The Earth Observer

An EOS Periodical of Timely News and Events

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EDITOR'S CORNER

There are two important announcements in this issue of The Earth Observer.

1. The selection for the first of the EOS-A series observatories has been announced. In the Project and the Program, we now all feel a sense of relief that this important step is behind us. The task now before us is to effect better coordination between the interdisciplinary scientists and the instrument principal investigators, team leaders, and team members, so that the geophysical and biological data products created truly address crucial issues in global change. The other task that will occupy much of our effort this year is the definition and selection of the EOS-B series observatories. Many of the IWG panels are working on questions to be answered about the B-observatories.

2. At the end of February there will be a meeting about Version 0 EOSDIS. The first day of this meeting is open, and will serve to inform the community about Version 0 plans and activities.

EOSDIS Version Zero Meeting

The Source Evaluation Board has been formed for EOSDIS, and is currently reviewing the Request-for-Proposal, to be released in March 1991. EOSDIS contractors will have 60 days to respond; then follows a lengthy evaluation period, with the award of the EOSDIS contract in 1992. In the meantime, the EOSDIS Distributed Active Archive Centers (DAACs) have all begun work on EOSDIS, with the goal to implement a working system in 1994.

On February 26-28, the EOS Project is holding a meeting about this "Version 0" EOSDIS, at the Greenbelt Marriott. The first day of this meeting, February 26, is open to everyone; the second and third days are for the DAAC staff and EOSDIS Advisory Panel. There is a Registration Fee of $50 to cover meeting rooms and refreshments. Register for the meeting by contacting Deborah Critchfield (202/379-0360, DCRITCHFIELD on GSFCMAIL), who also has information about hotel accommodations. The agenda is available from Gail McConaughy (301/286-7741, GMCCONAUGHY on GSFCMAIL).

Jeff Dozier
EOS Project Scientist

NASA SELECTS PAYLOAD FOR FIRST EOS SATELLITE

On January 18, 1991, NASA selected 11 instrument investigations for flight on the first satellite of the Earth Observing System (EOS), plus one instrument for flight on a satellite of opportunity. The instruments selected for flight on the first satellite are AIRS/AMSU-A/-B, ASTER, CERES, EOSP, HIRDLS, LIS, MIMR (pending resolution of technical issues), MISR, MODIS-N/-T, MOPITT (pending resolution of technical issues), and STIKSCAT. HIRIS has been confirmed for development and tentative selection for subsequent flight. ACRIM has been selected for flight on a satellite of opportunity.

[NASA Selects Payload continued on page 2]

Nasa Selects Payload continued

EOS, the centerpiece of NASA's Mission to Planet Earth, will study the interactions of the atmosphere, land, oceans, and living organisms, using the perspective of space to observe the Earth as a global environmental system.

The first EOS satellite, scheduled to be launched aboard a TITAN-IV vehicle from the Western Test Range in 1998, is part of the three-satellite EOS-A series. Each satellite will have a five-year design life, resulting in a 15-year-long global data set. The primary goal of the EOS-A series is to provide a suite of measurements related to potential global warming and other critical aspects of global change. Specific observations include the Earth's radiation balance, atmospheric circulation, air-sea interaction, biological productivity, and land-surface properties.

A complementary 15-year EOS-B series of satellites is also planned, with the first satellite to be launched about two and a half years after the first EOS-A satellite. The particular size of and payload for the EOS-B satellites, as well as the launch vehicle requirements, will be studied during 1991.

Nine of the instrument investigations for flight aboard the first EOS-A satellite constitute a minimum set of synergistic instruments for making simultaneous observations. To give two examples of how this instrument set focuses on critical issues of global change:

- Depending on their type, clouds can reflect incoming solar radiation, thus cooling the Earth's surface, or trap heat emitted by the Earth, thus warming the surface. To better understand the role of clouds in global change, EOS will measure incoming and emitted radiation at the top of the atmosphere (the function of the CERES instrument). Then, to study characteristics of the atmosphere that influence radiation transfer between the top of the atmosphere and the surface, EOS will observe clouds (with MODIS-N), water vapor and cloud water (with MIMR), aerosols (with EOSP and MISR), temperature and humidity (with AIRS/AMSU-A/-B), and directional effects (with MISR).

