The Earth Observer

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EDITOR'S CORNER

MY REPLACEMENT — Michael King

Vince Salomonson, Director of the Earth Sciences Directorate at NASA Goddard Space Flight Center, has recommended to Goddard and NASA management that Dr. Michael D. King be appointed as the next EOS Senior Project Scientist. During late August and early September, Michael will work with me to effect a graceful transition of duties and responsibilities before my return to teaching and research at the University of California, Santa Barbara.

Michael King brings to this position a strong scientific background and a distinguished record of scientific accomplishment. He was awarded the NASA Exceptional Scientific Achievement Medal in 1992 and is a Fellow of the American Meteorological Society. He has also served many years as the Project Scientist of the Earth Radiation Budget Experiment (ERBE), is a member of the CERES Science Team, and has been Deputy Team Leader of the MODIS Science Team. His experience in the study of the Earth-atmosphere radiation budget and his work on clouds and aerosols, including model development and use of observations from spacecraft and aircraft, coincide well with the priority assigned these problems in the U.S. Global Change Research Program.

I have enjoyed immensely my 2+ years as the EOS Senior Project Scientist. Most gratifying of all my experiences in this job has been learning more about the Earth system. My colleagues among the EOS investigators have patiently explained the nuances of scientific questions from the Earth's core to the stratosphere, and I thank you all for making me a more broadly informed scientist. I hope I have correctly and fairly represented your collective interests and scientific issues in the restructuring of the Earth Observing System.

—Jeff Dozier
EOS Project Scientist

Inside

INVESTIGATORS WORKING GROUP MEETS IN KEYSTONE COLORADO

—*Renny Greenstone*
EOS Project Science Support Office, Hughes STX Corp.

The EOS Investigators Working Group (IWG) met in Keystone, Colorado on July 20-22, 1992. Proceedings of the meeting will be available in September, or soon thereafter, and will be sent routinely to those on the attendance list. Others may write to Hannelore Parrish at the address shown elsewhere in this newsletter for a copy of the Proceedings.

The original plan had been to focus the meeting heavily on scientific issues related to EOS, but the potential for further reductions in the EOS budget led to devoting much of the meeting time to budgetary issues. Because of the new concerns, the evening meeting of the Science Executive Committee of the IWG was largely devoted to planning for a special session of the EOS Payload Advisory Panel. That special session was held on the final morning of the three-day IWG meeting.

Budget Issues

Following a revised agenda, Jeff Dozier, EOS Project Scientist, and Chris Scolese, EOS AM Project Manager at the Goddard Space Flight Center, reviewed some of the possible changes that could come about in the EOS flight program, should there be major cuts in the EOS budget. Only minimal changes are being considered for flights through the year 2000. A major cost-saving change would be the adoption of a common spacecraft design for the PM-1 and later launches. There is a plan to rely more heavily on the international partners for participation in the program.

IPCC Update

Bob Watson reviewed the latest findings of the Intergovernmental Panel on Climate Change (IPCC), as embodied in a newly released 1992 report. He said that there were no fundamental changes from the 1990 report. The report notes that the rate of increase of methane in the atmosphere has been slowing, but this is not well understood.

The IPCC scenarios for future climate changes have been changed—the effects of population increases and the possible use of nuclear power are now taken into account. The concept of using Global Warming Potential (GWP) to compare the effects of the different greenhouse gases is now regarded as too simple, and it has been concluded that fully coupled chemistry/climate models are needed to make the correct estimates. There are still key issues that need to be resolved concerning clouds, water vapor, ocean/atmosphere interactions, and the cryosphere.

Landsat

Ghassem Asrar, EOS Program Scientist, and Darrel Williams, Landsat Project Scientist, discussed developments related to Landsat. DoD and NASA are now the joint managers of the Landsat program. The current schedule calls for a January launch of Landsat 6 and a mid-97 launch of Landsat 7. Landsat 8 is to have a 1996 "new start." Its characteristics are yet to be defined, but there is to be a 3.7 micrometer channel, and channels at 10 or 11 micrometers are being considered.

Joint Oceans/Atmospheres Panel Meeting

At a joint meeting of the EOS Oceans and Atmospheres Panels, there were presentations on several proposed "Topical Science Workshops," and several special presentations. The three Topical Science Workshops that were addressed were: (1) Air/Sea Interactions (Drew Rothrock), (2) Clouds and Radiation (Bruce Barkstrom), and (3) Tropospheric Chemistry (John Gille).

Following the Workshop discussions, Dave Diner described the possibilities for adding polarization channels to the MISR instrument, achieving an accuracy better than 0.5% with a 30 x 50 km nadir field of view.

Wayman Baker discussed the strong support for the LAWS instrument that is being offered by the French (CNES) and indicated that DoD and DoE are also expressing interest in collaborating on the LAWS mission.

Bill Rossow gave a talk on clouds, radiation, and climate, drawing on the work of the International Satellite Cloud

Climatology Project (ISCCP). The least-understood aspects of his subject matter are the large-scale atmospheric circulation and latent/radiative energy exchanges, as well as natural variability and climate feedbacks.

Joe Waters gave a fast-paced review of the many excellent results regarding ozone and interacting species that have been coming from the UARS program.

Bob Dickinson discussed a wide range of phenomena related to the role of water in climate models. The great variability, by orders of magnitude, in worldwide precipitation leads to considerable error in regional predictions by climate models.

DAY 2—Science Discussions Continued

The current level of understanding of the global carbon cycle was reviewed by Berrien Moore. The primary uncertainty in the carbon budget seems to be a missing sink for 1-to-2 Gigatons carbon per year. EOS could contribute to solving the carbon problem in several ways: MODIS could help to define the amount of carbon that is fixed; EOS instruments could define land-use change; ASTER/HIRIS/Landsat could distinguish vegetation types; and nitrogen mineralization could be determined.

Mark Abbott's review of ocean productivity dealt with the need to consider processes at many scales. EOS will be very helpful to ocean science by providing overlapping observations of air/sea fluxes, vector winds, sea-level variability, ocean color, and sea ice.

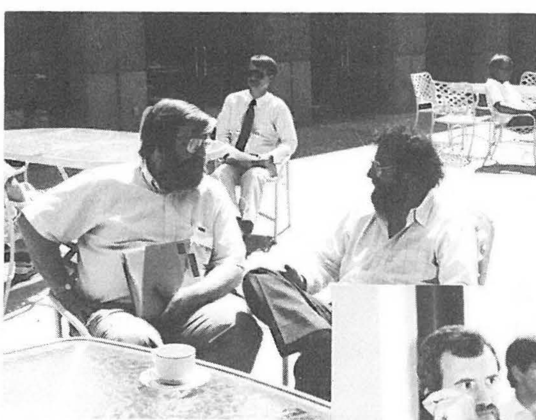
Ricky Rood invited EOS investigators to tell him what products they will need from his global data assimilation effort.

Aerosols and climate were Jim Hansen's subject matter. He discussed the effect of aerosol particle size on both stratospheric and tropospheric radiative forcing. Tropospheric aerosol forcing is more dependent on single scattering albedo than is stratospheric forcing. SAGE III from EOS could provide the information necessary to determine the stratospheric forcing; only EOSP could determine the tropospheric forcing.

Dave Schimel reported on the biogeochemistry of methane. He showed that EOS will provide the multisensor approach needed to measure the interacting factors that determine methane's fate.

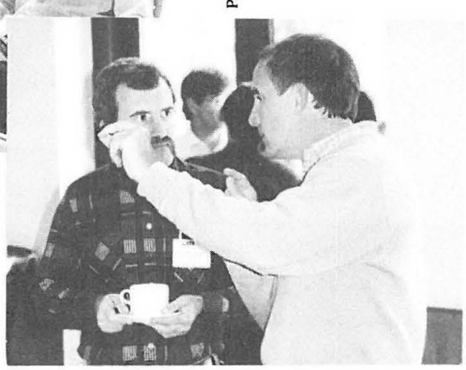
Martha Maiden and her colleagues presented the latest developments in the EOSDIS Pathfinder effort. SMMR data are now included. One hundred terabytes of GOES data are now in the archives.

At the end of the day, Mous Chahine briefly discussed validation of EOS data and invited all PIs and IDS investigators to join in the activities of the Validation Panel. ❑



Photos by C. Griner

▲ Dixon Butler & Bob Watson chat on the patio, Wayman Baker looks on.



Berrien Moore III making a point with Peter Mouginis-Mark ▶

News From NASA's Public Affairs Office

HAPPY ANNIVERSARY: August 28, 1992 marks the 28th anniversary of both the launch of the Nimbus-1 satellite and the first METEOR satellite in the former Soviet Union. Since August 28, 1964, seven Nimbus spacecraft have been launched, the last being Nimbus-7 on October 24, 1978. Nimbus-7 is alive and well and is the primary source of total ozone data for the United States. Also, last year about this time, the Goddard-managed Total Ozone Mapping Spectrometer aboard a METEOR-3 satellite was launched from Plesetsk Cosmodrome, Russia. Both instruments are operating within nominal limits, and more than 99.5 percent of all available ozone data has been collected and distributed for analysis.

PANEL REPORTS

Joint Meeting of the Atmospheres and Oceans Panels

—Dennis L. Hartmann, Atmospheres Panel Chairman, and Drew Rothrock, Oceans Panel Chairman

A joint meeting of the Oceans and Atmospheres Panels was held at the EOS IWG meeting in Keystone, Colorado on July 20, 1992. Several topics were discussed, and a brief summary of that discussion is presented here.

