat. The instrument requirements are summarized in Table 1. Dean Gesch (EDC) gave a review of current DEM data characteristics and availability, including the current restrictions associated with the Defense Mapping Agency (DMA) Digital Terrain Elevation Data (DTED). ETOPO5 data are available globally but the accuracy is insufficient for the EOS instruments. The Digital Chart of the World covers 85% of the globe and can be used to develop a 1 km global DEM. The DMA DTED cover 60% of the World and has a c. 100 m horizontal posting but has restricted access. Peter Muller described various means for generating DEMs from existing satellite sensors and outlined the Committee on Earth Observation Satellites (CEOS) GLOBE program, which has as its objective the development of a global 1 km DEM. As part of its activities, GLOBE has recently received the public release of a 1 km product from the DTED data.

Based on the summary of instrument requirements, the case for three data initiatives was developed: 1) a publicly available global, 1000 m data set be available at least by TRMM launch minus 6 months (this would meet the TRMM, MODIS and MISR requirements), 2) a publicly available global, 500 m data set (this would meet the instrument processing requirements of MODIS [250 m] and MISR [275 m]), and 3) a publicly available global, 100 m data set (this is required to meet the requirements for MISR and ASTER processing, and high quality Landsat 7 processing). Two suboptions were developed to include with the 1 km data summary statistics from 100 m data and to generate a global hybrid product of mixed resolutions based on the best available data. It was recommended to base the priority for data set generation on availability, feasibility, and quality. Flow diagrams were

developed to show a possible production scenario for each of the data initiatives.

An executive summary of the meeting was presented to representatives of the EOS program and project management. Martha Maiden agreed to pursue the formulation of a working groups with a threefold purpose: (1) to steer the development of an EOS at-launch DEM product, (2) to hold discussions with the DMA about using the DTED data for EOS, and (3) to evaluate the feasibility of filling the holes in the global 1 km DEM by use of satellite derived data. It was recognized that similar initiatives may be needed with respect to developing other ancillary products for EOS instrument data processing. ■

EOS Instrument DEM Requirement Summary

Instrument	Horiz Accuracy	Vert Accuracy	Comments
MISR (L2+science)	1.1 km	100 m	refinement by image correlation - derived from the 100 m
MISR (275 m)	500 m	50 m	not planned as part of standard processing
MISR (L1 processing)	100 m	30 m	
MODIS (1k/500 m)	1 km	100 m	required
MODIS (250 m)	500 m	50 m	goal
ASTER	100 m	30 m	refinement by image correlation
ASTER (1 processing)	1 km	100 m	Japanese access required
Landsat 7 (ETM)	100 m	30 m	user need
Landsat (Color)	1 km	100 m	potential for land processing
TRMM	1 km	100 m	Japanese access required

Table 1. Instrument Requirements For Digital Elevation Data.

NASA Awards Internet Public Access Grants and Cooperative Agreements

—Barbara Selby, Headquarters, Washington, DC (Phone: 202/358-1983)
—Allen Kenitzer, Goddard Space Flight Center, Greenbelt, MD (Phone: 301/286-2806)

NASA has selected ten organizations to receive a total of $6.8 million to help develop applications and technologies as part of the agency's efforts to stimulate public use of Earth and space science data over the Internet. This is the final selection for the current competition and follows the awards announced in August of this year (see Table 1).

These awards are made by the NASA Information Infrastructure Technology and Applications (IITA) program, a part of the federal initiative to stimulate a U.S. National Information Infrastructure, commonly called the "Information Superhighway." The IITA program aims to provide broad public access to remote sensing data, including Earth and space science data, for general purposes such as education, environmental emergency response and agriculture.

"We're especially pleased by the diversity of institutions and users represented by this set of projects," said Paul Hunter, IITA program manager at NASA Headquarters, Washington, DC. "We'll reach museum visitors in six states, plus the District of Columbia; farmers in Wisconsin; flood emergency managers in the southeast; Native Americans in the Great Plains; and many, many students nationwide. The developer community includes both large and small universities such as the University of California at Berkeley and Bowie State University in Bowie, MD, as well as large and small businesses."

