The Earth Observer

An EOS Periodical of Timely News and Events

Vol. 3, No. 2 February 1991

EDITOR'S CORNER

The Scope of EOS

"Everything should be made as simple as possible, but not more so."
- A. Einstein

The goal of the Earth Observing System is to advance the understanding of the entire Earth System on the global scale through developing a deeper understanding of the processes within the system's components, the interactions among components, and how the Earth is changing. EOS supports investigations of the Earth System with four distinct objectives:

- creation of an integrated scientific observing system,
- development of a comprehensive data and information system,
- acquisition and assembly of a long-term global data base of established quality and reliability, and
- improvement of our predictive models of the Earth System, a longer-term goal only attainable if the other objectives are successfully achieved.

A difficult hurdle in the establishment of a new scientific program is the funding ramp needed in the early years. While no credible scientist argues against a Mission to Planet Earth, competition for money leads to a natural question, "What could we do that is simpler, quicker, and cheaper?" In the national dialogue about EOS, the urge to simplify has led to a generic, short-sighted recommendation, "Don't do this big mission. Just do my piece."

The Earth System is complicated, and important manifestations of global change occur in all its components over a range of spatial and temporal scales. The highest priority research questions, and the associated measurements, are those that address the most important issues in global change and that hold the most likely promise of increasing our understanding of the Earth. Our understanding is incomplete, particularly of the feedback between components. Thus, narrowing our focus to one or two research topics on a particular component of the Earth System is a dreadful mistake. We must investigate a range of research topics and allow for the certainty that better understanding during the lifetime of EOS will cause us to adjust the priority among research topics.

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EOS UPDATES

The Science Executive Committee of the EOS IWG is preparing a document on "Science Strategy of the Earth Observing System," which will describe the science goals and objectives of EOS and the needed measurements and data system to achieve these. It will be sent to the EOS IWG for review about April 1, with comments due back to Jeff Dozier on April 12.

The Payload Panel meeting, scheduled for May 7-9 in Easton, Maryland has been cancelled.

The next EOS IWG meeting will be in the early fall. Meeting sites are being investigated. Watch future issues of *The Earth Observer* for more information.

Editor's Corner continued

We cannot escape the task of defining priorities, and the EOS scientists faced some difficult decisions in our recommendations about the instruments that constitute the payload of the EOS-A1 satellite. The selected payload is a compromise package that supports an integrated mission for research in Earth System Science. We have guarded against being too confident or too arrogant in our judgement when we identify today's most important unanswered questions and needed measurements. From the history of science, we are painfully aware of the ignominious obscurity that initially greeted some outstanding, far-reaching work. Therefore, we have included in the EOS-A1 payload instruments that measure state variables for the energy cycle, the hydrologic cycle, and biogeochemical cycles for the land, ocean, and atmosphere. All EOS-A1 instruments have a heritage in existing satellite or airborne sensors, reducing the risk that the mission will require unanticipated financial resources.

The EOS-B payload must fill in with instruments to measure atmospheric chemistry and dynamics, topography of the ocean surface, and ice sheets, and the motions of the plates on the Earth's surface.

We owe the next generation of Earth scientists our best judgement about the range of measurements they will need to examine global change. While each scientist might prefer a small satellite with his or her most important instruments, the integrated need encompasses a range of instruments that measure variables in all components of the Earth System over the long term. Understanding will not come easily or simply or cheaply.

Jeff Dozier
EOS Project Scientist

Panel Reports

EOS Physical Climate and Hydrology Panel

The EOS Physical Climate and Hydrology Panel met after the EOS Investigators Working Group (IWG) meeting in Hampton, Virginia on November 8, 1990. The purpose was to review the first draft of a substantial component of the Physical Climate and Hydrology Panel "Science Plan," and to discuss a plan to promote greater scientific interaction between investigators involved in climate and hydrology research.

Science Plan

The panel is completing a science plan entitled *EOS Science Priorities for Physical Climate and Hydrology,* which includes the following elements:

I. Introduction

The importance of physical climate and hydrology in global change.

II. Key Measurements

The key physical and biological variables, fluxes, and reservoirs or volumes critical to assess changes in the state of climate and hydrologic systems.