1. Topical Science Workshops, General

Drew Rothrock led a discussion of the nature and purpose of the Topical Science Workshops. The ideas expressed here are extracted from the discussion. These workshops might serve one of several purposes, from introducing the capabilities and research interests of various EOS instrument and interdisciplinary investigations to each other, to producing a document detailing plans for producing data products at several stages of EOS. The more-popular view seems to be that these workshops should "solve someone's problem"—that is, should provide some documentation that explains EOS and gives some detail of what we plan to accomplish in the way of providing credible geophysical measurements and scientific results. They should answer some part of the question, "What specifically will EOS provide in some topical area of Earth sciences?" This answer cannot be couched in generalities about understanding carbon cycles or documenting heat budgets, but must specify what storage quantities and what flux quantities in balance equations will be measured or estimated from models, and must assess our ability to make these measurements from space. The need for specific scientific and observational goals points towards a structured workshop, possibly with a strawman scientific and observational plan to be modified by the workshop members.

An especially important purpose is to initiate a dialog among members of the instrument teams and the interdisciplinary investigations about the needed measurements and the capabilities of specific instruments to provide them. Cutbacks in EOS funding may mean that interdisciplinary investigators will not find available some of the data products they had thought they could obtain with a simple inquiry to EOSDIS. Beginning to clarify who will provide what data products is crucial, and will aid in our reviews of payload questions.

It is clear that the demand for early payoff from EOS requires that we identify near-term data and scientific products, and not focus solely on future measurements from the EOS-AM and later platforms. Showing present results and results to be obtained from payloads launched in the next five years is of great importance. Three phases of measurement and associated research can be defined: research with data available now, with data taken during the next six years from satellites launched before the first EOS platform, and with data from the EOS platforms.

Identifying gaps in the present group of EOS investigations could be one workshop objective. This would point out, for example, terms in balance equations that no one is now planning to measure or that cannot be measured, and make explicit the limitations or boundaries of our "Earth Observing System." It would also aid in the definition and release of future AO's.

Clearly, these workshops should state spatial and temporal data sampling requirements. These requirements should be objectively determined from science requirements, through a clear line of argument. These arguments may be based on accurate measurements of terms in balance equations or on the resolution of key phenomena.

2. Air-Sea Flux Workshop

The appropriate scope of a workshop on air-sea fluxes was explored as part of the general workshop discussion. It is clear that turbulent fluxes would be a key element. Whether surface radiation should be included in this topic or in the Clouds and

Radiation Workshop (see below) was less clear, but the view was that surface radiation fluxes are sufficiently distinct from the whole atmospheric radiation balance, and sufficiently coupled to other fluxes at the surface, to warrant inclusion in an air-sea flux workshop. Precipitation is a related topic, but might be the subject of another topical workshop. Air-sea exchange of trace gases such as carbon dioxide, methane, nitrous oxide or carbon monoxide could be included, but it is not clear whether it is so large a topic as to overload a turbulent air-sea flux workshop.

3. Clouds and Radiation Workshop

Bruce Barkstrom described a plan for a topical science workshop on clouds and radiation. The primary purposes would be to review the state of our current understanding of this critical research area; discuss how the various EOS instruments can work together to provide new and more-detailed information on the interaction of clouds, water vapor and radiation in climate; refine the EOS data products list for clouds and radiation; and begin to develop a plan for validating these data products. He proposed tentative dates of Nov. 17-19 and Dec. 1-3, possibly in western Florida.

4. Tropospheric Chemistry Workshop

John Gille proposed that a small workshop be held to discuss the most effective use of EOS measurements for tropospheric chemistry. The meeting would review the important scientific questions, assess the potential contributions of EOS instruments (MOPITT and TES, plus AIRS, HIRDLS, MODIS, SAGE-III, etc.), identify the most-promising opportunities for combined spaceborne and *in situ* measurements, develop plans for validation of the spaceborne measurements and develop plans for more specialized follow-on meetings to continue more detailed planning and analysis. Bob Watson suggested that the best plan would be to focus on tropospheric chemistry and transport, especially near the tropopause, rather than sources and sinks of trace gases. Gille proposed that the meeting be held at NCAR, tentatively in autumn of 1992.

5. Polarization Measurements from MISR

David Diner presented a proposal to make polarization measurements from MISR. Currently, no polarization measurement capability is planned on EOS-AM, since EOSP has been deferred to a later mission (most likely around 2003), and MODIS polarization channels have been deleted. The goal of this modification is to make scientifically meaningful measurements of polarization with minimal disruption or risk to the basic MISR design, and yet keep costs and demands on spacecraft to a minimum. Adding a simple polarization measurement capability to MISR wouldaccomplish the following: enhance the aerosol measurement capabilities of the EOS-AM platform; reserve EOSP involvement in early EOS activities; enable the EOSP team to strengthen the case for global polarimetry and evaluate the benefits of along-track versus cross-track operation; and provide an early start to learning how to best combine MISR and EOSP aerosol data to give the best possible optical property information.

The proposed measurement capability would have the following characteristics (we present characteristics revised since the workshop):

- 5x5 km instrument field of view
- Sample spacing of 2.5 km
- Single nadir view
- Swath width of 96 km
- MISR imaging capability (275 m sampling) would be used to measure the homogeneity of the scene within polarimeter footprints
- Wavelengths of 443, 555, 670 and 865 nm (same as MISR cameras)
- Polarization accuracy better than 0.5%
- Signal-to-noise ratio >500 for 10% equivalent reflectance

Larry Travis commented that the MISR polarization concept is not what you would do for polarization measurements if you were building a polarization instrument (you would do EOSP), but that it would provide some interesting data. No other polarimetry is in the near-term planning except the French POLDER, which provides good BRDF information, but the polarization accuracy is not as good as needed (1-2%). MISR with these modifications could provide polarization data of an accuracy not otherwise available in this time frame.

6. LAWS

Wayman Baker reported that LAWS is moving forward with the assistance of domestic and international partners. The French have a strong interest, as do DOE, DOD, and NOAA. ❑

SCIENCE TEAM MEETINGS

ASTER Science Team Meeting

—Yasushi Yamaguchi
Geological Survey of Japan

The ASTER Science Team met on June 22-25, 1992 at the Geological Survey of Japan (GSJ), Electrotechnical Laboratory (ETL), and National Research Laboratory of Metrology (NRLM) in Tsukuba, Japan. These locations are three of nine research institutes located in the Tsukuba Research Center, Agency of Industrial Science and Technology (AIST), Ministry of International Trade and Industry (MITI). Tsukuba is a planned "science city" located approximately 60 kilometers north of Tokyo. Many of the Japanese ASTER Team members are studying in this research center and the other institutes in the Tsukuba area.

Joint ASTER Science Team meetings are held twice a year, once in Japan and once in the United States. This meeting was the fourth of this series and was attended by more than 80 individuals. Japanese participants included 19 Japanese ASTER Science Team members, people from Earth Resources Satellite Data Analysis Center (ERSDAC) and Japan Resources Observation Systems Organization (JAROS), the instrument developers, interpreters and observers. A 23-person U.S. contingent included members of the U.S. ASTER Science Team, the JPL ASTER Science Project, several individuals from the EOS Project Office at GSFC and a representative from the EROS Data Center. Also attending was a representative from the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO).

The meeting began with a one-day plenary session and was followed by 2.5 days of splinter working group meetings. It closed with a plenary session the last half of the fourth day, in which the Japanese working group chairpersons provided summary reports of the working group meetings.

Participants were welcomed to the meeting by Katsuro Ogawa, the Director General of GSJ. Hiroji Tsu, ASTER Science Team Leader from GSJ, then provided the latest ASTER project status and laid out the issues that needed to be addressed in the current meeting. He emphasized the urgency of establishing an ASTER operations scenario. Bruce Guenther from the EOS Project Science Office at GSFC briefly reported on the restructured EOS Program.

Hiroyuki Fujisada of ETL provided an instrument overview, focusing on observational performance specifications. Masahiko Kudoh of JAROS showed the current instrument development status. The ASTER layout and configuration were extensively changed from the design shown at the previous science team meeting, in order to meet the restructured EOS-AM1 accommodation requirements. The ASTER instrument is composed of five physical subsystems: the Visible and Near InfraRed subsystem (VNIR), the ShortWave InfraRed subsystem (SWIR), the Thermal InfraRed subsystem (TIR), the Common Signal Processor (CSP), the VNIR Electronics (VEL), and the Master Power Supply (MPS). The SWIR and TIR now will be mounted directly on the spacecraft structure, and the VNIR, CSP, VEL and MPS subsystems will be independently mounted on a mounting plate. The thermal design of ASTER was also changed. Mr. Kudoh reported significant progress in the instrument development, highlighted by the completion of a Breadboard Model (BBM), which was used for evaluation and technical confirmation of critical components. He also reported that the ASTER development schedule is dependent upon a timely delivery of the kinematic mount from NASA for inclusion in the engineering model.

Detailed instrument development status of each subsystem was presented by the engineers of the Japanese contractors; NEC for VNIR, MELCO for SWIR, and Fujitsu for TIR. They showed the results of BBM tests such as radiometric resolution, spectral characteristics, MTF, band-to-band registration, polarization, non-linearity, pointing capability, and cryocooler performance.

One of the primary concerns to be addressed at this meeting was that of instrument operations. Several presentations in the plenary session offered insight into various aspects of this topic. Major points of discussion are: (1) the maximum number and duration of individual observations per orbit; (2) data acquisition modes (combination of each subsystem operation); (3) the total number of instrument pointings; and (4) duty allocation to different observation categories, (e.g., emergency data acquisition, on-request observations, regional multi-temporal monitoring, and global mapping). Fumiho Takahashi of NEC discussed the instrument constraints for ASTER on-orbit operation. Yoshinori Miyazaki of GSJ and Bob Hekl of JPL reviewed users' requirements on data acquisition scenario and showed the results of data acquisition analysis studies. Then Ed Chang of GSFC presented an overview of the EOS-AM1 operations concept.

