FINAL VERSION
May 15, 1989

III

Committee on Earth Observations Satellites
(CEOS)
Third Plenary Meeting

April 4-5, 1989
Ottawa, Canada

INTRODUCTION

The third plenary meeting of CEOS was convened April 4, 1989, chaired by Dr. Edryd Shaw, CCRS. Participants were in attendance from Australia, Canada, ESA, EUMETSAT, FRG, Japan, NASA, NOAA, and the UK. Dr. Shaw reviewed the proposed agenda, which was approved without comment. Dr. Shaw noted that CEOS evolved from a multilateral committee formed first in 1980 to coordinate remote sensing satellite programs.

ACTIONS FROM THE SECOND CEOS PLENARY

Dr. Shaw called on ESA, which hosted the last CEOS plenary. Dr. Pfeiffer reviewed the action items from the last meeting.

2.1: By January 1, 1987, each member will provide a forecast of upcoming meetings to ESA and then update the list on a semi-annual basis. ESA will distribute the information to CEOS members. STATUS: **Closed.** All CEOS participants were sent a list of all the meetings reported to ESA in November. NOAA has updated its contribution and this was distributed.

2.2: NOAA and NASA will provide a written report on past satellite anomalies by 12/31/86. STATUS: **Closed.** Mr. Schneider stated that NOAA did provide a written report in July 1987. This has been updated and a new report was distributed.

2.3: The Consultative Committee on Space Data Systems (CCSDS) should be invited to attend future WGD meetings and CEOS WGD should be represented at relevant meetings of the CCSDS Panel 2. STATUS: **Closed.** This is completed and is covered in the WGD report.

2.4: New CEOS members should provide the Chairman of the Working Group on Data with the name of their agency contact point by December 31, 1986. STATUS: **Closed.**

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OVERVIEW

- Australia and EUMETSAT were made members of CEOS, and the Terms of Reference were modified to permit Observer status for entities with substantial ground segment activity. This ensures that no organizations are disenfranchised by the dissolution of IFEOS.

- The CEOS Working Group on Data (WGD) was made a Standing Group, with a more permanent status than its prior ad hoc designation. The Plenary Terms of Reference were amended, and Terms of Reference for the WGD were approved. The work to date and future directions were strongly endorsed, additional guidance offered, and the importance of the WGD was stressed by the Plenary members.

- The CEOS Working Group on Sensor Calibration and Performance Validation (Cal/Val) was discussed at length. ESA has an action to find a new chairman or to continue its current role. The group was asked to meet more frequently and improve communications; members were asked to designate one or two points of contact at an appropriate level to ensure the right participation and a direct connection between activities in the WG and funding allocation decisions for cal/val activities in their agencies. Emphasis was placed on coordinating with non-space agency programs of potential value in cal/val.

2.5: New CEOS members should provide the Chairman of the Working Group on Sensor Calibration and Performance Validation with their agency point of contact by December 1, 1986. STATUS: **Closed.**

2.6: The CEOS Working Group on Data is requested to study the work of the CCSDS relevant to CEOS members, in particular the work of Panel 2 (Standard Data Interchange Structures) and to report back to CEOS. STATUS: **Closed.**

MEMBERSHIP

Dr. Shaw reviewed the CEOS Terms of Reference regarding membership, and compared them to the IFEOS membership terms. He noted that CEOS does not currently have an Observer status. Dr. Butler recommended that Observer status be added to CEOS. There was discussion of the meaning of Observer. Dr. Duchossois noted that in the discussion of the Working Group on Cal/Val, there was a decision to invite non-space agencies, with participation based on specific contributions. Dr. Butler suggested that having a space segment activity in Phase A/pre-Phase A or a significant ground segment activity that supports CEOS member agency programs is sufficient for CEOS participation. This would permit the European Community (EC) to become an Observer. A new paragraph was agreed to be added to the Terms of Reference.

Dr. Shaw asked for comments on the proposal to reduce the interval between meetings of the CEOS plenary from 24 months to 18 months. Mr. Goldsmith suggested that the Terms of Reference permit the group to meet as frequently as required, which may be more often than 18 months. Dr. Shaw pointed out that the Terms of Reference say "at least" once every 2 years. Dr. Smith indicated that having some time frame for frequency of meetings is appropriate. The Working Group on Data has been meeting on 6-month centers, and Dr. Smith suggested the Plenary might want to hear the progress being made and provide guidance more frequently than every 2 years. It was agreed that the wording in the Terms of Reference was sufficiently flexible to support CEOS requirements.

Mr. Graham, CSIRO, made a formal request for Australian membership in CEOS, based on Australian contributions in the form of the Atmosphere Pressure Sensor, and participation with the UK in the ATSR instrument for ERS-1. In addition, Australian ground segment activities and the substantial Australian scientific interest and participation in cal/val activities provide the basis for full Australian membership. There was consensus and Australia was admitted.

Mr. Morgan requested membership status for EUMETSAT on the basis of geostationary meteorological satellite responsibilities as well as its intention to

contribute hardware and ground segment support for the polar platform era. In addition, Mr. Morgan reviewed the EUMETSAT activities in organizing user symposia. EUMETSAT was formed through an intergovernmental treaty and expects to have an ongoing, long-term presence in space-borne remote sensing activities. There was consensus and EUMETSAT was accepted as a member.

With regard to the EC, Mr. Goldsmith suggested that the EC be formally notified of the disbandment of IFEOS and that they be invited to request Observer status. Dr. Butler requested that New Zealand be similarly informed (ACTION 3.1). Dr. Smith asked that the host for the next meeting be requested to invite New Zealand and the EC to attend and participate in the next meeting (ACTION 3.2).

Dr. Duchossois raised the question of members who do not participate. Mr. Brescia made a statement at the request of Brazil. There have been changes in the Brazilian governmental structure for science and technology, and a new Special Secretary for Science and Technology was being sworn in during the week of the Plenary. This made it impossible for Brazil to attend. It was noted that the CEOS Plenary members from Brazil, Italy, and India had been encouraged to send representatives to the working groups, and Brazil did attend the most recent WGD meeting. Dr. Butler asked that the CEOS chair specifically address the CEOS representatives in those agencies not represented, and encourage their future participation. The letter should stress the importance of their continued involvement (ACTION 3.3).

WORKING GROUP ON DATA

Dr. Shaw chaired the second day of the CEOS Plenary. Mr. Mignogno (NOAA/NESDIS), the chairman of the Working Group on Data (WGD), presented the WGD report (Document C3.1). He summarized the activities of the WGD since the last CEOS Plenary. The report was prepared at the sixth WGD meeting in Washington in March 1989. Mr. Mignogno reviewed the charter of the WGD, which came from the first two CEOS plenary meetings. In response to the need to ensure its continuation, the WGD prepared proposed WGD Terms of Reference, which were distributed in advance to all Plenary members. The Group is building on the experience of past and current missions to provide a rational basis for longer term missions such as the polar platforms. The report covered the major areas of activity: user product formats; catalog systems; lexicon and data dictionary; networks; storage and distribution media; data management strategies; remote sensing training; and relationships to other groups including the Consultative Committee on Space Data Systems (CCSDS).

In the area of user product formats, a CEOS superstructure has been agreed upon as the basis for format generation, and sensor-specific subgroups have

developed or are developing specific implementations based on the superstructure. The WGD has approved standard formats for AVHRR, SAR, and MOS-1 sensors. Document approval and registration procedures are under development under the aegis of the CEOS Librarian function, which in now being fulfilled by NOAA. WGD is working with CCSDS in implementing Standard Formatted Data Unit (SFDU) concepts in data products. Mr. Mignogno described future work directions in this area.

Catalog systems is an area of recent attention. A subgroup has been established and has been involved in the following activities: the development of goals, implementation and evaluation plans for a prototype international directory; the creation of a conceptual model for a catalog system; and the definition of the methods and content for the exchange of information between directories and inventories and between related inventories. The NASA Master Directory (NMD) will serve as the basis for the development of the prototype international directory. Terms of Reference have been developed for this subgroup.

Regarding networks, information is being exchanged and this process will be continued. Storage and distribution media activities have focused on exchange of information about new optical storage technology, particularly CD-ROM and WORM optical disks. Information on benchmark tests and sample user products have been exchanged. In the area of data management strategies, WGD members have kept the group informed about their agency archival plans so that informed decisions can be made by all participants. The WGD explored possible initiatives in the area of remote sensing training, but it was decided that more efficient methods exist to disseminate such information than using a group that meets twice a year. It was agreed, however, that members would continue to summarize information on remote sensing training activities in their country/agency reports to the group.