(a) Importance of observations
(b) Current measurement capabilities
(c) EOS contributions
(d) Recommendations

III. Critical Process Studies

IV. Development of Predictive Capability

The panel reviewed Parts I and II during the meeting, identified omissions and areas of potential improvement, and then requested individuals to provide improvements or more detailed reviews. A

substantial number of revisions have now been submitted for the second draft. The panel also defined the components and formats for parts III and IV. A final document is planned for the next IWG.

Science Conference

The panel endorsed the importance of holding a scientific meeting to present and discuss the scientific foundations and active research in physical climate and hydrology that lead us into the EOS era. The following scientific meeting announcement describes the purpose and organization of the meeting:

SCIENCE FOUNDATIONS FOR THE EOS ERA:
PHYSICAL CLIMATE AND HYDROLOGY

July 22-26, 1991
Earth System Science Center
248 Deike Building
The Pennsylvania State University
University Park, PA. 16802

Purpose: EOS principal investigators, interdisciplinary science co-investigators, instrument investigators, and team members represent enormous scientific expertise and interest in physical climate and hydrology. However, the necessity for focused efforts in planning and management for a new start for the Earth Observing System has resulted in limited scientific interaction among the breadth of investigators and limited scientific outreach opportunities. In order to promote greater scientific interactions, the EOS Science Panel on Physical Climate and Hydrology proposes to convene a scientific conference with the following objectives:

- present and discuss the scientific foundations in physical climate and hydrology preceding and leading to the EOS era;
- join the full breadth of EOS investigators in climate and hydrology (interdisciplinary investigators and instrument investigators) in a discussion of scientific activities in order to promote greater awareness of scientific objectives and methodologies and to promote greater interaction;
- entrain and educate a broader segment of the scientific community with regard to EOS science and plans;
- highlight the importance of physical climate and hydrology in the U.S. Global Change Research Program through a limited set of distinguished lectures.

Organization: The meeting will be open to all EOS investigators with direct scientific involvement in the physical climate and hydrology aspects of the mission. However, to ensure open and frequent discussion and interaction, the meeting will be limited to 80 participants. A presentation on science activities will be a requirement for EOS investigators who attend the workshop. This requirement will ensure active participation, and also sets the length of the workshop at 5 days with at most 15 presentations per day. These should include individual research presentations as well as presentations of elements of coordinated team investigations. They must be a balance of interdisciplinary investigations, instruments investigations and team members investigations.

With the purpose of entraining future EOS investigators, graduate students (not necessarily involved with EOS) will be invited to apply for special travel scholarships .

During a few of the evenings, distinguished speakers (organizers of major international programs of direct interest - e.g. GEWEX, members of Academy panels or universally recognized scholars) will be invited to give special seminars.

The conference will be well advertised to attract a strong pool of graduate student applications and to invite other participants, as space permits. Volunteered abstracts from outside the EOS community will be accepted if time permits.

Next Panel Meeting

The panel agreed to meet at the next scheduled IWG meeting. An in-depth discussion of GEWEX is planned. In addition, the panel plans to discuss collaboration, coordination and prioritization of field studies associated with EOS physical climate and hydrology. The panel recognizes that field support may be limited and that there are substantial potential benefits in collaboration efforts.

Eric J. Barron
Panel Chair

Precision Orbit Determination/Mission Design Panel

The Precision Orbit Determination/Mission Design Panel met on November 6, 1990 prior to the IWG Meeting at NASA Langley. The meeting was attended by John Lundberg (Univ. of Texas), Ming-Ying Wei (NASA HQ), Chris Scolese (GFSC), Dixon Butler (NASA HQ), Eric Kasischke (ERIM), JoBea Way (JPL), Tom Yunck (JPL), Bob Schutz (Univ. of Texas), Allen Andrews (NASA HQ), Ed Harrison (LaRC), Piers Sellers (GFSC), David Schimal (CSU), and Byron Tapley (Univ. of Texas). The principal item on the agenda was a discussion of the issues related to the equator crossing times of the EOS-A and EOS-B platforms. A summary of those issues is presented in the following report.