Isao Sato of GSJ reported on plans for the ground data system. The ASTER ground data system will evolve from the Japanese Earth Resources Satellite Data Information System (ERSDIS) implemented at ERSDAC Data Center in Tokyo for processing, archiving, and distributing special data products of Japanese Earth Resources Satellite (JERS-1) data.

R.J. Thompson, representing the EROS Data Center, described the Land Processes DAAC, which will have responsibilities for land-related data to be acquired by ASTER, MODIS, and HIRIS. He also discussed several Pathfinder and topographic data programs.

Jack Salisbury of Johns Hopkins University reported on spectral libraries and Hugh Kieffer of USGS discussed possible ASTER geometric processing approaches. The plenary session was concluded with Yasushi Yamaguchi of GSJ reporting on the current status of the Japanese Earth Resources Satellite (JERS-1), which was launched on February 11, 1992.

Oeprations and Mission Planning Working Group
(Leaders: Hiroji Tsu/Dave Nichols)

Ed Chang of GSFC, Bob Hekl of JPL, and Yoshinori Miyazaki of GSJ discussed the results of ASTER operations scenario studies conducted in both the U.S. and Japan. Dave Nichols discussed the instrument observation modes. Hiroji Tsu and Yoshinori Miyazaki discussed instrument duty cycle allocation. Yasushi Yamaguchi of GSJ reported the operations requirements from the ASTER Cal/Val Working Group and the Geology Working Group. Based upon these discussions, Dave Nichols summarized the preliminary operations requirements. It was concluded that flexibility is required to optimize data acquisition within resource allocation, but the Working Group members could not, at this time, quantify science impacts derived from spacecraft or instrument resource constraints. An interim meeting of this working group was proposed for August, in the U.S., to finalize a recommended design reference instrument operations scenario that would be the basis for the spacecraft and instrument Preliminary Design Reviews.

Calibration and Validation Working Group
(Leaders: Yasushi Yamaguchi/Philip Slater)

Bruce Guenther of GSFC described the cal/val concept of the EOS Project Office and reported on the discussions at the last EOS Cal/Val Panel meeting. The justification for the filter purchase for EOS-AM1 instruments was presented by Hugh Kieffer of USGS. Then, the calibration plans of each subsystem were presented by the contractors and discussed by the working group members in order to prepare for the planned calibration peer review. Akira Ono of NRLM proposed a document on ASTER calibration requirements. NEC engineers showed in-flight calibration results of JERS-1 OPS. Fumihiro Sakuma of NRLM reported their experience on radiometer stability tests. Yasushi Yamaguchi of GSJ summarized ASTER operations requirements for cal/val. Kohei Arai of Saga University, Phil Slater of the University of Arizona, and Hugh Kieffer discussed the ASTER in-flight calibration plan. Discussions on validation activities did not take place this time, but Anne Kahle of JPL proposed to identify volunteers for four validation working groups in the EOS Cal/Val Panel.

Registration Working Group
(Leaders: Hiroshi Watanabe/Hugh Kieffer)

Hiroshi Watanabe of Japex Geoscience Institute Inc. (JGI) reviewed jitter/stability requirements. Scott Lambros of GSFC explained the current spacecraft jitter/stability performance estimates. Most of these estimates satisfy the instrument requirements with some exceptions; one example is cooler-generated jitter. Hiroshi Watanabe proposed to evaluate the SWIR band-to-band registration method using JERS-1 OPS data. Hugh Kieffer of USGS explained the geometric calibration requirements and proposed that a decision be made as to who will be responsible for: (1) completing the geometric error budget table; (2) development of prelaunch geometric measurements; and (3) development of in-flight geometric observations and analysis methods.

Digital Elevation Model (DEM) Working Group
(Leaders: Yoshinori Miyazaki/Harold Lang)

Dave Pieri and Harold Lang of JPL distributed a questionnaire on potential ASTER DEM needs to all the team members. The survey results will be summarized at the next U.S. ASTER Team meeting scheduled for November and will also be sent to Japan. Yoshinori Miyazaki of GSJ proposed performing a DEM generation study using JERS-1 OPS data, if possible.

Atmosphere and Atmospheric Correction Working Group
(Leaders: Tsutomu Takashima/Frank Palluconi)

It was identified that the best known source of profile information is the NOAA/NMC 4-D Global Numerical Model. Frank Palluconi proposed obtaining additional information on NMC model availability to EOS and ASTER. Ron Welch of South Dakota School of Mines and Technology proposed developing a cloud masking algorithm. Tsutomu Takashima of Meteorological Research Institute (MRI) and Frank Palluconi of JPL will establish requirements for a cloud masking algorithm by the next meeting. The Working Group members reiterated the need to coordinate and cooperate with MODIS and MISR efforts in atmospheric correction.

Geology Working Group
(Leaders: Yasushi Yamaguchi/Lawrence Rowan)

Based upon the latest performance data, the maximum temperature that can be measured by the SWIR bands with the low gain-2 setting was updated. Yasushi Yamaguchi of GSJ and Hiroshi Watanabe of JGI reported the results of trade-off studies on the SWIR spectral bandwidth. The working group members agreed with a 40 nm bandpass for Bands 5 and 6. Then, ASTER operations requirements were discussed and summarized as follows: (1) instrument mode requirements are for daytime full-mode (VNIR +SWIR +TIR), daytime VNIR mode, nighttime TIR mode, and nighttime SWIR+TIR mode; (2) pointing change capability of once per orbit and 10,000 to 25,000 total pointing changes for 5 years should be possible; (3) daytime observations may need to be divided into 3-to-4 discrete observation sequences; and (4) data should be acquired at least once for all land areas and, if possible, twice with different illumination conditions in appropriate terrain.

Data Receiving, Processing, and Archiving Working Group
(Leaders: Isao Sato/Graham Bothwell)

Isao Sato of GSJ showed the Japanese ASTER Ground Data System elements and the development schedule. Ed Chang of GSFC presented the EDOS concept and proposed solutions for ASTER-related topics such as quicklook flag and application process ID (APID). Graham Bothwell of JPL presented three alternative architectures for the U.S.-Japan GDS interfaces, and this led to much discussion of various trade-off issues associated with the location of Level 1 processing and archiving. Steve Larson of JPL described preliminary ideas about the core data processing architecture. Isao Sato presented the tentative cloud assessment requirements. Vu Saito of ERSDAC presented an outline of the ERSDIS (JERS-1 ground system at ERSDAC) structure and the user interface functions.

Airborne Sensors Working Group
(Leaders: Shuichi Rokugawa/Simon Hook)

Hiroshi Watanabe of JGI reported on the current status of the ASTER Airborne Simulator (AAS). Simon Hook described NASA's future airborne campaign including Far-East areas in 1993. Japanese Team members expressed interest in this plan, and will investigate the possibility of an EOS Airborne Campaign in Japan, with the help of U.S. members.

Emissivity-Temperature Separation Working Group
(Leaders: Shuichi Rokugawa/Alan Gillespie)

The working group members reported their emissivity-temperature separation algorithm evaluation results. Further evaluation will be continued and discussed at the next meeting, and 3-to-4 algorithms will be selected for detailed follow-on evaluation. Working with the Atmospheric Correction Working Group on operational scenarios for obtaining atmospheric profile data was proposed, as well as considering the use of synthetic targets in algorithm evaluations.

Data Product Working Group
(Leaders: not identified yet)

Graham Bothwell of JPL proposed the new Data Receiving, Processing and Archiving Working Group. The immediate goal of the working group is to develop an integrated Japan-U.S. product list, and subsequently to document the product specifications in a common fashion. Charles Voge of JPL showed the U.S. software development plans and schedule. The charter and membership of this working group will be determined by the Team Leaders.

The next Joint Science Team meeting will be held the week of February 1, 1993, in the U.S., most likely Las Vegas, Nevada. ❑

MODIS SCIENCE TEAM MEETS

GODDARD SPACE FLIGHT CENTER (April 15 and 16, 1992)

The MODIS science team met in three plenary sessions, and in four disciplinary groupings—atmosphere, calibration, land, and ocean.

Plenary Sessions

At the first plenary session, Vince Salomonson called attention to four key issues: (1) the need to respond to changes, proposed by the Santa Barbara Research Center (SBRC), in the filter specifications for a number of the MODIS bands; (2) the status of algorithm development; (3) decisions needed in regard to peer review; and (4) validation of data products. At this first session Ghassem Asrar was introduced as the new EOS Program Scientist, and Tony Janetos was introduced as the MODIS Program Scientist.

Dick Weber noted the recommendations by SBRC to alleviate difficulties with the filter requirements. SBRC said that the problems are due to very stringent tolerances and listed their requested changes. The discipline groups were directed to discuss the proposed changes, and to report back at a later plenary session.

Michael King, MODIS Deputy Team Leader, stated that the EOS Project requires that all instrument algorithm development efforts have annual peer reviews. This became the subject of much discussion at the discipline group sessions.

At the second plenary session the peer review process was discussed. Viewpoints of the various discipline groups on how to conduct this process were presented. Salomonson recommended that the Ocean Group's proposal should be adopted as a model, with each group free to adapt it to its own needs. The Ocean Group's concept is to have a three-tier Discipline-Team-Community review process to be conducted annually. Otis Brown explained that community awareness and approval are important to the peer review process.

Al Fleig presented a plan for testing the MODIS product generation system , in which Steve Unger and John Barker will generate "synthetic" data sets, which will then be modified to look like a MODIS data stream.