- Through their intake and emission of carbon dioxide, the primary anthropogenic greenhouse gas, terrestrial and marine plants are a key part of the global carbon cycle. To better understand their role as a source or sink for carbon, EOS will observe the biological productivity of lands and oceans (with MODIS-N and MODIS-T respectively). However, to do so accurately, EOS must also estimate atmospheric characteristics as noted above. Additionally, EOS will study surface properties that affect biological productivity at high resolution spatially (with ASTER) and spectrally (with HIRIS, when flown on a later satellite of this series). For oceanic gas exchange, EOS will estimate surface winds (with STIKSCAT).

A 10th instrument investigation (HIRDLS) will extend the monitoring of important stratospheric chemical constituents beyond the planned lifetime of the Upper Atmosphere Research Satellite (UARS), which is scheduled for launch in late 1991. An 11th (MOPITT) will monitor carbon monoxide and methane in the lower atmosphere.

ACRIM does not require flight in a polar orbit and, therefore, has been confirmed for flight on a satellite of opportunity. HIRIS has been confirmed for development, to better understand the technical complexities that could affect schedule and risk.

As a supplement to these instrument investigations, a Wide-Band Data Collection System (WBDCS) will be included on EOS-A as a capability of the satellite platform. Although initially designed for seismic purposes, it will support the collection of global *in situ* data.

This instrument complement represents a conservative selection for EOS-A, leaving significant potential payload reserve in the TITAN-IV launch vehicle and the TDRSS data link. The TITAN-IV can lift more than 15,000 kilograms (kg). After accounting for fuel, flight-support equipment, and 1,000 kg of reserve, about 11,000 kg are available to EOS. The total mass of the first EOS-A satellite is about 10,000 kg, including contingency for both payload and platform, so there is a margin of 1,000 kg. Of the 3,500 kg allocated for payload mass (including about 30% contingency), only 81% is required for the first EOS-A satellite.

By the end of the five-year mission, the average power output from the solar panels will be reduced by approximately one-half. At that time, 93% of the 3.3 kilowatts allocated for the payload will be needed. Margin is also available in the data downlinking capacity; 35% of the peak TDRSS data-link capacity

is needed for the first EOS-A satellite. If HIRDLS and MOPITT were deleted and HIRIS added, 91% of the payload mass and 70% of the data link would be needed, with no significant change in power.

The confirmed instrument payload represents an increase of one instrument investigation over that of UARS, which has 10. It also represents a payload mass of 2,800 kg, compared with the UARS payload (74% instruments and 26% cryogen) of 2,500 kg. The total dry mass of the Gamma Ray Observatory is 14,000 kg, while that for the EOS-A satellite is 10,140 kg.

Proposed by the President and approved by Congress as a new NASA program in the FY 1991 budget, EOS has three closely linked objectives: the creation of an integrated Earth observing system, the development of a comprehensive data and information system, and the assembly of a long-term global data base. The overall goal is to study how the Earth functions as a system, ultimately providing a context for understanding global warming and other critical aspects of global change.

EOS is NASA's central contribution to the U.S. Global Change Research Program. Internationally, EOS is closely coupled with NASA's foreign partners. The EOS-A instrument investigations include instruments from Canada, the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), the European Space Agency (ESA), and Japan, plus an additional joint development with the United Kingdom. Both ESA and Japan plan satellites of their own to complement EOS. Currently, one NASA instrument (CERES) is planned for flight aboard an ESA satellite.

These investigations, initially proposed in response to the EOS Announcement of Opportunity issued by NASA in January 1988, have been supported to conduct definition studies over the past year and a half.