Issues Associated with the Equator Crossing Times for the EOS-A and EOS-B Platforms

Both technical and operational requirements for the selection of equator crossing times for the Earth Observing System place essential constraints on the scientific return from the mission. The weights assigned to each of these constraints are derived from the priorities of the program. Since the NASA and European platforms will be in sun-synchronous orbits, the local time at which the platforms cross the equator will be essentially constant from one orbital revolution to the next. The equator crossing times for the EOS-A and EOS-B platforms are currently scheduled to be 1330 (ascending) and 0130 (descending). The issue as to whether or not the 1330/0130 crossing times are the most appropriate for the EOS-A and EOS-B platforms has been placed before the POD/MD Panel for discussion and review. This summary attempts to identify the scientific and operational issues associated with selecting the equator crossing times.

Scientific Issues

The Land/Biosphere, Physical Climate/Hydrology, Atmospheres, Oceans, and Biogeochemical Panels have presented the scientific requirements for the equator crossing times as they relate to their areas of interest. These requirements were summarized in the August/September issue of *The Earth Observer* (Vol. 2, No. 7). Since then, the volcanology investigators have also expressed opinions on this issue. In summary, for the oceanography studies, there should be one crossing time within one to one and one-half hours of local noon (1330 or 1030) to maximize solar reflection while avoiding sun glint.

The Land/Biosphere and Biogeochemical investigators would prefer a mid-to-late-morning crossing to minimize the effect of cloud contamination on the surface-imaging instruments (MODIS, HIRIS, etc.). This argument is based on the finding that in certain areas there is little or no probability of obtaining less than 10 to 20% cloud cover in the afternoon (1330) while in other regions there is a three-fold increase in the probability of obtaining less than 10 to 20% cloud cover in the morning (1030) versus the afternoon. Consequently, for those investigations which rely heavily on the surface imagers, a morning crossing time is desired.

The Physical Climate/Hydrology and Atmospheres investigators would prefer to have platforms at both the morning and afternoon crossing times to provide better sampling of diurnal variations. The volcanology investigators have suggested that the 1330 crossing time would provide the maximum temperature difference between solar-induced surface heating and volcanic heating. Alternatively, the 1030 crossing time with its reduced cloud contamination would provide better viewing conditions for surface areas that are in sunlight. Consequently, the requirements for volcanology need further review before any definitive statements are presented. The Oceanography Panel has indicated that either the 1030/2230 or the 1330/0130 crossing time would be satisfactory.

The principal issue in terms of selecting crossing times for scientific return reduces to one of selecting the priorities for the passive surface imaging instruments, which attempt to measure the reflected and emitted radiation of the surface and clouds, i.e., MODIS, HIRIS, and ASTER. The Land/Biosphere and Biogeochemical investigations are depending on these instruments with minimal cloud interference. The Atmospheres and Physical Climate/Hydrology investigations are depending on these instruments to view sub-kilometer-size clouds.

Operational Issues

The European Space Agency's polar platform (EPOP) is currently scheduled for crossing times of 1030/2230. To provide complementary coverage for im-

proved diurnal sampling, the crossing times for the EOS-A and EOS-B platforms were selected to be 1330/0130. However, the Biogeochemical and Land/Biosphere investigators have indicated that the instruments on EPOP do not satisfy the same measurement requirements that MODIS-N is capable of attaining. Thus, while the issue of diurnal sampling is addressed by having different crossing times between EPOP and EOS-A and EOS-B, the arrangement of instruments between the platforms is not favorable for several investigations.

Since EOS-A is tentatively scheduled to carry the passive surface imaging instruments, it has been suggested that the crossing time for EOS-A be switched from 1330/0130 to 1030/2230. This arrangement has two principal complications. First, this change may be viewed as placing some of the EOS-A instruments in competition with some of the instruments on EPOP instead of complementing them because of their overlapping capabilities. Second, the recommendation of the Payload Advisory Panel (as presented in Berrien Moore's letter of 10 September 1990 to Dr. Fisk) were derived under the assumption that both the EOS-A and EOS-B platforms should fly within 10 to 15 minutes of each other to maintain the synergism between the two payloads since one platform could not accommodate all the complementary instruments. Thus, there is a serious conflict of the requirements for diurnal sampling of the atmosphere and platform synergism with the requirement for a morning crossing time.