Mr. Mignogno reviewed WGD coordination with other international groups. WGD has coordinated its work with the CEOS Cal/Val Working Group, particularly in the area of SAR. In fact, the SAR format subgroup and the SAR cal/val subgroup recently held back-to-back meetings at JPL. CCSDS and WGD are continuing close cooperation. A project is currently underway in joint development of a sample CD-ROM with the CEOS superstructure and using SFDU concepts.

Moving to longer term issues, the WGD reiterated its desire to provide a foundation for the polar platform era in the data-related areas described above. Mr. Mignogno noted that all the Space Station partners are members of the WGD, and presentations have been made on polar platform activities. In the future, WGD will welcome proposals from ICWG, and will respond to polar platform data system requirements by providing relevant inputs.

Mr. Mignogno presented the WGD recommendations to the Plenary (Document C3.1). Mr. Tanaka asked about the AIAA Committee on Standards. Ms. Shaffer explained that the AIAA committee does not overlap or duplicate the work of the CEOS WGD. Mr. Marelli expressed some concern about diluting the work of the WGD through too much integration with other organizations with different objectives. He suggested that polar platform data system coordination will be a substantial challenge, and suggested that this should be an area of primary importance for the future WGD activities. He stressed the importance of random access media and networks as areas for work in the future as well. He cautioned against devoting too much attention in WGD to more advanced technology concepts such as artificial intelligence and on-board processing, even though these are areas of great interest.

Dr. Shaw noted that the coordination with CCSDS was undertaken at the specific request of the last CEOS Plenary. AIAA is being handled through distribution of information by WGD to them, and nothing more is required there.

Dr. Langner asked about the relation between International Space Year (ISY) and CEOS WGD. Mr. Mignogno mentioned that at the first Space Agency Forum for ISY (SAFISY) meeting, the WGD was mentioned specifically. Common format efforts will be relevant in the Global Information Systems Test (GIST), for example. Mr. Marelli added that one of ISY's objectives is to increase public awareness of Earth observations and that standardization of data approaches in areas such as catalogs and data formats is important in easing user access.

Dr. Thomas noted that the UK finds the work of the WGD very helpful and has benefitted from it. However, resource limitations exist that cause problems in supporting all the subgroup activities. Mr. Mignogno explained that the Catalog subgroup has held its meetings back-to-back with the WGD meetings. It was noted, however, that the subgroups are most effective when the proper participants are in attendance. This suggests that several individuals from each agency or country might well be involved at the subgroup level, although the working group plenary delegations should be led by someone with more general authority.

Mr. Marelli described the difficulty in imposing standards across different contractors within a single program (e.g., ERS-1), and noted the likelihood of increasing difficulty when moving to larger and more complex missions. He emphasized the importance of providing support at the management level for active participation in the development of common approaches through the WGD as a significant opportunity for long-term savings and efficiencies. Dr. Tilford seconded Mr. Marelli's statement, noting that every hour spent now working on commonality is likely to save many times more hours in the future.

Dr. Shaw asked the plenary members to respond point-by-point to the WGD recommendations.

1. Endorse the WGD progress to date and approve future work, recognizing the necessity of resource commitments.

The Plenary expressed great satisfaction with the substantial progress to date and provided the following additional guidance for future activities:

- o Avoid undue attention to emerging technology (e.g., artificial intelligence, on-board processing, etc.)
- o Focus on polar platform
- o Continue to emphasize networking and random access media in the context of polar platform.

Dr. Butler asked if the WGD could meet jointly with the newly created Eos Investigator Working Group Data Panel at the earliest opportunity. Dr. Tilford expressed his hope that when ESA establishes some comparable forum for EPOP investigators, that it would work closely with the WGD as well as with the NASA and Japanese counterparts.

2. Modify CEOS Terms of Reference and approve proposed WGD Terms of Reference to make the WGD a standing group.

NOAA presented proposed language to be added to the "Organization and Procedures" section of the Terms of Reference. Dr. Shaw expressed Canadian support for the proposal. There was consensus on making this addition. The Plenary then addressed the proposed WGD Terms of Reference. These were also accepted without modification.

Dr. Tilford suggested modifying recommendation #6, to read "Continue efforts to consolidate Earth observation data management cooperative efforts in the CEOS WGD."

Dr. Readings asked for clarification of the role of CCSDS. Ms. Howard explained the role of CCSDS and noted the attached report on CEOS-CCSDS cooperation.

With these modifications, the recommendations were accepted.

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WORKING GROUP ON SENSOR CALIBRATION AND GEOPHYSICAL VALIDATION

Dr. Duchossois reported on the work of the CEOS Cal/Val Working Group (Document C3.2). He reviewed the purposes and objectives of the cal/val group, and the approach and results achieved. At the Frascati Plenary, it was recognized that sensor calibration and performance validation activities are an integral part of any remote sensing mission. Such activities are complex and costly, and this enhances the potential benefits of international cooperation/coordination through optimization of use of resources and exchange of data.

The third WGC/V meeting was held in ESTEC in July 1988, and had approximately 40 participants. The agenda focused on engineering calibration of optical and microwave sensors, and geophysical validation of data from short-term missions. Preliminary discussions took place on polar platform system cal/val issues. Dr. Duchossois noted that the majority of participants in this meeting were active microwave experts.

Summarizing activities to date, Dr. Duchossois reported that extensive exchange of information was accomplished on cal/val activities. For example, NASA, NOAA, and CNES conducted a joint project using a calibration sphere for optical sensors. The final report was just distributed. Another example is the NASA SIR-C calibration workshop. Cal/Val WG members were invited to provide comments on the recommendations. JPL provided detailed information on the SAR calibration system approach. This provided a basis for CEOS cal/val collaboration related to SAR. The Workshop report emphasized the need for international cooperation, particularly regarding test sites. SAR experts have met several times in conjunction with other meetings to continue cooperation.

Another area of progress was identification of opportunities for improved efficiency or effectiveness through international coordination. One example is the development of common SAR transponder specifications. Seven international organizations have agreed to deploy transponders in compliance with these specifications. This work was accomplished through exchange of correspondence. Airborne campaign planning was facilitated, including a NASA agreement in principle to deploy the NASA ROWS instrument in 1990-91. Additional campaigns are being considered and planned to support multiple missions and provide a common basis for intercalibration. NOAA agreed to make modifications to certain moored buoys to increase the utility of resulting data in support for ERS-1 cal/val requirements.

Definition of performance parameters to be measured is an area of attention, initially regarding SAR instruments. Development of a common definition of terms is an

important element of this, in coordination with the WGD. An inventory was made of instrumented/tended test sites of interest to optical and other sensors.

At the third WG meeting, reconstituted focused subgroups were created in place of the earlier subgroups. These focus on SAR calibration and thermal infrared sensor cal/val. The objective is to facilitate detailed examination of issues and development of coordinated plans. Additional ad hoc technical meetings have been planned to address wind-wave validation, the SAR-scatterometer airborne campaign, and ground data collection. The SAR subgroup is the only one that has been active to date. The wind-wave group has not met regularly, but has taken advantage of other meetings to gather informally. The thermal-IR group has not been active.

Discussions were initiated on polar platform cal/val. In this area, there are three generic sensor types: reflights or modifications of previously flown instruments for which cal/val approaches exist; new sensors that exist currently as laboratory or airborne instrumentation for which cal/val work has begun but is not mature; and new/very advanced concepts for which cal/val approaches have yet to be developed. Discussion at the 1988 cal/val WG meeting included consideration of advantages and disadvantages of cal/val for polar platforms. As a result of the discussions, members were invited to provide comments. The WGC/V generated recommendations for actions related to development of additional airborne facilities, supersites and sites of opportunity, stressing the importance of maintaining archives and documentation, definition of "standards," implementation of airborne campaigns, etc.

The group considered funding commitments, which are substantial for cal/val activities. The WG members were asked to explore within their agencies how best to ensure that adequate funding and reliable commitments are made to support important cal/val activities. There was also recognition of the need for improved communication and effectiveness in the group. The participation needs to be more consistent for each agency.

Dr. Duchossois reported on the first meeting of the SAR calibration subgroup which was chartered at the last WGC/V, and met in January 1989 at JPL.

In conclusion, Dr. Duchossois recommended reorganizing the working group, with more frequent meetings, focused meetings of the specific subgroups, and special ad hoc meetings. Each agency should appoint a maximum of two points of contact and select appropriate attendees. The efficiency of action monitoring and circulation of information should be improved. The group recommends that the test site survey be continued and expanded. A task force is recommended in order to investigate reference calibration sources. Action is required on the subject of atmospheric models for correction of sensor data. Instrument modeling also requires further joint action.