Howard Gordon and Yoram Kaufman discussed atmospheric correction algorithms. Gordon proposed a second-order algorithm, to be used by both SeaWiFS and MODIS, which includes a term for Rayleigh scattering.

The group discussion reverted to the issue of filter specifications. Weber asked that team members propose band-by-band changes. Relaxation of the band edge specifications would offer relief. Some displeasure was expressed by the Science Team members at the quick-response requirement on specification changes.

At the third plenary session, Vince Salomonson introduced the new proposed MODIS logo, and also recommended that MODIS-N now be referred to simply as MODIS, since MODIS-T has been deselected.

Phil Slater reported on some concerns of the Calibration Group. There is a problem with non-uniform contamination build-up on the MODIS mirror. There is lingering disagreement on the use and value of the Solar Diffuser Stability Monitor. He is concerned about a possible order-of-magnitude price jump if there is too much delay in revising the filter specifications. He stressed the need for more representation by Science Team members at Calibration Panel meetings. On the plus side, Slater expects the cross-calibration visible-infrared radiometer to be ready in time for use with SeaWiFS.

For the Atmosphere Group, Michael King stated that only those recommended filter changes that could be easily assessed would be accepted. Many of the recommended changes would severely impact the Atmosphere Group's objectives. The MODIS Airborne Simulator (MAS) has been returned to the manufacturer for modification in preparation for various field campaigns, starting with ASTEX in the Azores.

Chris Justice reported for the Land Group. There are no major changes in the Data Products list. Budgetary constraints could inhibit the 93-94 field campaigns. EOSDIS has not responded to Justice's request that they address the overall EOS topographic requirements. There is a need for liaison with other instrument teams to develop a unified approach on issues such as pointing accuracy and topographic requirements. The topic of determining satisfactory, multi-use test sites will be addressed at the June EROS Data Center DAAC Advisory Board meeting.

Otis Brown presented the Ocean Group's plan for making filter recommendations. They expect SBRC/GSFC to deliver software needed to study the impact of the requested changes. They will then provide preliminary comments within a week of receipt of the software and "final" comments in two to three weeks. The relationship of SeaWiFS to MODIS needs clear definition. Salomonson said that support for the SeaWiFS follow-on is embedded in the MODIS contract, but that the current SeaWiFS and MODIS contracts must be kept separate so that SeaWiFS development will not be hindered.

Discipline Group Reports

[The rest of this report is drawn from minutes of the individual MODIS Discipline Group meetings. Items covered at the plenary sessions are not repeated.]

Atmosphere Discipline Group

Michael King said that the review of the proposed filter changes was impeded by lack of knowledge of the cost/performance tradeoff between bandwidth tolerance and edge range. The Group felt that the peer review should be interactive, preferably through oral discussion. The strength of the investigator's work should be reviewed and changes suggested where needed, rather than giving a "yes/no" response to a funding proposal.

There are some problems with the MAS instrument on the ER-2 aircraft, resulting from the contractor's unfamiliarity with the hostile aircraft environment: (1) gain changes due to temperature changes; and (2) 400 Hz noise arising from the pod heaters surrounding the data system.

Calibration Discipline Group

John Barker said that he plans to provide data users with a scheme for automated quality assurance of the data, along the lines used for Landsat. It is important to study misregistration and geometric effects on the instrument Modulation Transfer Function and on radiometric error. Ken Brown reported on the successful role played by the MAS instrument in the recent FIRE campaign.

Discussion of crosstrack calibration problems led to conclusions that the best approaches to polarization and contamination problems with the MODIS scan mirror are the vicarious methods using aircraft underflights. Therefore, it was recommended that the ER-2 experiment with the NASA Aircraft Satellite Instrument Calibration (NASIC) instrument be made as stable as possible and that a boresighted camera be flown with the experiment in order to solve the registration problem.

Land Discipline Group

Chris Justice reported that the Land Group needs calibration- and sensor-related information on: (1) the 3.75 μm band calibration; (2) the difference in MTF between bands 1 and 2; and (3) the impact of the proposed filter specification changes on land sensing and atmospheric corrections.

John Barker recommended a minimum goal of registration at 250 m, and not 500 m, for bands 1 and 2. The Project should decide whether the Land Group's geometric specifications are met by using either Ground Control Points or a spacecraft-configured system. Looking at misregistration effects from variations in topography, Jan-Peter Muller recommended a grid spacing of 0.5 km. June Thermosgaard reported that DAAC activities have included a study showing that misregistration effects from terrain displacements can be up to 2 AVHRR pixels, and up to 3 pixels for large scan angles.

Justice reported that the MODIS team is planning to select land cover test sites by biome throughout the global land surface. EDC is preserving worldwide historical Landsat data, with a goal of three scenes per year. Huete added that MODIS has requested EDC to purchase 50 MSS scenes to be used for algorithm development and validation.

Peter Mouginis-Mark discussed volcanic eruption effects on the atmosphere. He needs continuous collection of the SW and LW infrared channels, and he needs absolute calibration of the thermal bands. He will be merging MODIS, MISR, ASTER, GLAS, and AIRS data for his volcanism studies.

Ocean Discipline Group

A substantial review of data products was made in view of the demise of MODIS-T. Generally, Oceans Group data products were not eliminated because of the loss of MODIS-T—in fact, "the product list may be complicated by the advent of both an A.M. and P.M. MODIS."

In instrument discussions, the need for MODIS thermal accuracy to be comparable to that of the Along Track Scanning Radiometer (ATSR) was stressed. ❑

LAWS Science Team Meeting

—Wayman E. Baker, LAWS Science Team Leader, NOAA/NMC

The LAWS Science Team met on July 28-30, 1992 in Falmouth, Massachusetts. The meeting was attended by 11 science team members, one associate team member, one adjunct team member, and 37 other people from NASA Headquarters, the NASA/Marshall LAWS Project Office, the NASA/Langley Research Center, the Department of Energy, France, the Netherlands, and private industry.

Highlights of the meeting included presentations by GE and Lockheed personnel on the findings of their Phase B design studies. Concerns raised during the mid-term engineering review a year ago regarding the reliability of the bearings to be used in rotating the LAWS telescope have now been alleviated. The contractors' catalyst life tests also indicate that the issue of laser gas lifetime no longer represents a significant risk to the LAWS mission. The past six months have also been very productive in significantly improving the realism of the observing system simulation experiments (OSSE's), using advanced cloud parameterizations and the aerosol data analyses from the Global Backscatter Experiment (GLOBE) survey missions.

With the above outstanding efforts put forth by the contractor teams and the OSSE work by science team members from Simpson Weather Associates, NASA/GSFC, and Florida State University, the LAWS Science Team now has a high level of confidence that the LAWS instrument, with a 5 Joule laser and a 0.75 m diameter telescope, has reached a level of maturity required for initiation of a Phase C/D effort. Potential international collaborations (with CNES) and domestic ones (with DOE and DOD) are being vigorously pursued in order to make the mission affordable to NASA. Special executive sessions were held on the afternoon of July 29 with French personnel and with representatives from the Los Alamos National Laboratory on potential joint research efforts.

The LAWS Science Team feels strongly that, whether or not LAWS ultimately remains in the EOS program, the direct measurement of global winds in the troposphere is critical to achieving some of the key EOS mission objectives. As an example, our present level of uncertainty in the horizontal transport (flux) of water vapor in the rawinsonde-sparse areas over the oceans and over the southern hemisphere land areas ranges from 50% to 100%. Without LAWS, which is the only instrument that can measure the ageostrophic wind (the wind component crucial for accurate transport calculations), our present level of uncertainty in the water vapor flux calculations would be with us throughout the EOS mission.

The next LAWS Science Team Meeting will be held in Clearwater, FL. February 2-4, 1993. ❑

WATCH FOR THIS ONE—SPIES

The spring meeting of the SPIE (The International Society for Optical Engineering) seems just made for the readership of *The Earth Observer*. The official title of the meeting, to be held in Orlando, Florida, 12 to 16 April, is "SPIE's International Symposium on Optical Engineering in Photonics and Aerospace Science and Sensing."

EOS scientist, Phil Slater of the University of Arizona, is overall Symposium Chairperson. EOS scientist, Bill Barnes of the Goddard Space Flight Center, is chairperson for the session on Flight Dynamics Sensing, which features sessions on Laser Radar Technology and Application, Solar Forcing of Climate Change, Passive Infrared Remote Sensing of the Clouds and the Atmosphere, Imaging Spectrometry of the Terrestrial Environment, Microwave Instrumentation for Remote Sensing of the Earth, Recent Advances in Sensors, Radiometric Calibration, and Processing of Remotely Sensed Data, Sensor Systems for the Early Earth Observing System Platforms (co-chairs are Bill Barnes and Dave Diner), and Small Satellite Technology and Applications.

Abstracts for contributed papers are due by 14 September, 1992, and must be submitted to OE/Aerospace Science and Sensing '93, SPIE, P.O. Box 10, Bellingham, WA 98227-0010.

ISLSCP - Americas Workshop

—*Piers Sellers*

Remote Sensing of the Land Surface for Studies of Global Change

MODELS-ALGORITHMS-EXPERIMENTS

The ISLSCP workshop was held at the Columbia Inn, Columbia, Maryland, June 23-26, 1992. Some 260 scientists and science managers attended with the goal of rationalizing the different activities taking place in the areas of modeling, algorithm development and field experiments. The workshop had four specific objectives:

1. Review the state and direction of Biosphere-Atmosphere model development; assess the data requirements for such models.

2. Assess the current state of satellite data algorithms in the context of generating global and/or regional data sets; assess what could be done with more resources.