NOAA's requirements for space-based remote sensing include having a system of polar orbiting satellites that provide both morning and afternoon crossing times. Initially, NOAA was to have a prominent role in providing instrumentation to the EOS program. It was envisioned that the NOAA instruments on EOS would replace those currently on the NOAA polar orbiting platforms. Consequently, NOAA's participation is a major factor in the selection of the 1330/0130 crossing times for the EOS A and B platforms since they could eventually replace the current series of NOAA polar orbiters that have afternoon crossing times. NOAA is currently investigating the possibility of providing instrumentation to be flown on EPOP to replace the platforms with morning crossing times. However, under the current arrangement, NOAA will maintain its polar orbit series through the EOS mission time frame as the baseline scenario for satisfying their measurement requirements.

John Lundberg
University of Texas

NASA Graduate Student Fellowships in Global Change Research

NASA has announced graduate student training fellowships for persons pursuing a Ph.D degree in aspects of global change research. These fellowships will be available for the 1991/1992 academic year. The purpose is to ensure a continued supply of high-quality scientists to support rapid growth in the study of the Earth as a system. A total of 37 fellowships were awarded in 1990. Up to 50 new fellowships will be awarded in 1991, subject to availability.

Applications will be considered for research on climate and hydrologic systems, ecological systems and dynamics, solid Earth processes, Earth system history, 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 Mission to Planet Earth.

The deadline for submitting applications is April 1, 1991. For further information contact Dr. Ghassem Asrar, NASA Headquarters, (202) 453-1720.

EOS Mission Operations Working Group (EMOWG)

What is the EMOWG?

The EOS Mission Operations Working Group (EMOWG), functions under the Goddard Space Flight Center EOS Ground Systems and Operations Project, Code 423, headed by Tom Taylor. The EMOWG is chaired by the EOS Mission Operations Manager (MOM), Angelita Kelly. Meetings are held every four to five months.

The purpose of the EMOWG is to address Mission Operations requirements for the different instruments, as well as for the science teams. The EMOWG is the forum for formulating and validating operations concepts, beginning with operations concepts onboard the observatory to and through the EOS Ground System. Discussion items include planning and scheduling, commanding, conflict resolution (within an instrument, between instruments, and among several instruments), realtime science data needs, realtime instrument monitoring, operations interfaces with the international partners, etc.

Participation is open to all EOS personnel who are involved with and/or care about mission operations. The EOS MOM subscribes to the philosophy that the primary reason and goal for mission operations is to fly the observatory in order to obtain the best quality data for use by the scientific community. In order to accomplish this, close interaction and dialogue with the instrument and science teams is absolutely essential. It is never too early to plan mission operations. A clear picture of mission operations can significantly influence the design of the observatory, the instruments, and the ground systems, including the science computing facilities. Each instrument and science team should designate a specific member(s) of the team who can and will take care of mission operations.

Personnel who wish to participate in the EMOWG or who would like to be included on the EMOWG distribution list should send a message to: Angie Kelly, Mail Code 423, NASA/GSFC, Greenbelt, Maryland 20771, or AKELLY/GSFCMAIL. Please indicate your name, affiliation with instrument/science team (if applicable), organization, address, telephone number (include FTS number), FAX number, and exact electronic mail address.

L to R: Neal Kuo, Larry Hovland, Dave Nichols, Harold Maurer, Steve Tompkins

Joint EMOWG/GSIWG Meeting

A joint meeting of the EOS Mission Operations Working Group (EMOWG) and the Ground Systems Integration Working Group (GSIWG) was held at the University of Colorado, Boulder, Colorado, on February 19-21.

The meeting host, Tom Sparn, of the Laboratory for Astronomy and Space Physics, welcomed the attendees. Tom Taylor, EOS Ground System and Operations Project Manager, and Kevin Niewoehner, NASA Headquarters, Code SE, EOS Mission Planning and Operations, provided introductory remarks.

After Angie Kelly, Mission Operations Manager (MOM), opened with remarks on her Mission Operations philosophy and the important role of the scientist (principal investigator/team leader) in mission operations, Joe Gitelman, Code 423, Chairman of the GSIWG, provided an update of the EOS Ground System architecture.

Science/instrument presentations were provided by Alex Goetz, HIRIS, Don Jennings, SAFIRE, Paul Bailey, HIRDLS, and Bill Weaver, CERES. Scott Lambros, Code 422, gave a summary of the confirmed EOS-A1 instruments. Tom Sparn updated the participants on the instrument support terminal (IST), as viewed by the scientist user.