The group intends to dedicate part of future sessions to definition of appropriate terminology, in coordination with the WGD. Polar platform cal/val requirements should be an area of focus for future work. Finally, a better mechanism is required in order to ensure adequate endorsement and implementation of actions.

Dr. Duchossois noted that the success of the WG has been varied, based on different sensor types. SAR is very active, thermal/IR is very quiet. He indicated that with the advent of the ERS-1 launch, it may be appropriate for a new chairman to assume the leadership of the group, and he suggested that perhaps some new definition of the scope of the group is required.

Dr. Shaw suggested that the planning be separated from the implementation, as a way of getting a better handle on the workload and ensuring that practical results are realized. Dr. Butler thanked Dr. Duchossois for carrying the heavy burden of cal/val promotion during the last few years, and endorsed the work to date and future plans. He noted that as a community, there does not yet seem to be a readiness to undertake the responsibilities required to carry out the necessary cal/val programs to support flight plans and scientific requirements. He raised the question of how to ensure that "meat" is put on the "bones" that have been laid out by the cal/val group to date. He asked how to ensure a common understanding of what the cal/val standards should be to meet user needs. CEOS is contributing to the definition and articulation of what this standard should be.

Mr. Koffler reiterated the importance of cal/val, and commended ESA on its leadership in this area. He particularly noted the great success in SAR coordination to date. NOAA has very active data collection efforts (airborne, shipboard, etc.), but has yet to be able to integrate them into a program that supports satellite cal/val requirements for the international Earth observations community.

Mr. Morgan noted the magnitude of the problem and the proliferation of focused subgroups that have been created. He stressed the need to minimize the bureaucracy associated with all the subgroups, and asked that emphasis be placed on coordination and perhaps conduct of workshops on a one-time basis rather than proliferating subgroups. This could encourage participation by scientific organizations and universities supplementing the expertise of the CEOS community.

Mr. Tanaka expressed Japan's satisfaction with the progress to date, particularly regarding SAR. He said that in Japan, recognition of the importance of cal/val and the availability of funding to support it has increased recently. For (J)ERS-1, planning is underway regarding cal/val in advance of launch. Japan will look to the CEOS Cal/Val Working Group for guidance in this area, particularly for SAR.

Dr. Croom reiterated the sheer enormity of the cal/val task, which to date has focused on the land surface and has not even begun to address the atmosphere, which has a complex set of cal/val aspects itself. Dr. Shaw stressed that each mission operator is ultimately responsible for calibrating and validating its own sensors, but that CEOS objective is to optimize these efforts to the benefit of the member community.

Mr. Marelli noted the frustration of attempting to coordinate plans that have not been finalized within the individual agencies responsible for each mission. He suggested that as missions move closer to launch and agency plans become firmer, greater coordination will become more practical and achievable. This is the time to move from very general topics onto more specific and realistic efforts. He noted that the same experience was true for WGD. We have reached the important stage of having broader recognition of the importance of cal/val work.

Dr. Parashar expressed Canada's appreciation of the WGC/V efforts. He noted that the lack of continuity in WG participants has been a significant obstacle to greater progress and stressed the importance of continuity to the plenary members. Should there be an attempt to define a "CEOS calibration plan standard?" Dr. Readings stated that the environment is getting more complex, not simpler. He suggested that a forum approach might be more appropriate than establishing lots of subgroups. The emphasis should be on exchange of information, which is a necessary foundation for identifying opportunities for cooperation. The WGC/V is not the appropriate forum for implementation.

Dr. Duchossois noted that the interest in CEOS is in part a function of the number of other missions planning to fly similar sensors. In addition, each agency has a different approach to assigning the responsibility for cal/val between instrument PIs, agency staff, etc.

Dr. Shaw returned to the specific recommendations. Mr. Koffler noted the pivotal role of the WGC/V in establishing the SAR subgroup, but noted that there is not necessarily a continuing level of effort at the WG level. He also raised the question of how coordination takes place between non-space-agency field campaigns with CEOS member activities to maximize the utility of the resulting data for cal/val. Certain standards and procedures need to be defined for in-situ data to ensure that they fit well into space agency cal/val objectives. He suggested that the WGC/V could provide this service of getting the relationship started and "catalyzed." The WG would be actively involved in starting focused activities, then revert to only an oversight role. Dr. Shaw summarized the guidance as "let go at some point" of the SAR subgroup; get the thermal/IR subgroup and the wind/wave special meeting started.

Dr. Shaw asked for response to the request to designate points of contact and ensure regular consistent representation. Mr. Marelli pointed out that cal/val expertise tends to be very specialized and cannot be adequately handled by two individuals. Dr. Butler noted that for NASA, two points of contact have been identified. Their role is not to be the experts in all technical areas, but to ensure that the appropriate specialist is aware of the specific activities in his/her area of specialty.

Mr. Marelli reasserted the question of where the WGC/V should stop. Should it undertake implementation or just exchange of information and development of standards for implementation? Dr. Duchossois agreed that perhaps the WG has been overly ambitious. It was agreed to develop a modified charter for the WG defining a less ambitious approach.

Mr. Goldsmith agreed that the WGC/V points of contact should not be focused specialists, but people with the ability to ensure the proper coordination with users. He suggested the problem has been a mixed approach of being both a group of experts and a forum for exchange of information. The representatives must be linked to the decisionmaking in their agencies for allocation of resources. If the participants are not sufficiently empowered, the WG will be just a technical forum. The charter of the group should be modified to ensure that members are sufficiently influential to facilitate the conduct of WGC/V objectives.

Dr. Duchossois emphasized the importance of coordination between the WGD and the WGC/V. As focused subgroups are created in cal/val, they should coordinate with the related WGD subgroups. Dr. Butler stressed the importance of information exchange and particularly the survey of available and existing assets in support of cal/val. The survey of reference sources is another important area to define or endorse standards for use by the community. Dr. Readings suggested that any survey efforts must be within specifically defined sensor groups. Dr. Butler suggested a broader effort to compile an overall inventory that may be of interest to the known universe of Earth observations sensors planned for flight in the next decade. Dr. Readings said that until instrument calibration requirements are known, resources cannot be determined.

Dr. Shaw summarized by saying that the first three recommendations are endorsed, the fourth is modified, the polar platform recommendations listed as 9 and 10 endorsed, and the rest too detailed to require plenary consideration. Mr. Marelli raised the issue that in addition to sensor-specific cal/val activities, there are other needs related to in-situ data collection and analysis, which are not always sensor-unique. The former require engineering expertise of space agencies, while the latter involves a much broader community that is more scientifically oriented. Dr. Croom refined this approach to identify the following three levels: sensor-unique calibration,

sensor-class intercalibration, and broader geophysical validation defined by specific parameters observed.

Dr. Shaw asked that ESA assume the responsibility for transferring the chairmanship to another CEOS member or continuing its leadership (ACTION ITEM 3.4).

Dr. Readings proposed changing the overall objectives to read:

"To promote cal/val activities in support of space missions and foster the exchange of information on program status and means related to calibration/validation

To identify areas of deficiency and to encourage the formation of specific groups for those areas with the specific aims of:...."

This wording was acceptable to the group. The revised charter for the WGC/V is attached and is available as Document C3.3.

OTHER BUSINESS/NEXT MEETING

The chairman asked if there were any new items of business. New CEOS members were asked to identify their points of contact for the two working groups. All members were asked to identify no more than two points of contact for the Working Group on Cal/Val
(ACTIONS 3.5 and 3.6).

Mr. Brescia reported that the Scientific and technical Sub-Committee of the United Nations Committee on Peaceful Uses of Outer Space (COPUOS) met on February 20-March 3, 1989 in New York and considered a role for the U.N. in International Space Year (ISY). During the session the US formally tabled a working paper that proposes a substantive scientific and technical role for the United Nations in ISY. The working paper, along with a brief abstract and relevant portion of the Sub-Committee's final report, was distributed (Document C3.4).

The US proposal is aimed at combining the training and educational capabilities of the Space Applications Programme with the resources available through the United Nations Environmental Programme Global Resources Information Database (GRID). The proposed UN activities would be separate from, but complementary to, activities being planned in the Space Agency Forum on International Space Year (SAFISY).

The US welcomed the views of CEOS members on the proposal and hopes that other governments, through their Foreign Ministries, will come forward with complementary activities to enhance the proposed UN role. Such contributions could be in the form of additional training courses, workshops, or seminars, or could include participation in one of the US activities, such as sponsoring an additional specialized workshop in conjunction with the US-proposed UN conference.