Nine of these instrument investigations selected for flight on the first EOS-A satellite, plus HIRIS, are also tentatively selected for flight on the remaining satellites of the EOS-A series; however, final determination of the instrument manifest on subsequent satellites will not be made until after instrument development is under way. This delay is intended to allow for continuing evolution in mission planning, which may result from availability of new technology, improvements in our understanding of measurement requirements, and availability of alternative sources of data.

During the coming year, definition studies will be conducted for the instruments under consideration for flight aboard the EOS-B series. These instruments will address elements of the Global Change Research Program not adequately covered by the EOS-A series; these elements include tropospheric and stratospheric chemistry, ocean circulation, glaciology, plate tectonics, and particles and fields.

There will be an external engineering review of the EOS Program later this year to verify or, if possible, improve current plans. Until and unless improvements are identified as a result thereof, development will proceed as designed in the baseline program plan.

Supplemental Information on EOS-A Instrument Selection

In addition to confirming the EOS-A instrument investigations, NASA confirmed the four Team Leaders and 61 Team Members who will conduct research and provide algorithms for geophysical and biological products using the Facility Instruments (AIRS/AMSU-A/-B, ASTER, HIRIS, and MODIS-N/-T). NASA also confirmed 29 interdisciplinary investigations, each involving a team of investigators, to conduct interdisciplinary research using data returned by EOS instruments.

The following instrument investigations have been confirmed for flight on the first of the three-satellite EOS-A series. Except for HIRDLS, all have been tentatively selected for flight on the remaining satellites of the EOS-A series. CERES and LIS are under consideration for additional flights of opportunity:

AIRS/AMSU-A/-B (Atmospheric Infrared Sounder/Advanced Microwave Sounding Units). Team Leader: Moustafa T. Chahine, Jet Propulsion Laboratory, Pasadena, CA. AIRS and AMSU-A/-B will measure atmospheric temperature profiles with an accuracy of 1° Celsius and will provide data on atmospheric water vapor, cloud cover, and sea- and land-surface temperatures. AMSU-B is a planned contribution from EUMETSAT.

ASTER (Advanced Spaceborne Thermal Emission and Reflection, formerly known as the ITIR). Team Leader: Hiroji Tsu, Geological Survey of Japan, Tsukuba, Japan. U.S. Team Leader: Anne Kahle, Jet Propulsion Laboratory, Pasadena, CA. ASTER, to be provided by the Japanese Ministry of International Trade and Industry,

will provide high-resolution images (15 to 90 meters) of the land surface and clouds for climatological, hydrological, biological, and geological studies.

CERES (Clouds and the Earth's Radiant Energy System). Principal Investigator: Bruce R. Barkstrom, Langley Research Center, Hampton, VA. CERES will continue long-term measurements of the Earth's radiation budget through observations of both short- and long-wave radiation. CERES is also planned to fly on one of ESA's polar platforms.

EOSP (Earth Observing Scanner Polarimeter). Principal Investigator: Larry D. Travis, Goddard Institute for Space Studies, New York, NY. EOSP will make global observations of polarized light to quantify the role of aerosols and clouds in heating and cooling the Earth, as well as help characterize cloud feedbacks in global change processes.

HIRDLS (High-Resolution Dynamics Limb Sounder). Principal Investigators: John C. Gille, National Center for Atmospheric Research, Boulder, CO and John J. Barnett, Oxford University, Oxford, England. This will be a joint instrument development with the UK. HIRDLS will use an infrared radiometer to measure levels of trace gases —such as ozone, water vapor, chlorofluorocarbons, and nitrogen compounds — that contribute to the greenhouse effect.

LIS (Lightning Imaging Sensor). Principal Investigator: Hugh Christian, Marshall Space Flight Center, Huntsville, AL. LIS will collect data on lightning distribution and variability across the Earth, contributing an understanding of lightning, convective thunderstorms, and rainfall.