L to R: Madeline Butler, Peter Doms, Joe Gitelman, Kevin Niewoehner, Tom Taylor

Other presentations included: Status of International Partner and NOAA Interfaces, Paul Hwang, Code 423; An Update on the Observatory Onboard Command and Data Handling System Design, Allan Tarleton, Code 421; CDOS Services and Concepts, Madeline Butler, Code 560; Space Network Scheduling Services, Allen Levine, Code 530; EOSDIS Core System (ECS) Overview and ECS Ancillary Data Concepts, Gene Smith, Code 502; ECS Flight Operational Overview, ECS Command Operations Concepts, and Instrument Interface Guidelines, Steve Tompkins, Code 510; and ECS Planning and Scheduling, Tom Barlett, Code 510. Joe Gitelman also presented the plans for the independent verification and validation of the EOS Ground System.

The meeting included splinter working sessions on four topics:

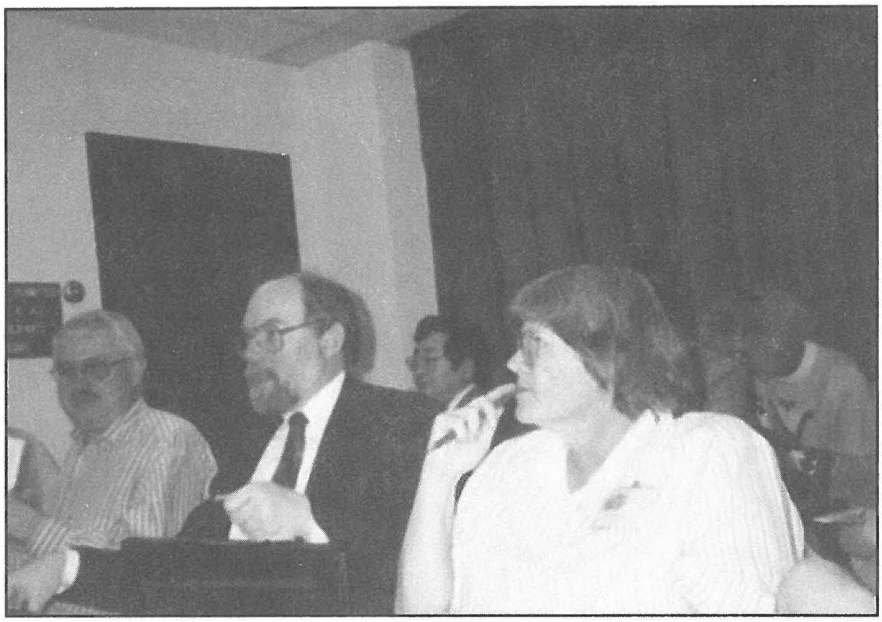
(1) planning and scheduling;

(2) realtime/quicklook data requirements;

(3) instrument design and interface guidelines; and

(4) ancillary data for mission operations.

The presentations and splinter sessions triggered lively discussions, especially on the issues relating to the observatory direct downlink system, quick look data (how many ways a user may request it), planning and scheduling scenarios, and the extent of scientist involvement, ancillary data (what does it consist of?), etc. Several action items were noted and assigned. It is hoped that future meetings will continue to generate the productive dialogue and information exchange which marked this meeting.



L to R, front: Bill Weaver, Gene Smith, Anne Kahle.
Back: Seung T. Kim, Karen McDonald

Some of the other attendees included Anne Kahle, ASTER, Jet Propulsion Laboratory (JPL); Steve Gunter, STIKSCAT, JPL; Larry Hovland, MISR, JPL; Dave Nichols, SAR, JPL; and John Boyd, EDC. Karen McDonald, GSFC ECS Contracting Officer, accompanied the GSFC team. The

meeting was conducted under the "brownout" guidelines for the ECS procurement.

A complete list of participants, detailed minutes of the meeting, and copies of the presentations will be available in the GSFC EOS library in late March, 1991.