NASA will be contacting CEOS members to coordinate views and interest prior to the meeting of the UN Committee on Peaceful Uses of Outer Space in June 1989.

Dr. Shaw addressed the date and place of the next meeting. Mr. Brescia reported that Brazil has expressed interest in hosting the next CEOS Plenary, but could not make a firm commitment prior to full coordination and concurrence from the very recently appointed Secretary. INPE has offered to confirm its ability to host the next Plenary by correspondence in the near future. If Brazil is unable to serve as host, the UK has offered to host the meeting. The date is tentatively scheduled for November 1990.

Dr. Tilford noted that he was asked to convey CNES' regrets at not being able to attend this meeting. Dr. Revah reported to NASA that CNES was unable to attend due to unanticipated scheduling problems for himself and Mme. Chevrel.

Dr. Shaw adjourned the meeting, with thanks to the participants for a productive session. Mr. Koffler thanked Canada for its hospitality on behalf of the group.

NOTE: Since the Plenary adjourned, INPE has confirmed its offer to host the next CEOS Plenary.

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CEOS Third Plenary Meeting
Action Items

3.1 Canada, as host, to notify the European Community and New Zealand formally of the disbandment of IFEOS and inviting them to request Observer status.

3.2 The host for the next meeting to invite New Zealand and the EC to attend and participate in the next meeting.

3.3 Canada, as host, to specifically address the CEOS representatives in those agencies not represented, and encourage their future participation. The letter should stress the importance of their continued involvement.

3.4 ESA to assume the responsibility for transferring the chairmanship of the CEOS WG on Cal/Val to another CEOS member or continuing its leadership. This should be done on a time scale to permit the next WG meeting to take place before the end of 1989.

3.5 New CEOS members (Australia and EUMETSAT) to identify their points of contact for the two working groups and to send the names and addresses to NOAA/Mike Mignogno for WGD and ESA/Guy Duchossois for the WGC/V.

3.6 All members to identify no more than two points of contact for the Cal/Val Working Group and provide those names and addresses to ESA/Guy Duchossois by May 15, 1989.

CEOS Plenary Session
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Dcouments Distributed

C3.1 CEOS WGD Report (Mr. Mignogno)

C3.2 CEOS WGCal/Val Report (Dr. Duchossois)

C3.3 Revised charter for WGCal/Val (Drs. Readings & Duchossois)

C3.4 ISY Handout (Mr. Brescia)

TERMS OF REFERENCE

OF THE

COMMITTEE ON EARTH OBSERVATIONS SATELLITES

Adopted September 25, 1984
Washington, D.C.

Amended November 11, 1986
Frascati, Italy

Amended April 5, 1989
Ottawa, Canada

TERMS OF REFERENCE

OF THE

COMMITTEE ON EARTH OBSERVATIONS SATELLITES

PREAMBLE

Remote sensing from space has evolved from an early period of limited applications satellite programs to a point where distinctions among existing missions result from the technology employed, rather than from the disciplines served in system operations. In the future, a number of international, national, and regional space-borne earth observations systems will operate simultaneously, and support both interdisciplinary and international applications.

The organization of international cooperation in space-borne earth observations systems also is evolving, from mission-specific reviews to the interdisciplinary coordination of multi-mission programs. Beginning with the first Multilateral Meeting on Remote Sensing - held in Ottawa on May 8-9, 1980, and attended by agency representatives from Canada, the European Space Agency, France, India, Japan, and the United States of America - current and potential operators of earth observations systems have met several times to discuss the means by which mutually beneficial cooperation and coordination could be achieved in both the near and longer term. As a result of these gatherings, the recent past has seen the creation of the Coordination on Land Observation Satellites (CLOS) by agency representatives from France, Japan, and the United States of America in Paris on November 13-14, 1980; the initiation of the Coordination on Ocean Remote Sensing Satellites (CORSS) in Paris on May 10-11, 1982, through the efforts of agency representatives from the European Space Agency and Japan; and the second Multilateral Meeting on Remote Sensing, held in Paris on May 12-13, 1982, and attended by agency representatives from France, Canada, the European Space Agency, India, Japan, and the United States of America.

This framework of initial discussion and cooperation has enhanced the utility of space-borne earth observations data to users worldwide, has encouraged the coordination of program plans among space-borne earth observations system operators, and has fostered international receptivity to and acceptance of space-borne earth observations system activities and applications.

Consequently, the assembled representatives of international, national, and regional space-borne earth observations systems:

AWARE of the overlap of space-borne earth observation mission objectives and of the interdisciplinary applications of remotely sensed data;

RECOGNIZING the advantages of ongoing communication and cooperation among space-borne earth observations system operators; and

DESIRING to promote the international growth and potential benefits of space-borne observations of the earth;

have affirmed the value of the activities described above, and have agreed to coordinate informally their current and planned systems for earth observations from space through the organization of a Committee on Earth Observations Satellites (CEOS).

The CEOS will not supersede current or potential agreements by members. Participation in the activities of the CEOS will not be construed as being binding upon space-borne earth observations system operators, or as restricting their right to develop and manage earth observations systems according to their needs.

MEMBERSHIP

International, national, or regional organizations responsible for a space-borne earth observations program currently operating, or at least in Phase-B or equivalent of system development, will be eligible for membership in the CEOS. Members must have a continuing activity in space-borne earth observations, intended to operate and provide data for some years. Initial members of CEOS are Canada Centre for Remote Sensing, Centre National d'Etudes Spatiales (France), European Space Agency, Indian Space Research Organization, Instituto de Pesquisas Espaciais (Brazil), Japan, U.S. National Aeronautics and Space Administration, and U.S. National Oceanic and Atmospheric Administration. The British National Space Centre (BNSC), Italy, and the Federal Republic of Germany (FRG) were admitted as members at the second meeting of CEOS, 10-12 November, 1986. Australia and EUMETSAT were admitted as members at the third meeting of CEOS 4-5 April 1989. The addition of further members will be with the consensus of current members of the CEOS.

International, national, or regional organizations currently having a space segment activity in Phase-A/pre-Phase-A or equivalent of system development, or a significant ground segment activity which supports CEOS member agency programs, may request the status of Observer in the CEOS. Addition of Observers will be by consensus of existing members. Observers may participate fully in CEOS discussions and have their views included in reports; however, approval by observers will not be required to establish consensus.

OBJECTIVES

The CEOS will seek to enhance the benefits of space-borne earth observations for members and the international user community.

The CEOS will serve as a forum for the exchange of technical information to encourage complementarity and compatibility among space-borne earth observations systems that are currently in service or development. Improved complementarity and compatibility will be sought through cooperation in mission planning and the development of compatible data products, services, and applications.

COOPERATIVE ACTIVITIES

Cooperation in the development and management of remote sensing programs can be of benefit to operators of space-borne earth observations systems and to users of earth observations data. Redundancy among systems and the utility of data can be optimized through the appropriate coordination of complementary and compatible space and ground segments, data management practices and products, and earth observations systems research and development.

CEOS members will exchange technical information on and pursue the potential for coordination of space and ground segments. Such coordination could include discussions on current and future mission parameters, sensor capabilities and intercalibration, and data and telemetry downlink characteristics. In addition, earth observations systems coordination within CEOS could address issues of ground station technical compatibility for back-up satellite tracking, command and control, and sensor and telemetry data reception.

CEOS members will investigate the means for increasing data utility and cost-effectiveness, for both operators and users. CEOS activity could include the coordination of data acquisition, sampling, and pre-processing methodologies; the standardization of data formats where appropriate; the increase in compatibility of data archives; and the enhancement of user access to CEOS member data bases, information products, and applications services. CEOS members will seek to assure that the user community is made aware of the satellite programs of members and encourage discussions between the users and the relevant satellite system operators, as necessary.

CEOS members will present their plans for emerging satellite remote sensing technologies and programs, and will discuss appropriate approaches for the coordination of future systems. CEOS members could address current developments and future directions and opportunities in earth observation from space, including free-flying spacecraft, mission-specific instruments flown on space transportation systems, and the placement of instruments on space platforms.

ORGANIZATION AND PROCEDURES

CEOS will convene at least once every two years in plenary session. The CEOS meeting will be organized and chaired by the host organization. The host organization will provide and distribute minutes of the meeting, and will report on any follow-on activities at the next regular meeting. At each meeting of the CEOS, the time, place, and host for the next meeting will be established.

CEOS also may establish, as mutually agreed, and on an ad hoc basis, special temporary Working Groups to investigate specific areas of interest, cooperation, and coordination and to report at subsequent plenary meetings. Continuation of each ad hoc Working Group requires confirmation at each plenary session. Conclusions

resulting from CEOS plenary sessions, or the findings and recommendations of ad hoc CEOS Working Groups, will be acted upon at the discretion of each CEOS member.