MISR (Multi-Angle Imaging Spectro-Radiometer). Principal Investigator: David J. Diner, Jet Propulsion Laboratory, Pasadena, CA. MISR will obtain global observations of the directional characteristics of reflected light, information needed for studying aerosols, clouds, and the biological and geological characteristics of the land surface.

MODIS-N/-T (Moderate-Resolution Imaging Spectrometer). Team Leader: Vincent V. Salomonson, Goddard Space Flight Center, Greenbelt, MD. MODIS consists of two imaging spectrometers, cne nadir viewing (MODIS-N) and one that can tilt (MODIS-T), for the measurement of biological and physical processes in the study of terrestrial, oceanic, and atmospheric phenomena on a scale of 1 square kilometer.

STIKSCAT (Stick Scatterometer). Principal Investigator: Michael H. Freilich, Jet Propulsion Laboratory, Pasadena, CA. Scatterometers are microwave radars that collect all-weather measurements of surface wind speeds and directions over global oceans. The data will be used to study atmosphere-ocean interactions, model upper-ocean circulation and tropospheric dynamics, and improve global weather predictions.

The following instrument investigations have been conditionally confirmed for flight on the first of the three-satellite EOS-A series (final confirmation, pending resolution of technical issues, is anticipated by early Summer, 1991). Additionally, MIMR has been tentatively selected for flight on the remaining satellites of the EOS-A series:

MIMR (Multifrequency Imaging Microwave Radiometer). Team Leader: TBD. MIMR, to be provided by the European Space Agency, will obtain global observations of a variety of parameters important to the hydrologic cycle: atmospheric water content, rain rate, soil moisture, ice and snow cover, and sea surface temperature.

MOPITT (Measurements of Pollution in the Troposphere). Principal Investigator: James R. Drummond, University of Toronto, Toronto, Canada. MOPITT, to be provided by Canada, is planned to obtain global measurements of carbon monoxide and methane in the troposphere. The distribution of carbon monoxide is a key to the atmosphere's capacity to oxidize pollutants, while methane is the most important greenhouse gas after carbon dioxide.

The following instrument investigation has been confirmed for flight on a satellite of opportunity:

ACRIM (Active Cavity Radiometer Irradiance Monitor). Principal Investigator: Richard C. Willson, Jet Propulsion Laboratory, Pasadena, CA. ACRIM will make long-term measurements of the total solar irradiance, to determine the influence of variations in solar output on climate change.

The following instrument investigation has been confirmed for development and has been tentatively selected for flight on the second and third satellites of the EOS-A series:

HIRIS (High-Resolution Imaging Spectrometer). Team Leader: Alexander F. H. Goetz, University of Colorado, Boulder, CO. HIRIS will use its high-resolution imaging capabilities (30 meters spatial resolution, 10 nm spectral resolution) to study biological and geophysical processes, as well as interactions along borders of different ecosystems.

The following instrument investigations are under consideration for flight on either the EOS-B series of satellites or other flights of opportunity:

Solar Ultraviolet Output

- SOLSTICE (Solar/Stellar Irradiance Intercomparison Experiment). Principal Investigator: Gary J. Rottman, University of Colorado, Boulder, CO.

Stratospheric Chemistry and Dynamics

- HIRDLS (High-Resolution Dynamics Limb Sounder). Principal Investigators: John C. Gille, NCAR, Boulder, CO., and John J. Barnett, Oxford University, Oxford, UK.
- MLS (Microwave Limb Sounder). Principal Investigator: Joe W. Waters, Jet Propulsion Laboratory, Pasadena, CA.
- SAFIRE (Spectroscopy of the Atmosphere Using Far Infrared Emission). Principal Investigator: James M. Russell III, Langley Research Center, Hampton, VA.
- SAGE III (Stratospheric Aerosol and Gas Experiment III). Principal Investigator: M. Patrick McCormick, Langley Research Center, Hampton, VA.
- SWIRLS (Stratospheric Wind Infrared Limb Sounder). Principal Investigator: Daniel J. McCleese, Jet Propulsion Laboratory, Pasadena, CA.