Angie Kelly
EOS Mission Operations
Manager (MOM)

Seasonal Sea Ice Monitoring Site (SIMS)

Seasonal Sea Ice Monitoring Site (SIMS) is a five-year multidisciplinary research project developed by the Earth Observations Laboratory of the Institute for Space and Terrestrial Science (ISTS/University of Waterloo, Ontario, Canada), in cooperation with several participating agencies:

AES / York University Microwave Group (Earth Observations Laboratory — ISTS/York University)
Ice Centre, Environment Canada (ICEC)
Canada Centre for Remote Sensing (CCRS)
Atmospheric Environment Service (AES), Downsview, Ontario
Department of Fisheries and Oceans, Winnipeg, Manitoba Norland Science, Ottawa, Ontario
National Research Council of Canada, Ottawa, Ontario
Jet Propulsion Laboratory (JPL), Pasadena, California.

Within SIMS, our primary objectives are to characterize the physical processes of atmosphere-cryosphere-hydrosphere interactions and to develop the capability to measure the pertinent variables using remote sensing data. Specific objectives include:

- validation of the geophysical characteristics of sea ice which can be measured from remote sensing data;
- development of an understanding of how this information can be extracted from digital data;
- description of the changes in microwavelength signatures of sea ice as a function of season, scale, and wavelength;
- development of proxy indicators which can be used to infer selected atmospheric state variables over the ice/snow surface in different seasons;
- identification of the synergistic relationships between SAR, passive microwave and optical/thermal wavelength remote sensing data for characterization of ice/atmosphere-related physical processes.

The SIMS project objectives required development of a surface validation site in Lancaster Sound, Northwest Territories (NWT), Canada. The pilot field study was conducted from May 12 to June 7, 1990. The 1990 field program was held coincident with overflights from a SAR aircraft (the X-band ICEC Challenger SAR, contracted from Intera Technologies). Four orbital sensors provided data in the visible, near infrared, thermal infrared and microwavelengths:

- Landsat Thematic Mapper;
- Systéme Probatoire d'Observation de la Terre (SPOT);
- US-NOAA Advanced Very High Resolution Radiometer (AVHRR); and
- Special Sensor for Microwave/Imaging (SSM/I).

Surface validation included measurements relating to the boundary layer climatologies (incident re-

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flected shortwave, snow pack extinction properties, sensible and latent heat fluxes, etc.), and geophysical properties (snow structure, ice structure, temperature profiles, free water content, surface roughness, etc.) of the seasonally varying snow-covered sea ice. All surface validation measurements were made throughout the duration of the field experiment at varying spatial and temporal scales. Analysis of the remote sensing of the observed variables is currently being conducted.

SIMS '91 will be conducted at the same field site from May 15 to June 30, 1991. Interested parties are asked to contact:

Dave Barber
Earth Observations Laboratory
University of Waterloo
Ontario, Canada.
Phone: (519) 885-1211, extension 2689.
Fax: (519) 888-6768.
Omnet: EOL.WATERLOO.

Dave Barber
Earth Observations Laboratory

Landsat Data Available at Reduced Cost

The Director of the U.S. Geological Survey (USGS), Dallas L. Peck, announced recently that approximately 600,000 Landsat scenes — all those acquired by multispectral scanners (MSS) aboard Landsat satellites more than two years in the past — are now available at reduced prices from the Earth Resources Observation Systems (EROS) Data Center (EDC) in Sioux Falls, South Dakota.

"One result of making the historic data more affordable is to facilitate research, including studies of long-term global change, for scientists on a limited budget," Peck said. "Landsat data provide a unique baseline of information about land conditions and changes during the 1970's and 1980's that is not available from any other existing data source and that could be critical in studies of global change." Peck also noted, "The ability to detect changes in vegetation and land-surface parameters is intrinsically linked to efforts to assess the impacts of global climate change, both as an early indicator of climate change and as a contributor to changes in the chemical composition of the atmosphere. Making these data more easily accessible is very timely in light of today's critical need for affordable worldwide satellite remotely-sensed data coverage required for critical environmental assessment and global change studies."

The new arrangement was made possible by a recent agreement between the National Oceanic and Atmospheric Administration (NOAA) and Earth Observation Satellite (EOSAT) Corporation, the firm that was awarded control over distribution of Landsat data in 1985. EOSAT retains exclusive sales rights to MSS data that are less than two years old and will have exclusive sales rights for all Landsat Thematic Mapper (TM) data until July 1994, at which time TM data more than 10 years old will become available from the EDC.