CEOS may establish, as mutually agreed, standing Working Groups where an ad hoc status is deemed insufficient. More permanent status may be required to ensure long-term continuity of work in certain areas where the magnitude and complexity of the task is not suitable to short-term solutions. These standing Working Groups shall continue without requiring specific confirmation by the plenary. The chairman of each such group shall report at each CEOS plenary session on the group's accomplishments and future plans. If the consensus of the plenary is that such a group is no longer required, the plenary may discontinue the group. In the absence of such a decision, however, the standing Working Group shall continue. Representatives from all CEOS members are invited to participate in all Working Groups.

CEOS will replace the Multilateral Meeting on Remote Sensing, the CLOS, and the CORSS. During the development of and action on CEOS activities, the member agencies of CEOS will follow the example of the successful international technical and programmatic cooperation achieved by the Coordination on Geostationary Meteorological Satellites. CEOS members also will consider the issues, concepts, and conclusions arrived at in previous gatherings of the Multilateral Meeting on Remote Sensing, CLOS, and CORSS, and will address current and future activities of space-borne earth observing systems.

CEOS encourages its members to maintain communication as appropriate with other groups and organizations involved in space-borne earth observations activities and applications through the relevant channels within their respective governments. Such groups and organizations include, but are not limited to, the Coordination on Geostationary Meteorological Satellites; the International Polar-Orbiting Meteorological Satellite Group; the Landsat Ground Station Operations Working Group; the Groupement des Operateurs des Stations SPOT; the World Meteorological Organization; the International Forum for Earth Observation using Space Station Elements; the United Nations Committee on the Peaceful Uses of Outer Space; the International Council of Scientific Unions; the Economic Summit of Industrialized Nations; and national, regional, and international remote sensing satellite data archiving, applications, and user organizations.

ADOPTION AND AMENDMENT

These Terms of Reference were adopted at the September 24-25, 1984 meeting of CEOS and were amended by consensus at the second meeting of CEOS, held in ESRIN, Frascati 10-12 November, 1986. Additional amendments were made at the third meeting of CEOS in Ottawa, Canada, 4-5 April, 1989. They may be further amended by consensus of the members.

TERMS OF REFERENCE

CEOS Working Group on Data

Membership

Membership in the CEOS WGD is open to all members of CEOS as defined in the CEOS Terms of Reference. Members may include in their delegations to WGD meetings any participants who have relevant expertise to contribute to the objectives of the WGD.

Objectives

The objective of the WGD is to enhance coordination, complementarity, and standardization of space-borne Earth observations data management for the benefit of the members and the international user community. This will be done through work initially in the following areas, with other topics to be added as may be agreed by the WGD:

User Product Formats

Catalog Systems

Common Lexicon and Data Dictionary

Networks

Storage and Distribution Media

Data Management Strategies

Among the specific goals of the WGD are development, implementation, and maintenance of recommendations for:

common formats for user products generated by different organizations using data from a single sensor;

common formats for user products generated from sensors of the same type operated by different entities;

facilitating location and utilization of Earth observations data held by CEOS members and other entities.

Procedures

The WGD shall meet approximately every six months, rotating venue among members. The chairman and secretariat for the WGD, designated by the plenary, shall prepare and distribute minutes for each meeting. At each meeting of the WGD the time, place, and host for the next meeting shall be established.

CEOS WGD shall coordinate its work with other international groups involved in related activities as described in the CEOS Terms of Reference. In particular, at the direction of the second CEOS plenary, the WGD shall work closely with the Consultative Committee on Space Data Systems (CCSDS).

Each member shall designate a point of contact for WGD correspondence.

The WGD may propose modifications to these Terms of Reference and such modifications will be submitted to the plenary for approval at the next plenary meeting.

Subgroups may be established to perform detailed technical work in specific areas. Subgroups shall be established by the consensus of the WGD. The WGD shall develop Terms of Reference for each subgroup. The chairman of each subgroup shall report at each WGD meeting on the group's progress and plans.

The WGD Library shall serve as the repository for documents and other material, such as implementation tools as may be agreed by the WGD.

The WGD shall develop a common lexicon and data dictionary.

The WGD shall develop additional procedures as may be required.

CEOS WGD SUBGROUPS FOR THE STANDARDIZATION OF USER PRODUCT FORMATS

TERMS OF REFERENCE

The ultimate goal is to minimize the effort required to generate and read data products which are supplied by different agencies from the same sensor, or from similar sensors on board different satellites.

In order to achieve the above, the Subgroup is tasked to:

1. Review formats used or planned by individual agencies;
2. Propose a sensor group format in conformance with CEOS recommendations;
3. Contribute to the WGD common Lexicon and Data Dictionary;
4. Invite experts to contribute to the subgroup work;
5. Generate a CEOS format document(s), for CEOS WGD recommendation;
6. Provide the CEOS Librarian with the relevant documentation, and any subsequent updates thereof;
7. Whenever feasible, provide the CEOS Librarian with associated tools for implementation of the recommendations;
8. Promote implementation of the CEOS format(s) and ensure that the necessary information is made available to the interested individuals/groups;
9. Examine implementations of that format(s) pursued by member agencies, be the forum for resolving technical issues, and update the documentation and recommendations accordingly;
10. Report to the CEOS WGD via the chairman of the subgroup.
11. Provide minutes of subgroup meetings to WGD points of contact.

Adopted at WGD-6
March 15, 1989

Committee on Earth Observations Satellites
Working Group on Data
Catalog Subgroup

Terms of Reference

The objective of the Committee on Earth Observations Satellites (CEOS) Working Group on Data (WGD) Catalog Subgroup (CS) is to develop and promote an approach for achieving an interoperable, international catalog system. A catalog system is a system by which a user can determine what data of interest exist, how they can be obtained, and acquire other information supporting the utilization of the data.

Specific issues to be considered by the CS include:

- Master Directory
- Inventory
- Connectivity between directory and inventory modules
- Guide (Catalog)
- Models
- Browse (added at WGD 7)

Recommendations developed by the CS will be passed on to the full WGD for concurrence. The CS expects to receive direct, semiannual guidance from the WGD on the scope and nature of the Catalog issues that it is to consider during each six month interval.

Membership to the CS is primarily limited to the member agencies of the WGD. Each agency is encouraged to select a primary point-of-contact having the following qualifications:

- be able to regularly attend CS meetings

- possesses technical expertise in directory, catalog, and inventory issues

- demonstrates cognizance of the importance of end-user requirements in all phases of development and implementation of catalog systems

The CS will meet at least every six months, preferably within a month before scheduled WGD meetings in order to facilitate the timely transfer of recommendations to the WGD for concurrence.

Adopted March 15, 1989

JOINT PLENARY MEETINGS
INTERNATIONAL FORUM ON EARTH OBSERVATIONS UTILIZING SPACE STATION ELEMENTS (IFEOS)
AND
COMMITTEE ON EARTH OBSERVATIONS SATELLITES (CEOS)

April 3-5, 1989
Ottawa, Canada

INTRODUCTION

A joint plenary session of the third meeting of the International Forum on Earth Observations Utilizing Space Station Elements (IFEOS) and the Committee on Earth Observations Satellites (CEOS) was held in Ottawa, Canada, hosted by the Canadian Space Agency (CSA), April 3-5, 1989. Participants were in attendance from Australia, Canada, ESA, EUMETSAT, FRG, Japan, NASA, NOAA, and the UK.

Mr. Mac Evans, Vice President (Operations), CSA, welcomed the participants. He noted that this is the first official meeting held under the auspices of the Canadian Space Agency. CSA will be responsible for major space activities in remote sensing, such as Radarsat. The Canada Centre for Remote Sensing (CCRS) continues its activities in data reception, processing, and applications, including the Radar Data Development Project, and Atmospheric Environment Service (AES) will continue its environmental observations activities. He reviewed the objectives of both IFEOS and CEOS. He noted the importance of international cooperation and the high priority Canada places on remote sensing and Earth observations.

Mr. Evans reviewed the proposed agenda which was approved without change. He then introduced the country/agency presentations.

ESA

Dr. Pfeiffer presented an overview of the ESA program (Document 1). He noted that ESA's Earth observations strategy was presented to the ESA Council, which confirmed the approach, but did not reach a final decision on future polar orbiting Earth observations missions. The ESA presentation reviewed objectives and strategies for the Earth observations program, described the proposed polar platform scenarios, addressed the rationale for two parallel series of platforms, and described the proposed instrument types for the polar platform missions and the instrument packages. Dr. Pfeiffer then presented the status of ESA polar platform development and addressed the payload accommodation study options.