Museums participating in this selection round include the Gulf of Maine Aquarium, Portland; Smithsonian Astrophysical Observatory, Cambridge, MA; Hands On Museum, Ann Arbor, MI; Lawrence Hall of Science, Berkeley, CA; Cranbrook Institute of Science, Bloomfield Hills, MI; Boston Museum of Science; The Exploratorium, San Francisco; National Air and Space Museum, Washington, DC; New York Hall of Science, Flushing Meadows Corona Park; and the Science Museum of Virginia in Richmond.

Schools and school districts under this selection include the Yarmouth, ME school district and Pioneer High School, Ann Arbor, MI. Several of the projects will identify additional schools and school districts for collaborative efforts.

The IITA program is administered from NASA Headquarters, with technical management and coordination provided by Goddard Space Flight Center, Greenbelt, MD.

NASA press releases and other information are available automatically by sending an Internet electronic mail message to domo@hq.nasa.gov. In the body of the message (not the subject line) users should type the words "subscribe press-release" (no quotes). The system will reply with a confirmation via e-mail of each subscription. A second automatic message will include additional information on the service. Questions should be directed to (202) 358-4043.

Table 1. NASA IITA Internet Grants and Cooperative Agreements

Passport to Knowledge: Electronic Field Trips to Scientific Frontiers via Interactive TV and the Internet — a $902,000 cooperative agreement between NASA and The Childhood Project, Inc., Summit, NJ. The NASA-funded portion of this project will use the Internet to provide on-line access to scientists' diaries and other curriculum materials in support of live, national, interactive television field trips to the Antarctic, the Kuiper Observatory and the Hubble Space Telescope.

Surfing the Net: Aquatic Applications of Archival Satellite Imagery — a $266,000 cooperative agreement between NASA and the Gulf of Maine Aquarium, Portland. This project will develop innovative K-12 learning activities using on-line data to investigate the land-sea interface, oceanographic applications and studies of the effect of human activities on the environment. Early efforts will be tested by classes in the Yarmouth, ME school district.

Windows to the Universe - An Earth and Space Science Internet-Based Active Learning System for the General Public — a $900,000 grant to the University of Michigan to create a learning system for Earth and simulation-guided animation and voice overlays to be implemented in museums and libraries nationwide. Collaborators in this project include the Hands On Museum, Ann Arbor, MI; Cranbrook Institute of Science, Bloomfield Hills, MI; and Pioneer High School, Ann Arbor.

A Science Infrastructure for Access to Earth and Space Science Data Through the Nation's Science Museums — a $900,000 grant to the University of California, Berkeley, to create a national Science Information Infrastructure, a natural partnering of science museums, teachers and research institutions to stimulate public awareness and use of remote sensing data and to deliver this information to the general community. This project presents a consortium of museums which include the Smithsonian Astrophysical Observatory, Cambridge, MA; Lawrence Hall of Science, Berkeley, CA; Boston Museum of Science; The Exploratorium, San Francisco; National Air and Space Museum, Washington, DC; New York Hall of Science, Flushing Meadows Corona Park; and Science Museum of Virginia, Richmond.

Dissemination of Atmospheric Sciences and Space Sciences Data and Information for K-12 and the Public: A Pacific Northwest Approach — an $880,000 grant to the University of Washington, Seattle, to make real-time and retrospective atmospheric and space science data available to the general public with special emphasis on products for use in science and mathematics instruction. Products will be tailored to display and explore the unique meteorology of the Pacific Northwest and the Puget Sound area.

Using Science and the Internet as Everyday Classroom Tools — a $667,000 cooperative agreement between NASA and the Smithsonian Institution Astrophysical Observatory, Cambridge, MA. Associates include Tenon Intersystems and AT&T. This project will develop a K-6 "hands-on" astronomy curricular theme that integrates science and Internet/computer activities into the daily life of the classroom.