3. Review completed and planned field experiments. What has been learned? What should be done in future experiments?

4. Develop a prioritized action plan for ensuring that modelers' requirements are being met as far as possible. This plan should also help prepare the community for EOS.

Most of the first two days of the workshop were spent on the first three items. A number of invited presentations summarized the progress made over the last few years in the areas of modeling, algorithm development and the design and execution of field experiments. Two issues became clear as a result of discussions following these presentations: first, modelers do not have ready access to the data sets they need (land cover, hydrometeorology, surface radiation budget, soils) and second, the modeling, algorithm development, and experimental activities are in danger of becoming decoupled.

The rest of the workshop was spent in hammering out prioritized data set requirements and discussing mechanisms for better communication among the different participating groups. By the end of the week an outline action plan had emerged which placed priority on assembling and making accessible the following data sets:

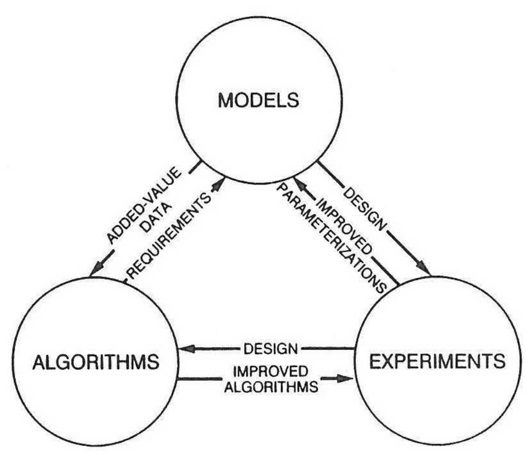
1. Land Cover: The AVHRR 1x1 km data should be processed into global time-series fields of FPAR (fraction of PAR absorbed by the canopy) and LAI (leaf area index).

2. Hydrometeorology: Global meteorological fields retrieved from numerical re-analysis should be manipulated to provide near-surface forcing data sets for temperature, humidity, windspeed, etc. Observations of precipitation and runoff should be worked up into easily accessible forms.

3. Radiation Budget: A closer interface with the ISCCP and related projects should be pursued with a view to obtaining surface radiation budget components at higher spatial resolution and also fields of incident PAR.

4. Soils and Soil Moisture: A small project should be set in place with the goal of providing a useful soil type and properties data set for use by global modelers within a short time frame. A small working group is to be set up to review methods for generating and validating global and regional soil moisture climatologies.

The workshop will generate a report and a special issue of the journal 'Remote Sensing of the Environment', due out within 120 days and the summer of next year, respectively. Also lines of communication with WCRP and IGBP were reviewed and put into place. Lastly, the workshop generated a resolution supporting the EOS Project, specifically the AM and PM platforms. It has since been passed on to Dr. Fisk of NASA Headquarters. ❑



- Careful specification of modeling goals and requirements
- Careful comparison of data requirements and algorithm limits
- Continuous connections to experiment design

Release of Updated EOS Data Products Report

—Yun-Chi Lu

A report titled ***"Earth Observing System Output Data Products and Input Requirements - Version 2.0"*** is available from the Science Processing Support Office (SPSO) at the Goddard Space Flight Center (GSFC). The SPSO report, now greatly expanded and consisting of three volumes (Volumes I, II and III), presents the latest information on EOS output data products and input requirements for 22 EOS instruments and 29 Interdisciplinary Science (IDS) Investigators. It provides additional information on the pre-EOS input requirements and data dependencies among EOS products, and includes both new and the updated data product information that has become available since the August 1991 release of the SPSO report (Version 1.0). The highlights of this release are:

- Revised payload information, reflecting the restructured EOS Program to allocate instruments to a number of small platforms instead of two large platforms (EOS-A and -B).
- Revised and expanded output data product information from AIRS, ASTER, CERES, MISR, and MODIS.
- Updated instrument team input data requirements for CERES, MODIS, and HIRIS, including expanded non-EOS input requirements.
- Revised best match EOS data products for IDS input requirements.
- New algorithm summary tables for EOS instrument teams and IDS investigators, showing the input-output relationships among EOS data products.
- A list of data products originally proposed for eight instruments (GLRS-R, GOS, IPEI, LAWS, MODIS-T, SAR, SWIRLS, and XIE), which are not considered for flight on U.S. EOS platforms.
- Essential data products identified by the instrument teams as most vital to meeting the scientific goals of the EOS Project, as defined in the EOS Program Level 1 Requirements document.
- Current (FY91) and future (FY94) data holdings of the original seven DAACs.
- Data products expected from the future missions/projects such as Earth Probes and Pathfinder activities.

Volume I of the report describes the characteristics of proposed instrument team output data products and input requirements and presents a link between EOS data products and corresponding Global Change Master Directory (GCMD) parameter keywords. Volume I also presents information on data products originally proposed for eight instruments which are not presently considered for flight on any of the U.S. EOS platforms. This volume describes the methodology and assumptions used in the EOSDIS baseline requirement analysis and includes the SPSO analyses of storage requirements, processing load, and data traffic flow estimates for EOS instruments.

Volume II is devoted to the SPSO analyses of IDS investigators' input requirements. For each investigator, input requirements were analyzed and matching best/alternative EOS data products were identified by comparing characteristics of input and output data products and considering the time of data availability. A best-match data product is defined as an EOS data product that closely matches input requirements in terms of product definition, accuracy, temporal resolution, and spatial resolution/coverage. An alternative-match data product is a data product that meets the input requirements to a lesser degree. In identifying the best and alternative match data products, a special consideration was given to the data products which will be available at the earliest possible time. Results of the analysis, which were revised to reflect the new EOS Program, were presented in two separate appendices: one listed by IDS investigator and another by instrument. Volume II also contains information on IDS investigators' input requirements which cannot be met by EOS instruments for each of the time periods before and after the year 2001.

Volume III presents algorithm summary tables for EOS instruments and IDS investigators. These tables are derived from the algorithms database developed by the SPSO and show data dependencies among EOS data products. Volume III also includes a comprehensive list of non-EOS input data required by all EOS instrument teams and IDS investigators, identifying external interfaces. Also included is the information on the current and future data holdings of the original seven DAACs and the data products expected from Earth Probes and Pathfinder activities in the pre-EOS era.

Most of the information presented in the SPSO report is also available from an interactive, on-line database, known as the Science Processing DataBase (SPDB). The SPDB is based upon a menu-driven, easy to use user interface and offers user-friendly query forms and on-line help. It provides not only data product information but also other related information such as retrieval algorithms, investigators, instruments, and platform information. In addition, the SPDB provides information on non-EOS data sets during the Version 0 timeframe. All database files are dynamically linked and users can access related information at any time without going back to the main menu. The SPDB also offers the capability to submit on-line comments or correction requests for timely updates of data product information between the releases of the hard copy reports. The on-line system can be accessed through either networks or direct dial-up.

The information presented in the SPSO report and the SPDB is based upon the data product information received up to July 1992. Further changes in the EOS Program are expected and the sets of proposed instrument team output data products may be substantially modified or reduced in the near future. Both the SPSO report and the contents of the SPDB will be updated as soon as new information becomes available.

The SPSO wishes to thank the AIRS, ASTER, CERES, MISR and MODIS instrument teams for providing the latest data product and algorithm information. If you have any comments on the SPSO document or need additional information on the on-line system (SPDB), please contact:

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News from the EOS News Electronic Bulletin Board

Thursday, August 13, 1992

TOPEX/POSEIDON LAUNCHED

On August 10, the TOPEX/Poseidon satellite was successfully launched aboard an Ariane 42P from ESA's Guiana Space Center in Kourou, French Guiana. TOPEX/Poseidon is designed to study ocean currents using radar altimetry, and will produce technology and a planned 3-to-5 year data set to be followed by EOS altimetry missions. This U.S.A.-France mission is the second major satellite (joining UARS) in NASA's Mission to Planet Earth. France's space agency, CNES, was responsible for the launch and two instruments (Single-Frequency Poseidon Altimeter and DORIS Dual Frequency System Receiver) and NASA was responsible for the spacecraft and four instruments (Dual-Frequency TOPEX Radar Altimeter, TOPEX Microwave Radiometer, Laser Retroreflector Array, and Global Positioning System Demonstration Receiver). NASA's Jet Propulsion Laboratory will conduct mission operations, data acquisition, and data processing, and the Centre Spatial de Toulouse will process data from the CNES instruments. The mission is presently in an assessment phase expected to last 45 days.

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PATHFINDER DATA SETS WORKSHOP

"Enabling the Inter-Use of Pathfinder Data Sets: A Combined Pathfinder Workshop" was held July 29-30 in Washington, D.C. The key issues discussed were formats, data binning and compositing, software tools, scientific visualization and analysis, and metadata. To produce Pathfinder data sets in Hierarchical Data Format (HDF; the EOSDIS Version 0 Standard), a technical interchange meeting was proposed. No standards were recommended for either spatial or temporal resolution nesting hierarchy, or for a binning technique, but Pathfinder Science Working Groups were asked to continue reviewing these issues and to suggest ways to "clump" the various resolution schemes. A smaller technical team will be convened to investigate a Pathfinder Data Sampler to refine issues of gridding schemes, resolutions, and the use of software tools. The sampler will be published when a useful product is achieved.

AUTOMATIC DATA DISTRIBUTION FOR A LARGE, GEOPHYSICAL DATA SET

—Stephanie Granger-Gallegos, Andrew Pursch, Ralph Kahn, and Robert Haskins
Jet Propulsion Laboratory, California Institute of Technology

1. Introduction

One of the goals of EOSDIS is to make large Earth science data sets, from many sources, available for inter-disciplinary studies. The mechanics of data delivery is a part of this problem—one that can take great advantage of recent developments in software capability and in network technology.