The ESA strategy addresses monitoring the Earth's environment on various scales from local to regional to global; managing and monitoring the Earth's resources; contining worldwide operational meteorological service; and contributing to understanding the structure and dynamics of the Earth's crust. The relevant satellites for these objectives are a successor to ERS-1, the second generation Meteosat, ARISTOTELES, and the polar platforms. Continuity of ERS-1 observations through an

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ERS-2 is a high priority for ESA, although there is discussion of some slight modifications to the ERS-1 instruments. A final decision has not yet been made. Second generation Meteosat is being planned in conjunction with EUMETSAT to extend the capabilities and provide continuity beyond the present for the Meteosat Operational Program (MOP). The first MOP satellite was recently launched successfully. ARISTOTELES, a dedicated solid Earth mission, is currently in extended system Phase A study. The polar platform missions are the longer term program focus. The first platform and launch will be provided by the Columbus programme, with the instrumentation and operations provided by the Earth Observations Directorate. Dr. Pfeiffer reviewed the contribution of each satellite mission to the scientific/programmatic objectives.

The original polar platform scenarios (parallel and interlaced) were described. In the parallel series, the A series primarily addresses ocean/ice/meteorological/operational concerns; the B series primarily addresses land/chemistry. In the interlaced scenario, the operational instrument package goes on both A and B series to achieve continuity. The interlaced scenario is disadvantageous financially, based on current analyses. The parallel scenario is currently the preferred approach within ESA. This is because the mission objectives can be better met with more focused payloads on each of the platform series to provide better optimization of payload grouping and data synergy. In addition, the orbital configuration can be better optimized in terms of altitude, repeat cycle, crossing time, etc. The payload instruments can be better optimized in design, and operational aspects are eased because each platform is less complex, and scheduling and mission planning are easier. In terms of engineering, easier payload accommodation, lower integration complexity, and easier on-board data management are all advantages of the parallel scenario. This leads to lower costs and somewhat lower risk.

The payload for the first platform (A1) includes the operational meteorological package, core facility instruments, and Announcement of Opportunity (AO) instruments. The operational meteorological package includes AMRIR, AMSU, Direct Broadcast, Argos, ERBI, and Search and Rescue. Core facility instrument candidates are wind scatterometer, radar altimeter, MERIS, MIMR, SAR, ATLID, LISA, and ALADIN. Final decisions will be made after Phase A study. B1 candidate instruments include HRIS, VHROI, HRTIR, MERIS, SAR, LISA, and Altimeter.

ESA Earth Observations long-term planning milestones were the next subjects reviewed. MOP-1 was launched March 6, 1989. The planned launch of MOP-2 is approximately 1 year later, and ERS-1 is currently scheduled for September 1990. The planned launch date for ERS-2 is 1994. ARISTOTELES is possible as a joint launch with ERS-2, but other possibilities also exist. Planned launch dates of EPOP-A1 and EPOP-B1 are in 1997 and 2000, respectively. Meteosat Second Generation launch has changed to 1998, which is later than previously planned. Earthnet now includes both a

mandatory program and an optional component to fulfill the needs of the ESA Earth observations strategy. Dr. Pfeiffer also showed the current international scenario with launch schedules.

Dr. Pfeiffer then addressed the polar platform development status in ESA. Two platform concepts were proposed to ESA. One was a SPOT-4 based platform concept from Matra, the other a concept for a larger BAe platform. The BAe proposal was solicited, while the Matra proposal was unsolicited. The ESA Council met in March 1989 and decided to ask both contractors to prepare new proposals in response to the same platform size so they could be better compared, and the decision will now be made in October 1989. The current baseline requirement for payload mass for the platform is approximately 1.7 tons, altitude range of 750-800 km, with 3000 W peak power. These are the general characteristics/capabilities to be addressed by the two new proposals. ESA is proceeding as fast as possible, appreciates the importance of maintaining continuity, and is undoubtedly aiming to meet the 1997 launch date.

The BAe proposal for a larger platform included options for downscoping to a smaller platform, but it was not optimized to the smaller configuration. This was the reason for requesting a new set of proposals working to the same specifications to permit fair and comparable evaluation of the two proposals. Atmospheric chemistry instruments are anticipated for inclusion on both A and B series. Only the A1 platform is within the Columbus programme. The follow-on A series, the entire B series, and all the instrumentation will be within the Earth Observations programme. Dr. Pfeiffer noted that in terms of program and budget approvals, ESA is trying to maintain the same schedule of getting approval for a resolution and declaration. In the beginning of 1990, the ESA Earth Observations programme is seeking a declaration with funding for the EPOP. The next Programme Board--Earth Observations (PBEO) meeting will request permission from delegates to start organizing the potential participants meetings for this program.

EUMETSAT

John Morgan gave the EUMETSAT presentation (Document 2). He expressed EUMETSAT's pleasure to be participating in the IFEOS/CEOS/ICWG meeting. All EUMETSAT members strongly support the need for continuity and improvement in the polar meteorological systems. A letter of intent has been sent to NOAA addressing possible contributions in terms of both space elements and ground system support. The contributions will include elements related to both morning and afternoon service. EUMETSAT's actual participation in the ESA program is still to be defined. The rapidly changing status of agency plans (NASA, NOAA, ESA, etc.) is of great concern to EUMETSAT. Mr. Morgan questioned the commitment of space agencies to long-term Earth observations and continuity. For the operational community, this is a major concern. He noted that this may be the single most important issue for this group to

address. EUMETSAT will be developing its specific plans in the next year. He noted that ESA's proposed "European strategy" is in fact an ESA strategy, and EUMETSAT remains open to evaluating other systems to meet its requirements.

Dr. Langham asked about EUMETSAT's plans for data downlink in S-band compared to X-band. Mr. Morgan stated that this is under study. EUMETSAT recognizes the significant investment already in place globally in S-band capability and the need for preservation of S-band service. The problem is that S-band downlink may not be adequate for the entire range of future mission requirements but in any case this service would be coordinated with NOAA. Use of data relay satellites and/or direct X-band downlink of global data (i.e., not direct broadcast for local reception) would be carefully studied in the next 12 months. Data continuity is the fundamental EUMETSAT concern. Satellite redundancy and on-ground backups cannot be accommodated within the ESA baseline program, but may be addressed through EUMETSAT contributions. These questions are under study by both ESA and EUMETSAT.

CANADA

Dr. Langham gave the Canadian presentation (Document 3). The Canadian Space Agency was officially formed March 1, 1989. Dr. Langham reviewed the new organization and its plans and relations with other Canadian agencies active in Earth observations. CCRS will continue with its ongoing or planned Landsat, SPOT, MOS-1, ERS-1, and polar platform data reception activities, and, in the case of SEASAT, ongoing analysis of the data received from the short-lived reception activity. He noted that AES also receives and actively uses data from the NOAA polar environmental satellite series. CCRS has been active in developing ground stations, image analysis and information systems and airborne radar. Two antennae are in operation at Gatineau and two at Prince Albert. Data processing systems include MOSAICS, developed for Landsat TM; GSAR, a flexible SAR processor with systems in five countries; and the Geocoded Image Correction System (GICS), which is used in half of the global ground stations.

In cooperation with CCRS Canadian industry has also developed many image analysis systems that are used widely in the international remote sensing community as well. Expert systems and information systems have been another area of attention for Canada. An ice information center and a crop information center exist, and a geoscience and an ocean information center are being developed. In the area of calibration/validation, developmental work related to Canadian systems includes atmospheric correction development for optical technology. Sea ice and ocean condition work in the Labrador Ice Margin Experiment (LIMEX) and Labrador Extreme Wave Experiment (LEWEX) campaigns have been very successful, and will be

developed into major validation campaigns for ERS-1. Also in terms of international cooperation, Canada is involved in SAR benchmark work.

The responsibilities of the Canadian Space Agency include space segment development and operations, cooperation with other space agencies, and space sensor development (if and when sensor development activities evolve). CCRS will continue its ground segment, applications, and airborne sensor and application development work. CSA will be the official Canadian representative in such international groups as ICWG, CEOS, etc. Although much of this work has been performed by CCRS, AES and the Department of Fisheries and Oceans also have very active remote sensing programs. CCRS and CSA will be working very closely together on Radarsat, ERS-1, and other programs of common interest. CSA staffing is anticipated to be approximately 300 people, and the total Canadian space budget is about $3 billion Canadian dollars over the next 10 years. Two of the three billion will be in CSA itself. The staff and budgets are a consolidation of activities previously in other government agencies.