Tropospheric Chemistry

- TES (Tropospheric Emission Spectrometer). Principal Investigator: Reinhard Beer, Jet Propulsion Laboratory, Pasadena, CA.

Atmospheric Sounding

- LAWS (Laser Atmospheric Wind Sounder). Team Leader: Wayman E. Baker, National Meteorological Center, Washington, D.C.

Ocean Circulation

- ALT (Altimeter). Team Leader: Lee-Leung Fu, Jet Propulsion Laboratory, Pasadena, CA.

Ice Sheet Topography and Plate Tectonics

- GLRS (Geoscience Laser Ranging System). Team Leader: Bob E. Schutz, University of Texas, Austin, TX.

Precise Orbit Determination

- GGI (Global-Positioning-System Geoscience Instrument). Principal Investigator: William G. Melbourne, Jet Propulsion Laboratory, Pasadena, CA.

Surface Imaging

- EOS SAR (EOS Synthetic Aperture Radar). Team Leader: Charles Elachi, Jet Propulsion Laboratory, Pasadena, CA. Support for the EOS SAR and its dedicated platform will require funding additional to that approved for the EOS Program.

Particles and Fields

- GOS (Geomagnetic Observing System). Principal Investigator: Robert A. Langel, Goddard Space Flight Center, Greenbelt, MD.
- IPEI (Ionospheric Plasma and Electrodynamics Instrument). Principal Investigator: Roderick A. Heelis, University of Texas, Dallas, TX.
- XIE (X-ray Imaging Experiment). Principal Investigator: George K. Parks, University of Washington, Seattle, WA.

Stan Wilson
EOS Program Scientist

Jeff Dozier
EOS Project Scientist

Panel Reports

Calibration Advisory Panel

At the last meeting of the Calibration Advisory Panel, assignment of responsibilities for calibration and validation was discussed. Information was presented about a calibration and data product validation agreement being developed by the International Coordination Working Group (ICWG). At a summer ICWG meeting, agreement was reached that the instrument provider (the agency developing an instrument) will be responsible for calibration of their instrument. For validation, scientific expertise is required which may exceed the capabilities of the instrument provider.

At that meeting, there were different views on the appropriate role of international scientific research programs. The European Space Agency (ESA) stated its concern on relying on international scientific programs for data validation and proposed dedicated campaigns which may be supplemented by contributions from large international programs. The NASA EOS Program Office's view is that the magnitude of such campaigns is far beyond the capability of platform provider agencies.

There was agreement that if there are similar types of instruments on multiple platforms, an integrated plan must be developed. The resolution was that the platform provider should coordinate validation with the larger research community and must develop an overall calibration and validation plan for the platform mission. The PIs must lead the calibration for each individual instrument since they are the most knowledgeable about the instrument.

Moustafa Chahine, AIRS Science Team Leader, was elected Panel Chairman. The Panel agreed to a Charter, which is provided below.

Bruce Guenther
Associate Project Scientist for Calibration

The Calibration Advisory Panel Charter

The various roles for the Panel include:

1. Advise and concur with the Project on the Project Calibration Plan.
2. Develop the Project Data Validation Strategy.
3. Advise and concur with the Project on the Project Data Validation Plan.
4. Assess progress toward meeting long-term mission goals as identified in the Project Calibration Plan and Project Data Product Validation Strategy.
5. Participate in the Project Calibration Reviews.
6. Support the EOS Investigator Working Group Cal/Val Advisory Panel Chair.

The technical scope of the Panel covers the end-to-end data products of EOS and includes:

1. Instrument calibration and cross-calibration of instrument before launch and in-orbit.
2. Validation of data products using *in situ* measurements and field experiments.
3. Insuring long-term stability of the data products to meet the requirements of EOS disciplinary and interdisciplinary investigations.

EOS Panels Meet Jointly

The Land Biosphere Panel and Biogeochemical Cycle Panel held a joint meeting at last November's IWG meeting to discuss science priorities, overpass time issues, and field experiments.