This article describes the approach we have taken to accessing large amounts of data, for research purposes, from a remote archive. The distribution method presented here is especially useful for making: (1) very large, or (2) rapidly changing data sets available to a wide community. Our application involves the validation of cloud parameters derived from the HIRS2/MSU (High Resolution Infrared Radiation Sounder 2 and the Microwave Sounding Unit) instruments aboard the NOAA polar orbiting satellites. These instruments have been continuously monitoring the Earth since late 1978. With the aid of a physical retrieval algorithm developed at the Goddard Space Flight Center (GSFC) by Susskind, Chahine, and co-workers, the data provide about 50,000 daily measurements of 40 meteorological parameters, including atmospheric temperature and humidity profiles, surface temperature and related properties, ozone abundance, and cloud field characteristics, spread non-uniformly over the globe (Susskind et al., 1983; 1984). A single year of the Level 2 (individual point) data product is about 10 GBytes in size. About 1.5 years of physical retrieval data are stored in the tape archive attached to the IBM/MVS at GSFC in Greenbelt, Maryland.

For the validation work, we are studying the spatial and temporal characteristics of the cloud parameters, relating them to the behavior of temperature and humidity on regional and global scales (i.e., the classic "Cloud/Climate Feedback" problem), and comparing them with similar parameters derived from other sources. [A discussion of the validation process, and the need for validated data to address a variety of interdisciplinary issues, is given by Kahn et al. (1991).] We, therefore, need timely access to any portion of the data, in files that are well documented and as easy as possible to ingest into analysis software. We also face the problem of a heterogeneous computation environment. Key analysis software and peripherals for this work are distributed on Sun, DEC, and Macintosh workstations, as well as a Cray. This collection of issues is similar to that for larger applications such as the Pathfinder effort (Thompson et al., 1991), in which we are participating, and the EOSDIS (Chase et al., 1986).

We divide our data stream into "Standard Data Files Processing," which involves steps that must be taken in order to acquire and begin working with the data, and "Data Analysis Tools," which includes linking a collection of existing software, and generating some new software that are primarily used in an interactive mode. The Standard Data Files Processing software is designed to make it as easy as possible to: (1) acquire the data from the archive at GSFC and convert to a transportable format; (2) extract manageably-sized subsets based upon choice of parameter, time, and/or space constraints; (3) perform error checking and statistical sampling of these subsets; and (4) keep careful track of the contents of the multitude of files generated by these processes. The discussion here is limited to items (1) and (4) of the Standard Data Files Processing. The next section reviews some of the innovations that are included in available transportable file formats, and discusses how they help make the distribution of large data sets feasible. The subsequent section describes the HIRS2/MSU automatic data delivery system, which makes use of these innovations, and which may serve as a template for the development of software to make other large data sets available to remote users.

2. The Advantages Of Using A Transportable File Format

Recently developed transportable file formats, such as the Hierarchical Data Format (HDF) from the National Center for Supercomputing Applications (NCSA) at the University of Illinois, and Network Common Data Format (NetCDF) from the Unidata Program Center at the University Corporation for Atmospheric Research (UCAR) address several major storage and throughput issues for large data sets. These packages are distributed free of cost. The following discussion emphasizes HDF, since we have adopted that software package for our work.

(1) Working within a heterogeneous computational environment, especially when working with large data sets, it is impractical to create and store multiple copies of data products in machine-specific formats. The problems include limitations of data storage capacity, and other data management issues, such as keeping multiple versions of files current.

One approach is to find ways of storing single copies of the data on centrally located disks, in a file format that is relatively easy to use by each of the workstations. Several have been tried, including: (a) converting all the data to ASCII standard, which achieves accessibility, but at a high cost in terms of storage volume; (b) storing the data centrally in a more-compact format, and developing conversion filters, which also achieves accessibility, but requires a new filter for each machine and for every derived data product that is to be shared across architectures. Managing a library of these files, which must be distributed on several machines, is a considerable task. Filters can also introduce unacceptably large data conversion problems, and (c) adopting a commercial database software that addresses these problems, but it is too expensive for many research projects, such as ours.

HDF provides a method similar to item (b) above, except that the HDF software already contains the information necessary to "filter" the data among all the machines supported, without requiring any additional effort by the user. HDF allows for efficient binary storage of Level 2 (point) and Level 3 (gridded) data in one file, and eliminates all but an initial file conversion for exchanging data among machines.

(2) A second issue regards identifying precisely the contents of data files. Even for a relatively modest study of regional cloud behavior, we commonly accumulate many tens of data files. HDF is "self-describing," which makes it possible to store in the file itself a complete description of the file's structure and contents. Current versions of these descriptions can be kept in a master description file, and written automatically to the data file at the time the data file is created, using subroutines provided by NCSA. In this way, any changes made to the descriptions or formats of the standard data products are reflected in the descriptions attached to the user's data files. Once created, file descriptions can also be read from data files by other programs.

(3) It is often advantageous to store spatial-and temporal-average products (Level 3 data) together with the original Level 2 data. HDF is very flexible in this regard; the user can create customized data structures from combinations of numerical, symbolic, and graphical data, and store them in a single HDF file.

The HDF software package provides a library of C-and FORTRAN-callable functions for storing and retrieving data from a file, as well as command line utilities, which are application programs executed at the command level. These utilities provide a means to edit, create, read, and display HDF files.

(4) From the user's point of view, it is worth mentioning that there are a number of commercial and public domain data analysis software packages available in the UNIX environment and on the Macintosh that work with HDF files. Table 1 is a partial list of available software, and software in development.

Name	Platform	Source	Comments
Currently Available:			
Data Scope	Mac	NCSA	Display, manipulate arrays & images
Image Tool	Mac	NCSA	Display, animate image & color bar
Layout	Mac	NCSA	Create presentation from images, text
Transform	Mac	Spyglass	Combines Data Scope & Image Tool
Format	Mac	Spyglass	Similar to Layout
Dicer	Mac	Spyglass	Select & view sections of 3-D display
XImage	Sun*	NCSA	Combines Data Scope & Image Tool
XDataSlice	Sun*	NCSA	Similar to Dicer
Reformat	Sun*	NCSA	Convert FITS, TIFF, GIF, SUN, raw raster files, & X-window dumps to HDF
LinkWinds	SGI	JPL	Interactive graphical analysis package
In Development or Testing:			
IDL**	Sun	RSI	Interactive graphics/imaging programming language
WIGSS	Sun	JPL/EDA	Interactive Geographic Subset Selection
NetCDF filter	Sun	NCSA	HDF*** interface to read NetCDF files and to store them as HDF files.

* 'Sun' also runs on many other UNIX platforms, including Apollo, Alliant, Convex, Cray, DEC-ULTRIX, and Silicon Graphics (SGI) Workstations.

** IDL runs on UNIX platforms as well as Vax/VMS and IBM PC.

*** HDF runs on UNIX platforms as well as Vax/VMS, IBM PC and Macintosh

Table 1. Partial List of Software That Automatically Reads Files in HDF Format

3. A Description Of The Automatic Data Delivery System

A remote user with a working account on the host computer can submit a one-line request for HIRS2/MSU Physical Retrieval data over the network, specifying the time span of the data requested and the network address of the remote user's node. The data delivery portion of the Standard Data Files Processing accepts this request, then converts the desired HIRS2/MSU data from the original IBM archive at GSFC into HDF Parameter files, attaches the appropriate documentation describing the data set and defining each parameter, and automatically transfers the documented HDF file to the user's node. The entire job is run in batch mode, so large data transfers can be accomplished over night, when the network is fast. For our application, this represents a vast improvement over data distribution via 9-track tape, since we have access to any part of the remote archive, avoid all the difficulties associated with tape handling, and can acquire the data in less than a day without taking the time of anyone at the archive. The remainder of this section and associated figures describe in detail the software we have developed.

The shell script called "hirs2hdf" is the top-level procedure that initiates the file conversion batch process (Figure 1). [Note that for this and Figure 2, we use ovals to designate program elements, rectangles to indicate data, lines with arrows to show the flow of control, and lines with circles at one end and arrows at the other for data transfer.] Input parameters, passed at the command line, are assigned to UNIX environment variables for use by the batch process. This process does the following tasks:

1. acquires the data set(s) for the desired day(s) from the archive on the IBM at GSFC;
2. executes a FORTRAN program to read the data set, extract the key parameters, and calculate several derived parameters, and outputs the data to a temporary file in Cray binary format;
3. builds a header for the HDF file that combines system information with relevant information contained on disk and in the software giving parameter definitions, units, references, data set origin, etc., to produce a unique header for each file (see Figures 2, 3, and 4);
4. executes a C program that creates HDF Scientific Data Sets from the data parameters and writes data to the HDF file;
5. transports the file to a remote node via the UNIX File Transfer Protocol (FTP);
6. maintains a log of the session, which also contains some sample data from the file;
7. launches a separate batch process to transport the session log to a remote node via FTP; and
8. cleans up any intermediate disk files on the Cray.

This completes the data distribution activity. We have, or are developing, additional software that allows us to create subsets of the delivered files, based on parameter values and spatial and temporal constraints, and to perform filtering operations and statistical summaries of the data.