The new prices for the historic MSS data are substantially lower than prices for more current data and images that are less than two years old. For example, a 9.5-inch black and white paper print of an historic Landsat image sells for $10.00 from the EDC, compared with $95 from EOSAT for an image less than two years old. Other EDC prices for standard products of MSS data and images at least two years old are $12.00 for a 9.5-inch black and white positive film, $18.00 for a transparency, and $200 for computer-compatible (magnetic) tape data.

If you would like further information about Landsat products available at the EDC, contact Customer Services, EROS Data Center, Sioux Falls, South Dakota, 57198. The telephone number is (605) 594-6151.

Global Change Meetings

March 20-22 Remote Sensing Society Conference, TERRA-1, *Understanding the Terrestrial Environment: The Role of Earth Observations from Space,* The Guildhall, Winchester, England. Contact Prof. P.M. Mather, Geography Department, The University, Nottingham, NG7 2RD, England; telephone: 0602 484848 Ext. 3040.

March 24-28 2nd Scientific Meeting of the Oceanography Society, St. Petersburg, Florida. Contact the Oceanography Society, 1755 Massachusetts Avenue, N.W., Suite 700, Washington, D.C. 20036.

March 28-30 *Squeezed States and Uncertainty Relations Workshop*, University of Maryland, College Park, Maryland. For information contact D. Han, NASA/GSFC, (301) 286-9414.

April 1-5 The International Society for Optical Engineering (SPIE), *OE/Aerospace Sensing: International Symposium and Exhibition on Optical Engineering and Photonics.* Marriott's Orlando World Center Resort & Convention Center, Orlando, Florida. For complete program information contact the SPIE, Bellingham, Washington, (206) 676-3290.

April 8-12 *Synthetic Aperture Radar: Design, Processing and Applications*, University of California, Los Angeles (UCLA). Contact Jo Bea Way at (818) 354-8225.

April 15-19 *The Global Change Research Program: Requirements, Technologies, and Opportunities,* University of California, Los Angeles (UCLA). Contact Jo Bea Way at (818) 354-8225.

April 22-26 AGU Meeting, *Chapman Conference on Geodetic VLBI: Monitoring Global Change*, Washington, D.C. For more information contact the AGU Meetings Department, 2000 Florida Avenue, N.W., Washington, D.C. 20009; telephone (202) 462-6900.

May 13-17 Seventh Catalog Interoperability Workshop, Annapolis, Maryland. Contact Janis Shipe (301) 513-1688 or NSSDCA::SHIPE, or contact Jim Thieman at (301) 286-9790 or NSSDCA::THIEMAN.

Future EOS Science Meetings

July 22-26 Science Foundations for the EOS Era: Physical Climate and Hydrology, Earth System Science Center, 248 Deike Building, The Pennsylvania State University, University Park, Pennsylvania. Contact Eric Barron, (814) 865-1619.

July TBD LAWS Science Team, Aspen, Colorado. Contact Wayman Baker, (301) 763-8005.

October 22-25 ALT Team Meeting (TOPEX), Paris, France. Contact Lee-Lueng Fu, (818) 354-8167.

Late Summer/ Early Fall EOS Oceans Panel Topical Science Meeting on Air/Sea Interactions. Contact Mark Abbott, (503) 737-4045.

EOS SCIENCE MEETINGS 1991

	Monday	Tuesday	Wednesday	Thursday	Friday	Sat/Sun
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	11	12	13	14	15	16 17
	← SAR Team	Meeting, Pasadena, California →				
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		← U.S. Aster Team Meeting	Pasadena, California →			
	25	26	27	28	29	30 31
		← SAGE III Team	Meeting, LaRC →			
		← TES Science Team, Denver, Colorado →				
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			← ICWG Meeting,	Paris, France →		
	15	16	17	18	19	20 21
		← Science Executive Committee	Washington, D.C.	(SEC) →		
	22	23	24	25	26	27 28
		← Calibration Panel Meeting, LaJolla, California →				
	29	30	1	2	3	4 5
		← CERES Conceptual Design Review & 5th	LaRC	CERES Science Team	Meeting →	
MAY	6	7	8	9	10	11 12
	13	14	15	16	17	18 19
	← UARS →					
	Science Team					
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			← EOS SAR Meeting, Bergen, Norway →			

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