Flood Management Enhancement Using Remotely Sensed Data — a $609,000 cooperative agreement between NASA and SENTAR, Inc., Huntsville, AL, to provide enhancements to existing flood management capabilities by using remotely sensed Earth data and the extension of Internet for the communication of data to the field.

Satellite-Data-Driven Real-Time Agricultural Management Decision Aids — an $842,000 grant to the University of Wisconsin, Madison, to develop four end-user applications of satellite data in the agricultural and environmental management arena: 1) irrigation scheduling for

(Continued on page 34)

Table 1. NASA IITA Internet Grants and Cooperative Agreements (Cont.)

on-farm use, 2) irrigation electrical demand prediction system for power generation decisions by utility companies, 3) estimation of the duration of leaf wetness leading to foliar disease prediction in potatoes, and 4) prediction of frost damage for protection of cranberry crops.

Emergency and Crisis Management: A Remote Sensing Application — a $263,000 grant to the University of North Texas, Denton, to build an application on the Internet to demonstrate the usefulness of NASA's remote sensing data for use in mitigation, preparation, response and recovery from natural and technological disasters.

SAIRE - A Scalable Agent-Based Information Retrieval Engine — a $600,000 cooperative agreement between NASA and Loral AeroSys, Seabrook, MD, with support from Bowie (Maryland) State University. This project will develop an intelligent software program that will accept simple descriptions of a request, then correct errors or add missing information, learn the user's preferences, and shield the user from complex querying mechanisms in order to access and present Earth and space science data available over the Internet.

KUDOS

Dr. Joanne Simpson, Chief Scientist for Meteorology at Goddard Space Flight Center and TRMM Project Scientist, has been given the American Meteorological Society's highest honor, that of being elected an Honorary Member. This award has been bestowed on very few *men* in the entire world over the past 75 years (the lifetime of the AMS), and she becomes the first *woman* to be so honored. She joins a group whose contributions are outstanding in the field of the atmospheric sciences, and thus brings great credit to the National Aeronautics and Space Administration and Goddard Space Flight Center.

Science Calendar

December 16	TES Team Meeting, NASA/Goddard Space Flight Center, Bldg. 21, Greenbelt, MD. Contact Reinhard Beer (beer@atmosmips.jpl.nasa.gov), tel. (818) 354-4748.
• 1995 •	
March 6-8	Workshop on Results from the GEOS-1 Five Year Assimilation—NASA/Goddard Space Flight Center, Greenbelt, Maryland. Contact Siegfried Schubert at (301) 286-3441, (schubert@dao.gsfc.nasa.gov), or Richard Rood at (301) 286-8203, (rood@dao.gsfc.nasa.gov).
April 19-21	CERES Science Team Meeting, NASA Langley Research Center. Contact John Nealy at (804) 864-4412, (cnealy@zippo.larc.nasa.gov).
May 3-5	MODIS Science Team Meeting (tentative). Contact David Herring at (301) 286-9515, (herring@ltpsun.gsfc.nasa.gov).
September 20-22	CERES Science Team Meeting, NASA Langley Research Center. Contact John Nealy at (804) 864-4412, (cnealy@zippo.larc.nasa.gov).

Global Change Calendar

• 1994 •

December 5-9	American Geophysical Union Fall Meeting, San Francisco, CA. Contact Karol Snyder, Tel. (800) 966-2481, FAX (202) 328-0566.