For the version 2.0 of the hirs2hdf software package (currently in development) we will use the HDF Vset format for our data archive. The Vsets were designed to store irregularly spaced and multivariate graphical and scientific data. Vsets have since evolved into a general and simple interface for storing almost any large, non-uniform dataset. This structure is particularly useful for parameters in the HIRS2/MSU Level 2 dataset, which must be stored as vectors. Data types supported by Vsets include byte, integer (2 and 4 byte), float and character values. The earlier HDF method of data representation was constrained to byte-and float-type data, which required us to work around this limitation in order to store integer values. Vsets also allow one to explicitly link diverse but related data items within an HDF file to form logically related groups. The data can be organized in a manner that resembles the UNIX file system. As with other HDF data, Vset data is self-describing and portable. Provisions have been made for attaching annotations and textual descriptions to each Vset.

4. Summy

With the aid of existing networks and a transportable file format (HDF), it is possible at minimal cost to make a large, geophysical data set available to remote users in a documented form that is relatively easy to store and to ingest into data analysis software. Table 2 summarizes our experience with the automatic data distribution system. Note that if a system of this type is used, and proper documentation files are created as part of the implementation, it should be feasible for an Earth Science researcher to acquire and use a number of major geophysical data sets as part of a modest interdisciplinary research effort.

1.	To discover the need for HDF, learn HDF, and apply it - ~ 1 year.
2.	Knowing what we now know, to rebuild from scratch - ~ 6 months.
3.	To create HDF files for a different data set, of comparable complexity, in an arbitrary format - <~ 2 months, depending on the documentation and hardware availability.
4.	To ingest a different data set, of comparable complexity, that is already in HDF format - ~ 2 weeks to read data, test, and to study the documentation. We welcome further discussion of this material and can be contacted via e-mail at eda@cyclone.jpl.nasa.gov.

Table 2. What We Have Learned About Time Scales for Working With New Data Sets

Figure 1
hirs2hdf - Part of the Standard Data Files Processing
(runs on GSFC Cray)

last revised: 07/15/92

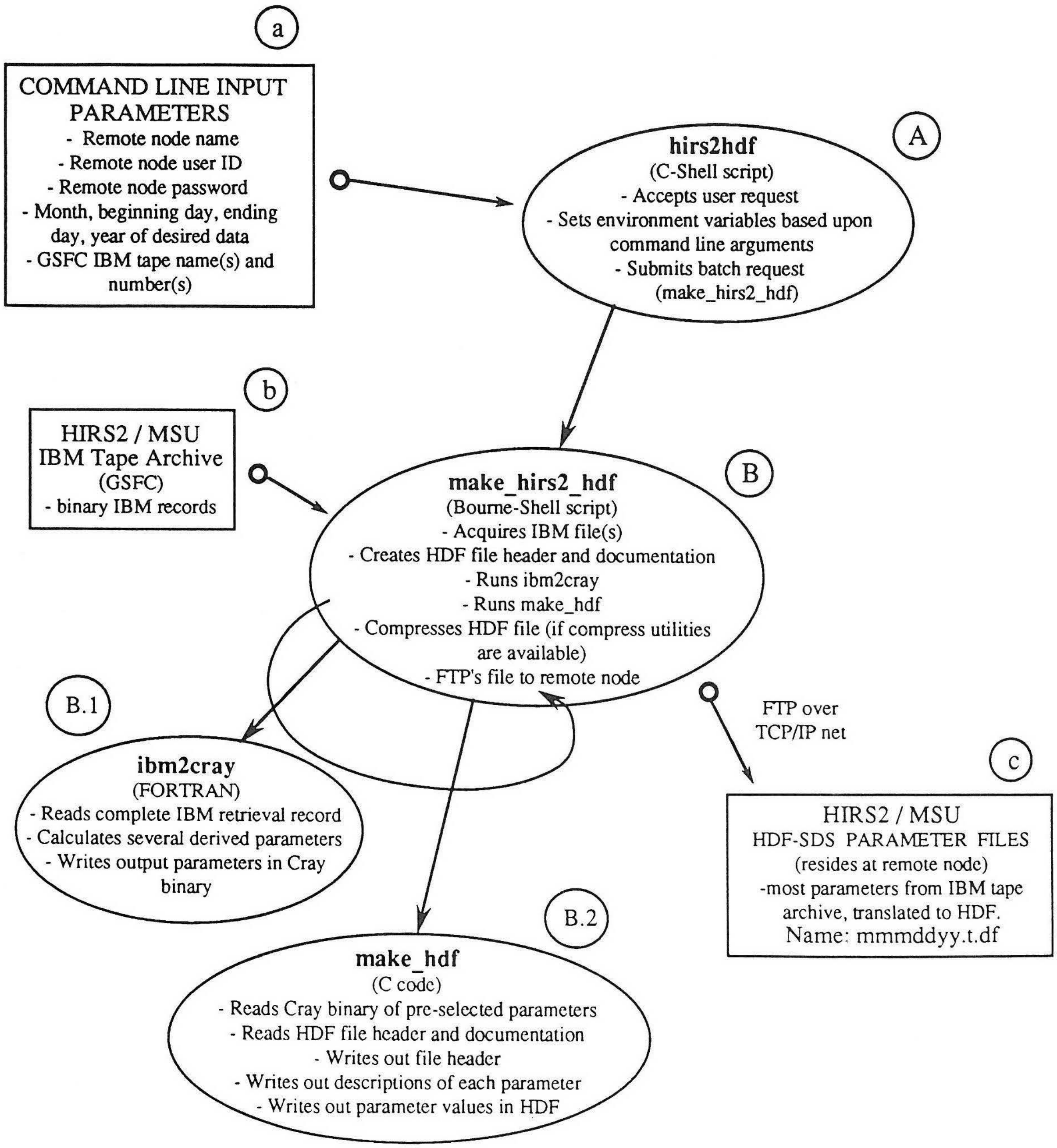

Figure 2

make_hdf - Part of the Standard Data Files Processing

(C Code on GSFC Cray)

last revised: 7/14/92

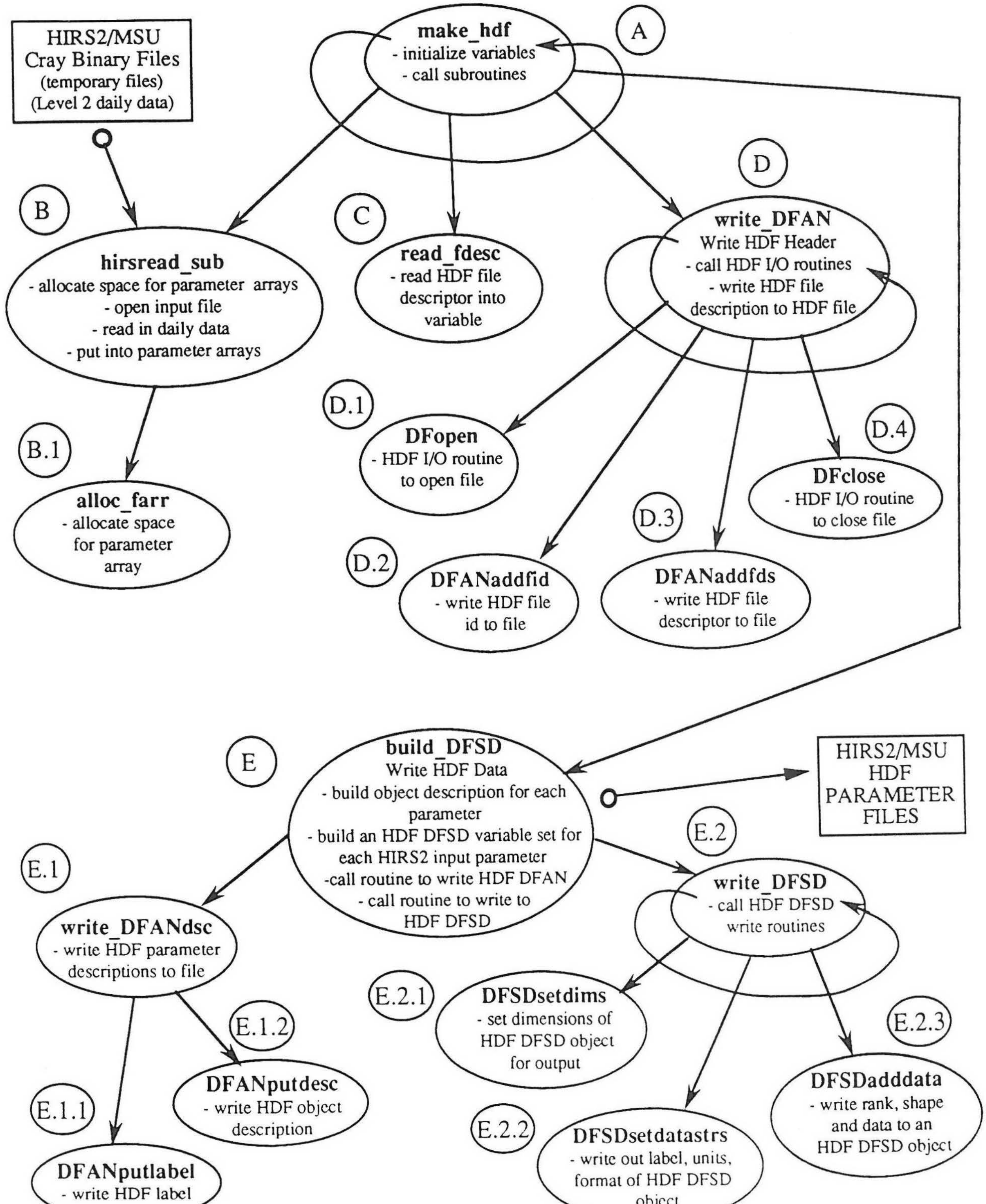

Figure 3

EXAMPLE OF A HIRS2/MSU FILE DESCRIPTION

FILE IDENTIFIER LENGTH: 5
FILE IDENTIFIER: LABEL
FILE DESCRIPTOR LENGTH: 1831
FILE DESCRIPTION:

Description: HIRS2/MSU parameters retrieved using the Goddard Laboratory for Atmospheres (GLA) Physical Inversion Algorithm Baseline 4.0. They are stored as individual objects of an HDF file. These files are the standard data source for most data analysis applications. Most of the parameters delivered on the original GSFC tapes are included. The following parameters were eliminated (either because of questions about definition, redundancy, or problems of interpretation of the values): tau; dlat; dlon; np; cldhgt; cldfrc; rthick. Thirty seven parameters remain. They are listed and defined in /edal/doc/hirs_daily/rec.doc.