Radarsat is now part of the new CSA. This includes moving the program management to Montreal, the location of CSA. The ground reception stations and the radar applications remain the responsibility of CCRS. Radarsat began as a program in 1980 and is currently awaiting final approval for Phase C/D. The plans include cooperative partnerships, including launch by the United States (1994), cost sharing by Canadian provinces, and global data distribution and cost sharing by the private sector. In the US, both NASA and NOAA are involved. Ground segment program costs and royalties on data sales are both means for cost sharing by the provinces and private industry. The SAR will be C-band (5.3 GHz), HH polarization, right-looking aspect, and will utilize two high speed (10 minutes capacity) tape recorders on-board. The instrument will be rotated to map Antarctica in its entirety during two different seasons in a cooperative venture with NASA. The SAR will operate in four modes: operational (100 km swath, 28m x 30m resolution, 4 looks); high resolution (55 km swath, 8m x 8m resolution, 1 look); experimental (looking outside the normal swath range--49-60 degree incidence angle, 100 km swath, 28m x 30m resolution, 4 looks); and scan SAR (500 km swath, 100m x 100m resolution, 6 looks). The orbit is now a dawn-dusk (i.e., crossing times of 6:00 am and 6:00 pm local), sun-synchronous orbit. This reduces the mass and power requirements because the satellite is rarely in eclipse and needs less on-board power storage capacity.

Final approval for Radarsat is expected within the next few weeks, leading to a 1994 launch. Mr. Saito asked about the role of the private sector in Radarsat. Dr. Langham said that Radarsat's primary purpose is to provide data for Canadian government requirements (ice, agriculture, etc.). The capacity for SAR data acquisition exceeds (Canadian) Government needs, particularly in so far as global data collection is concerned. This spare capacity will be made available to a private sector company

which will have exclusive commercial marketing rights to Radarsat data in exchange for a contribution to the ground segment of the program.

Radarsat is a 5-year mission. The duty cycle foreseen for the radar is 28 minutes per orbit. Continuity in the form of follow-up missions is of importance, and will be addressed once final approval is obtained for the first mission. This is important in building operational user commitment to data use. Mr. Marelli asked about the compatibility of the dawn-dusk orbit with other missions that have different orbits. Dr. Langham noted that this orbit, in fact, alleviates ground station conflicts. The Australian representative asked about southern hemisphere data collection plans. Dr. Langham said that both NASA and the Canadian government have interests in southern hemisphere data collection. Direct reception agreements are foreseen, and this will be discussed with Australia, among others. The final decision on the bus has not yet been made. The mission control facility will be a CSA responsibility, while Canadian data acquisition and processing remains with CCRS. The 5-year lifetime is driven primarily by the life expectancy of the travelling wave tube.

Radarsat data policy foresees three user categories: operational use by government agencies of the partner countries, research sponsored by government agencies, and commercial. In Canada, government interests are primarily operational, whereas NASA's interests support research. Private sector interests will be served by the Canadian company selected as a partner. Foreign access (i.e., non-partners) will be through the private sector distributor, or through cooperative research activities which may take the form of an AO. The downlink will be in X-band, and the data rate is 100 Mbps in each of two channels.

After lunch, Mr. Leo Sayn-Wittgenstein, CCRS, assumed the chairmanship of the meeting.

AUSTRALIA

Mr. Graham gave the Australian presentation (Document 4). He noted that Australia puts high priority on Earth observations. Currently, Australia is active in receiving and processing data from Landsat and MOS-1, and soon will come on-line for SPOT. ERS-1 data will also be received and processed in Australia. In the international scientific realm, Australia is active in IGBP, ISY, and other related programs. A national committee was convened to assess possible Australian participation in the polar platform/Earth observations program. Australia hopes to expand its participation in international space-borne remote sensing activities through the contribution of instruments. Cooperation with the UK in the ATSR instrument, which will fly on ERS-1, is an example. Australia is active in science and calibration/validation, and attends international forums to plan international cooperation. The Australian Space Office funds approved programs. The

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Commonwealth Scientific and Industrial Research Organization (CSIRO) is concerned with research and industrial development. It is expected that some of CSIRO's work will provide the foundation for future space programs. Within financial and other constraints, CSIRO strongly supports the polar platform programs.

Five interdisciplinary investigations were submitted by Australia in response to the NASA Eos AO, along with several Australian co-investigators on other proposals. Dr. Graham Harris was selected as a PI for Eos. The Atmosphere Pressure Sounder (APS) instrument proposal was also submitted to NASA and ESA, but was not accepted by either. It was submitted to ADEOS as well, but was again not accepted. Australia nonetheless plans to continue to develop the instrument at least through the model stage. The instrument will be flown as an airborne sensor development model to demonstrate its performance and the results will be published. Further work will rely on user organizations, such as the Bureau of Meteorology and the Australian Space Office.

A multispectral sensor program is underway in CSIRO. The emphasis is in applying multispectral data to geoscience applications. This has led to interest in development of airborne instruments for geology, and work on agricultural and other non-geologic applications as well. Three flexible, evolutionary instruments are under development. The Modular Environmental Agricultural Scanner uses a rotating mirror with a wide swath width, and will have 64 channels in visible, near IR, and thermal IR bands. It is intended to be versatile and permit selection of bands through software. The Pushbroom Airborne Imaging Remote Sensor is the next stage; it is to move from a mechanical scan mirror to a pushbroom scanner with high spectral resolution and 128 bands. Again, the intention is to have the capability to select bands using software, and to fly the instrument on aircraft. This would be a stepping stone to a future space instrument. Detector technology development is being funded at the University of New South Wales. The ultimate goal is an instrument with a 128 x 256 array, which was proposed for ADEOS as well, but not accepted. The continued development of these instruments is demonstration of the Australian commitment to Eos, and its perception of the importance of acquiring and being able to use high volumes of data from remote sensing in the future.

The Australian Center for Remote Sensing has been receiving Landsat TM data for the last 4 years, is receiving MOS-1 data, and is being upgraded for the reception of ERS-1 data. While the Center is mostly land-oriented, there is strong interest in oceanographic and coastal applications. A second station is being actively pursued to meet these interests through the CSIRO Marine Laboratory in Hobart, Tasmania. The station would be able to receive data from the coasts of Antarctica and New Zealand. This is being handled in cooperation with New Zealand.

Mr. Graham stated Australia's strong belief in the importance of international direct readout of data so that local users with inherent knowledge have direct access to scientific data.

In answer to a question, Mr. Graham said that the AUSSAT program is run by its own separate statutory organization. There was discussion of possibly flying scientific/meteorological instruments on-board, but this has not materialized. Currently there is only one experimental payload onboard, and this is a communications transponder sponsored by AUSSAT itself.

FEDERAL REPUBLIC OF GERMANY

Dr. Langner presented the programs of the Federal Republic of Germany (Document 5). He covered the objectives of the Earth observations programs, status of instrument development and ground segment activities, and national requirements and priorities for the polar platforms. There are discussions ongoing about a German space agency, which may result in the establishment of such within the next few months. Presently, Earth observations activities have the objective of ensuring access for the German user community to regional and global Earth observation data through participation in ESA programs, and the development and operation of selected and advanced instruments for ESA satellite missions and NASA Shuttle flights. User needs relate to basic research as well as operational/practical geoscience applications in a range of disciplines. Environmental monitoring is currently an area of increasing political and popular interest.

One program in the FRG is development of the X-band Synthetic Aperture Radar (X-SAR) in cooperation with Italy and NASA. The instrument will fly on the shuttle as part of the Shuttle Radar Lab in conjunction with the NASA Shuttle Imaging Radar, which operates in L- and C-band. The instrument is in Phase C/D, which started in 1987. An industrial contract was recently signed between Dornier and Selenia Spazio. A joint mission planning/mission operation team is being developed. Fifty-five experiments were proposed for X-SAR and 180 for SIR-C. These were evaluated and PIs were selected. A study has been initiated for possible flight of an advanced X-SAR on Eos. Modifications would be required in light of the different mission characteristics. These include different altitude, addition of electronic beam steering, dual polarization, high resolution and scan SAR modes, 5-year lifetime, 15-52 degree incidence angle, and swath width of 40-150 km. This study will be completed this year.

MOMS status was reviewed as well. MOMS is scheduled for flight on the Spacelab-D2 Shuttle mission. This instrument combines high resolution (5 m) multispectral capability with stereo coverage. Flight is planned for late 1991. MOMS-

D2 is considered for experimental flight, and was proposed to ESA in response to its polar platform AO.