• 1995 •

January 15-20	75th AMS Annual Meeting, Diamond Anniversary, Dallas, TX. Contact Monica Walters, Tel. (202) 466-6070, FAX (202) 466-6073.
February 6-10	Optical Remote Sensing of the Atmosphere, Salt Lake City, Utah. Contact Optical Society of America, 2010 Massachusetts Avenue, N.W., Washington, D.C. 20036-1023. Tel. (202) 223-0920; FAX: (202) 416-6100.
February 16-21	AAAS Annual Meeting and Science Innovation Exposition, Atlanta, GA. Call (202) 326-6450.
Feb. 28-Mar. 2	ACSM/ASPRS '95 Annual Convention, Charlotte, NC. Contact Ann Ryan Tel. (301) 493-0290; FAX (301) 493-0208.
March 6-8	International Symposium on the Expansion of the Remote Sensing Market, Paris, France. Contact Dr. Paul Kamoun, Organizing Committee Chairman, AAAF/EARSC Symposium, 100, Boulevard du Midi, 06322 Cannes-La-Bocca Cedex, France. Telefax: (33) 92.92.30.10 or Claude Frédéric, Symposium Coordinator, AAAF/EARSC Symposium, 6, Rue Galilée, 75782 Paris Cedex 16, France. Telefax: (33) 1.47.23.89.11.
May 15-18	Preliminary Announcement and Call for Papers, Workshop on Pollution Monitoring and GIS, LESPROJEKT—Forest Management Institute, Brandys and Labem, Czech Republic. For further information contact: Tomas Benes, Tel. +42 202 3581, ext. 330; +42 202 3727; FAX: +42 202 3371.
July 10-14	International Geoscience and Remote Sensing Symposium, Congress Center, Firenze, Italy. Contact IEEE Geoscience and Remote Sensing Society, 2610 Lakeway Drive, Seabrook, TX 77586-1587. Tel. (713) 291-9222; FAX: (713) 291-9224; e-mail: stein@harc.edu.
August 14-18	International Symposium on Radiative Transfer, Kusadasi, Turkey. First announcement and call for papers. For further information contact: Prof. M. Pinar Menguc, Dept. of Mechanical Engineering, U. of Kentucky, Lexington, KY 40506-0046; Tel. (606) 257-2673; FAX: (606) 257-3304; e-mail: menguc@ukcc.uky.edu.
September 18-20	Third Thematic Conference on Remote Sensing for Marine and Coastal Environments: Needs, Solutions, and Applications, Westin Hotel, Seattle, Washington. Sponsors: ERIM, MSRC, EPA. Contact Robert Rogers, Tel. (313) 994-1200, ext. 3453; FAX: (313) 994-5123.
September 25-29	Global Analysis, Interpretation, and Modelling (GAIM), The First GAIM Science Conference, Garmisch-Partenkirchen, Germany. GAIM is an Activity of the International Geosphere-Biosphere Programme (IGBP). For further information contact: IGBP Secretariat, Institut für Meteorologie, Freie Universität Berlin, Carl-Heinrich-Becker-Weg 6-10, 12165 Berlin, Germany or Dr. Dork Sahagian, GAIM Task Force Officer, Institute for the Study of Earth, Oceans and Space, U. of New Hampshire, Morse Hall, 39 College Road, Durham, NH 03824-3525, U.S.A. Tel. (603) 862-1766; FAX: (603) 862-1915; e-mail: gaim@unh.edu.

• 1996 •

February 27-29	Eleventh Thematic Conference on Geologic Remote Sensing, Las Vegas, Nevada. Contact Robert Rogers, ERIM, Box 134001, Ann Arbor, MI 48113-4001. Tel. (313) 994-1200, ext. 3453; FAX: (313) 994-5123; e-mail: raeder@vaxc.erim.org.

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Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

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Space Administration
NASA-451

The Earth Observer

The Earth Observer is published by the EOS Project Science Office, Code 900, NASA/Goddard Space Flight Center, Greenbelt, Maryland 20771, telephone (301) 286-3411, FAX (301) 286-1738, and is available on World Wide Web via Mosaic at Uniform Resource Locator (URL) http://spso.gsfc.nasa.gov/spso_homepage.html. Correspondence may be directed to Charlotte Griner (cgriner@ltpsun.gsfc.nasa.gov) or mailed to the above address. Articles (**limited to three pages**), contributions to the meeting calendar, and suggestions are welcomed. Contributions to the Global Change meeting calendar should contain location, person to contact, telephone number, and e-mail address. To subscribe to *The Earth Observer*, or to change your mailing address, please call Hannelore Parrish at (301) 441-4032, send message to hparrish@ltpsun.gsfc.nasa.gov, or write to the address above.

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Executive Editor: Charlotte Griner
Technical Editor: Renny Greenstone
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