Science Priorities - Land Biosphere

Goals: Observe and model the surface and atmospheric state variables and forcings which govern the exchanges of radiation, heat, mass, and momentum between the two systems. Monitor natural and anthropogenic changes in global vegetation cover.

Requirements: Satellite data should include global vegetation index data every 5-10 days, global climatological forcing data every 6 hours, and global radiation forcing data every 1-3 hours. Other data requirements are 4-D analyses, surface meteorological observations, trace gas concentrations, and optical depth observations. Additional activities include field experiments/ground surveys, and long-term monitoring sites.

Science Priorities - Biogeochemistry

Goals: Monitor changes in surface and atmospheric state variables over land and oceans that govern element cycling (especially C, N, S and P) within the fluxes between the land and ocean biospheres and the atmosphere. Model the responses of cycling and fluxes to directional forcing and natural variability. Model the response of atmospheric composition to anthropogenic and natural forcing. Monitor the response of biogeochemical cycles to anthropogenic forcing, and similarly model these responses.

Requirements: Satellite data should include global vegetation index data every 5-10 days, ocean color every 1-3 days, global climatological data for forcing at 5-10 days with sample diurnal cycles, atmospheric composition every 1-10 days, high-resolution vegetation composition every 20 days, and phytoplankton pigment composition at any ship of opportunity. Other data requirements include surface meteorological observations, surface atmospheric composition and fluxes, soil type/characteristics, topography, water composition—marine and freshwater, rain/snowfall composition, and plant community composition. Other activities include field experiments and ground/air surveys, long-term monitoring sites, and ship-borne studies.

Overpass Time Issues

The arguments for and against a morning overpass time were presented. Arguments in favor of a 1030 crossing time include a much more favorable viewing condition in the humid regions—the tropics and mid-latitudes—in the growing season (higher probability of low cloudiness in the mornings), lower aerosol burden, and this crossing time would be better for MOPITT/TRACER/TES, which require 20 x 20 km clear pixels. Arguments against the 1030 crossing time were, the loss of thermal data at time of peak surface heating (although the value of such thermal data has yet to be established) and the possible jeopardy of a CERES/imagery combination for afternoons.

The combined panel was overwhelmingly in favor of a move to 1030. The Oceans Panel, when consulted, expressed no preference for 1330 over 1030. The Precision Orbit Panel could see no technical problem with the proposed move.

Field Experiments

The schedule of planned international field experiments addressing biogeochemistry and land surface interactions at large scales was discussed in some detail. A full list will be assembled and circulated to panel members by Schimel/Sellers. Mechanisms for coordinating EOS and non-EOS field activities will be explored.

David Schimel
Biogeochemical Cycle Panel Chair

Piers Sellers
Land Biosphere Panel Chair

The Earth Observer is published by the EOS Project Science Office, Code 900, NASA/Goddard Space Flight Center, Greenbelt, MD 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. Deadline for all submissions is the 20th of each month.

EOS SCIENCE MEETINGS 1991

	Monday	Tuesday	Wednesday	Thursday	Friday	Sat/Sun
FEBRUARY					1	2 3
	4	5 LAWS Science Team Clearwater, Florida	6	7	8	9 10
	11	12 GLRS Team Meeting Greenbelt, Maryland	13	14	15	16 17
	18	19 AIRS Team Meeting	20 Pasadena, California	21 MODIS Science Team Greenbelt,	22 Maryland	23 24
	25 Atmosphere Panel	26 Greenbelt, Maryland	27 EOSDIS Version 0 Workshop, Greenbelt, Maryland	28 SEC Wash., D.C.	1	2 3
MARCH	4	5	6	7	8	9 10
	11	12 EOS SAR Meeting Pasadena, California	13	14	15	16 17
	18	19	20	21	22	23 24
	25	26	27 TES Science Team Denver, Colorado	28	29	30 31

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