Level 2 data for: 06 jul 79, 0Z - 24Z. Platform: TIROS-N

Reference: Susskind, J., J. Rosenfield, D. Reuter and M. T. Chahine, 1984: Remote Sensing of Weather and Climate Parameters from HIRS2/MSU on TIROS-N. J. Geophys. Res. 89, 4677-4697.

Contact: Robert Haskins
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(818)354-6893

Regional Boundaries are: Global

Number of Parameters: 37

Parameters:

YYMMDD, HHMMSS, QUADLATS, QUADLONS, DNFLAG, LANDWTR_FLAG, SAT_ZEN_ANGLE, GEOPOT_THICK, HIRS8_OBS, VIS_REFLECTANCE, SRFC_EMIS_MW, SRFC_PRES, TROP_PRES_RTR, SRFC_TMP_RTR, SST_ANOMALY, TMP_PROFILE_RTR, QUAD_NUM_TMPS, QUAD_FLAG, TMP_RTR_FLAG, TB_RESIDUAL, TB_RMS_TMP, RHUM _PROF_RTR, PRECIP_WTR, WATER_FLAG, TB_RMS_WTR, HIRS8_TBDIF_WTR, HIRS10_TBDIF_WTR, CLOUD_EFRAC_L1, CLOUD_TOP_PRES_L1,CLOUD_EFRAC_L2, CLOUD_TOP_PRES_L2, RMS_ERR_INCCLD, RMS_ERR_PRECLD, CLOUD_CLEAR_PARM, HIRS8_TBDIF_CLD, OZONE_RTR, 03SENS

Comments:

Binary HDF file creation date: Mon Nov 4 16:42:31 EST 1991
Binary HDF file created on a CRAY Y-MP

SDS COUNT: 37

Figure 4

EXAMPLES OF HIRS2/MSU PARAMETER DESCRIPTIONS

SDS DATA DIMENSIONS: 4 x 44821
SDS DATA LABEL: QUADLATS
SDS DATA UNITS: Degrees
SDS DATA FORMAT: F6.2
HDF OBJECT REFERENCE NUMBER: 9
HDF OBJECT DESCRIPTION:
Latitudes of four individual quadrants for cloud retrieval

SDS DATA DIMENSIONS: 4 x 44821
SDS DATA LABEL: QUADLONS
SDS DATA UNITS: Degrees
SDS DATA FORMAT: F7.2
HDF OBJECT REFERENCE NUMBER: 12
HDF OBJECT DESCRIPTION:
Longitudes of four individual quadrants for cloud retrieval.

SDS DATA DIMENSIONS: 1 x 44821
SDS DATA LABEL: TMP_ERR_FLAG
SDS DATA UNITS: N/A
SDS DATA FORMAT: I3
HDF OBJECT REFERENCE NUMBER: 57
HDF OBJECT DESCRIPTION:
Error flag for temperature retrieval.
=> Positive IERR means successful temp retrieval and retrieved temp
was used for water, ozone, and cloud retrieval.

=> Negative IERR means temp retrieval failed and first guess
temp and moisture is used in subsequent cloud retrieval.

1000+K	Converged on Kth iteration in retrieval This parameter is always stored as 1 on the tapes that we receive from GSFC.
1100	Did not converge after 9 iterations. This parameter is always stored as 1 on the tapes that we receive from GSFC (The information about whether or not the retrieval converged is lost.)
2	SST retrieval was not attempted over ocean, climatology SST is used.
3	Residual for HIRS2 channel 2 was large. Ignore retrieved temperatures above 200 mb.
-4	Cloud clearing was not attempted; too cloudy to do a retrieval.
-5	Big (1 degree) RMS on Tb residual in temp sounding channels, or in MW2 channel.
-6	Not used.

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5. Acknowledgment

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The Earth Observer

The Earth Observer is published by the EOS Project Science Office, Code 900, NASA/Goddard Space Flight Center, Greenbelt, Maryland 20771, telephone (301) 286-3411, FAX (301) 286-3884. Correspondence may be directed to Charlotte Griner at the above address. Articles, contributions to the meeting calendar, and suggestions are welcomed. Contributions to the meeting calendar should contain location, person to contact, and telephone number. To subscribe to ***The Earth Observer***, or to change your mailing address, please call Hannelore Parrish at (301) 513-1613, or write to the address above.

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Direct Broadcast System

As part of EOS, NASA will develop and implement a Direct Broadcast (DB) System for continuously transmitting real time data from the AM, PM, and CHEM spacecraft directly to ground stations. Information and a questionnaire (due Sept. 15) were mailed to 700 addressees on July 24 in an effort to determine the number, distribution, and data requirements of potential users. Responses will also be used to assemble an EOS DB User Group. NASA is prepared to offer technical assistance and advice to those interested in acquiring or constructing an EOS DB Ground Station. If you did not receive this mailing and would like to participate, please contact Dr. James Dodge, Program Scientist for EOS Direct Broadcast, Code SED, NASA Headquarters, Washington, D.C., 20546; telephone: (202) 358-0763; E-mail on OMNET: J. DODGE.

EOS SCIENCE CALENDAR

September 22-24	AIRS Team Meeting, Santa Barbara, California. Contact G. Aumann at ((818) 397-9534
September 14-18	EOS Calibration Panel Meeting, Logan, Utah. Contact Bruce Guenther at (301) 286-5205
October 13-15	TES Team Meeting, Boston, Massachusetts. Contact R. Beer at (818) 354-4748
October 20-22	CERES Team Meeting, Hampton, Viginia. Contact B. Wielicki at (804) 864-5683
October 25-26	MODIS Oceans Group Meeting, Santa Barbara, California. Contact W. Esaias at (301) 286-2717
October 27-29	MODIS Team Meeting, Santa Barbara, California. Contact L. Stuart at (301) 286-5411
October 26	MODIS Calibration Group Meeting, Santa Barbara, California. Contact P. Slater at (602) 621-4242
November 10-12	ASTER Team Meeting, Tucson, Arizona. Contact Dave Nichols at (818) 354-8912
December 1-2	Atmospheres Topical Science Meeting, Tampa, Florida. Contact D. Hartmann at (206) 543-7460
January 6-9, 1993	HIRIS Team Meeting, Boulder, Colorado. Contact A. Goetz at (303) 492-5086
February 1-5, 1993	Joint Science Meeting, Las Vegas, Nevada. Contact Dave Nichols at (818) 354-8912

GLOBAL CHANGE MEETINGS

• 1992 •

October 12-16	Workshop on synthetic Aperture Radar System and Its Application in Natural Resources, ITC, Enschede, The Netherlands. Contact Dr. Yousif Ali Hussin, ITC, 350 Blvd 1945, P.O. Box 6, 7500 AA Enschede, The Netherlands. Phone: (31)(53)874-444; Telefax: 31-53-874-400 or 31-53-874-399; Telex: 44 525 ITC NL.
November 2-6	Sixth Australasian Remote Sensing Conference, *Remote Sensing and Spatial Information,* Michael Fowler Centre, Wellington, New Zealand,. Contact Stella Belliss, DSIR Physical Sciences, P. O. Box 31-311, Lower Hutt, New Zealand; Phone +64-4-5666919, extension 8693; FAX +64-4-5690067.
December 4-6	Computer Science for Environmental Protection 6th Symposium, Munich Germany, sponsored by German Computer Soc. Contact Information: Siemens Nixdorm Information System. Phone: 49 89 636 48466.
December 7-11	American Geophysical Union Fall Meeting. Contact Karol Snyder, Civic Auditorium/Brooks Hall, San Francisco, California. Phone: (202) 939-3205 or 1-800-966-2481; FAX: (202) 328-0566.
December 8-12	Natural Hazards Induced by Environmental Changes Int'l Conference, (Zurich) Davos, Switzerland, Sponsored by European Foundation Commission of European Communities. Contact Dr. Josip Hendekovic European Science Foundation 1 quai Lezay Mamesia, F-67000, Strasbourg, France.

• 1993 •

February 8-11	Ninth Thematic Conference on Geologic Remote Sensing: *Exploration, Environment, and Engineering,* Pasadena, California. Contact Nancy Wallman, ERIM, Box 134001, Ann Arbor, MI 48113-4001 USA, Phone (313) 994-1200, ext. 3234, FAX (313) 994-5123, Telex: 4940991 ERIMARB.
April 4-8	25th International Symposium on Remote Sensing and Global Environmental Change, Graz, Austria. Contact: Robert H. Rogers, ERIM, P.O. Box 134001, Ann Arbor, MI 48113-4001, Phone: (301) 994-1200, ext. 3382, FAX: (313) 994-5123.
April 19-23	Call for Papers, First Thematic Conference, International Symposium "Operationalization of Remote Sensing". ITC, Enschede, The Netherlands. Contact: Prof. J.L. Van Genderen, ITC, P.O. Box 6, 7500 AA Enschede, The Netherlands, Phone: 31-53-874-254, FAX: 31-53-874-436, Telex: 44525 ITC NL.

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