The Millimeter Wave Atmospheric Sounder (MAS) is another experimental instrument under development. It measures global profiles of atmospheric constituents. It is scheduled for flight on ATLAS missions on the Shuttle. PRARE (Precise Range And Range Rate Equipment) is a contribution to the ERS-1 mission. It is a precise S/X-band, two-way microwave tracking system for geodetic/geodynamic applications and support of radar altimeter measurements.

The Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) provides more precise information on the chemistry, dynamics, and energy budget of the middle atmosphere. In addition, MIPAS can measure the global distribution of a large number of atmospheric constituents including ozone and water vapor, and produces temperature profiles of the middle atmosphere. It was proposed to the ESA AO for polar platform and was selected for Phase A study.

The Conical Scan Radiometer (CSR) is an airborne instrument developed in cooperation with France, which measures Earth radiation budget parameters. It could be a contribution to a polar platform. A version of this instrument, SCARAB, has been proposed for flight on a Soviet Meteor spacecraft and could fly on the polar platform.

The lidar has been flown as an airborne instrument. Phase A study for a spaceborne instrument has been completed. The lidar and the CSR were both proposed to the ESA AO, as well. These are considered potential core instruments, not national contributions for EPOP.

In the area of data utilization, DLR has a national data center to build up and operate the German national ground segment for national and ESA programs. Dr. Langner reviewed the German ERS-1 ground segment. The portable station for Antarctica was described. In February 1989, offers from industry were received. Dornier was selected, and a contract should be in place by the end of April 1989. The location for this station has not yet been decided. Esperanza (Argentinean Base) and Tenienta Marsh (Chilean Base) are the alternatives under consideration. Work is scheduled to be completed by the end of 1989/early 1990. Acceptance tests follow, with earliest operation in February 1991.

National requirements and priorities for ESA polar platform missions, in the German view, are for operational meteorology continuity after NOAA-K,L,M without a gap, with a payload provided by NOAA and EUMETSAT, and ocean/environment/climate monitoring providing continuity after ERS-1 and -2, with the payload provided by ESA. Dr. Langner reviewed a list of measurement parameters of interest to the FRG. This leads to instrumentation priorities for visible and TIR

imager, TIR and MW sounder; scatterometer; radar altimeter with precise positioning; medium resolution imaging spectrometer; Earth radiation budget instrument; and limb sounder for trace gas measurements in the atmosphere. This list is coincident with the ESA and NASA plans for polar platform instrumentation. In response to a question regarding SAR for polar platform, Dr. Langner said it was important to continue current development work, but prior to the end of the century, no operational SAR is foreseen for land applications. For ocean applications, there is no objection to a SAR, but it is of less priority in terms of scarce payload resources, compared to the range of instrumentation that could be flown in place of a SAR. The ESA platform is not expected to have the resources necessary for a large advanced X-SAR--this would require the capabilities of the NASA platform.

JAPAN

Mr. Tanaka gave the Japanese presentation (Document 6). He reviewed the status of Earth observations programs in Japan, both current and future. He described ground facilities and other space activities in Japan. The organization chart for Japanese space activities was presented. Mr. Tanaka explained that NASDA is supervised by the Science and Technology Agency (STA), and funded by the Japanese government, but is a quasi-governmental agency, not really part of the government. NASDA and ISAS are the only agencies that can launch spacecraft. Mr. Tanaka described the other agencies involved in space activities, including MITI and the Ministry of Transport (which is the parent organization for the Japanese Meteorological Agency). The Tropical Rainfall Mapping Mission (TRMM) rain radar of the Communications Research Laboratory, which is part of the Ministry of Posts and Telecommunications, is in Phase A. Many agencies are interested in becoming involved in global change monitoring in Japan. Japanese space policy is contained in the annual Space Development Plan which is issued by the Space Activity Commission every March. This plan defines all the space programs of Japan.

The status of Japanese satellites was presented. GMS has been operating since the first satellite was launched in 1977. Landsat data reception began in 1978. SPOT data reception started in 1988 and is continuing. MOS-1 was launched in 1987, and is continuing. The Japanese ERS-1 [(J)ERS-1] is in Phase C/D, with launch scheduled for 1992. (J)ERS-1 is a joint NASDA/MITI program. MOS-1B is scheduled for launch in 1990. GMS-4 is scheduled for August 1989. EXOS-D and Geotail are ISAS programs. GMS 4 and 5 have a 5-year lifetime, but GMS-5 will be launched 4.5 years after GMS-4's launch to build up on-orbit spares. ADEOS is now in Phase B, and Phase C/D approval will be requested in 1990. February 1995 is the most likely launch date if approval is obtained. TRMM is under study with NASA, and could be launched in 1994/95. Mr. Tanaka noted the proposed launch date in 1996 for EDRTS (1 year after ADEOS). Even though Earth Data Relay and Tracking Satellite (EDRTS) is not an Earth observations satellite, it will make a significant contribution to NASDA's

Earth observations programs. EDRTS is in Phase B as well. The Japanese Polar Platform (JPOP) is in pre-Phase A. Phase A will begin in 1989 for JPOP.

For MOS-1, Japan is operating three ground stations (NASDA plus two research organizations). In addition, ground stations are in operation in Thailand (provided by Japan); Maspalomas, Fucino, Kiruna, and Tromso (ESA); Alice Springs (Australia); and Gatineau (Canada). (J)ERS-1 is under development by NASDA and MITI. Its objectives are to establish the technology of active microwave sensors (SAR) and high resolution optical sensors (OPS), and to survey terrestrial resources and monitor the environment.

Mr. Tanaka then described ADEOS, the Advanced Earth Observation Satellite. The objectives are to continue Earth observations technology, to develop advanced optical sensors, to contribute to the international community, to conduct experiments with ETS-VI and EDRTS, and to develop modular type satellite components to establish polar platform technology. ADEOS will be launched in the interval between (J)ERS-1, Topex/Poseidon, and UARS in the early 1990s, and NPOP and EPOP in the late 1990s. Mr. Tanaka reviewed the main characteristics of ADEOS, and the proposed data flow concepts. The payload includes the OCTS, AVNIR, and AO sensors. The official selection of AO sensors will be announced after the Phase C/D approval is received from the Space Activities Council. 1,200 kg is available for payload, of which approximately 400 kg is reserved for AO sensors, along with 300 W of power, and less than 100 Mbps data rate. Discussions have just begun regarding possible use of TDRSS (NASA) for ADEOS data relay as well.

Japan is participating in the International Polar Platform Program to be part of an international Earth Observing Complex in the late 1990s. Japanese participation includes research in Global Change, provision of instruments for NPOP, and provision of JPOP in the future. STA, MITI, JMA, and NASDA are the Japanese participants. The potential Japanese instruments for flight on NPOP are AMSR and ITIR.

The MOS-1 ground system is considered the prototype for future ground systems. The tracking and control station in Tsukuba will be used for (J)ERS-1 as it is now for MOS-1. Mission management is in Hatoyama (Earth Observations Center) for MOS-1. This requires close and continual communication and coordination between Tsukuba and Hatoyama. Researchers participating in the MOS-1 verification program are provided data by NASDA at no cost. Other data distribution is handled by the Remote Sensing Technology Center (RESTEC) and foreign ground stations. An additional distribution channel from (J)ERS-1 for research users, who will have access at a lower cost than commercial users, is now under consideration. This may also be the channel for operational government users, and the cost basis could be the cost of reproduction.

Dr. Duchossois asked about the (J)ERS-1 orbit (relatively low) in light of the high level of solar activity anticipated in 1992 when the satellite will be launched. Mr. Tanaka responded that there will be an active orbit maintenance program. This will include establishing more than one tracking station with one at a high latitude, to help maintain the orbit. This may be Kiruna. These plans are still under development. Dr. Duchossois clarified that his concern is stability of the data, if the satellite orbit is adjusted too frequently. Mr. Tanaka said that the orbit is very difficult to change, and was chosen as a balance of many concerns. The (J)ERS-1 SAR duty cycle is 15-20 minutes per orbit, and 5 minutes per orbit for OPS. The OPS has a mechanical cooler which has a limited lifetime, and this is the limitation on operating time for the sensor.

UNITED KINGDOM

Dr. Thomas and Dr. Croom gave the UK presentation (Document 7). Dr. Thomas reviewed the current and future programs of BNSC. Current programs include ERS-1, UARS, EODC, and AMSU-B. The British National Space Council was formed in November 1985. It comprises four partners: the Department of Trade and Industry, the Ministry of Defence, the Science and Engineering Research Council, and the Natural Environment Research Council. A new Director General was appointed in April 1988 (Arthur Pryor). The Royal Aerospace Establishment in Farnborough and the Rutherford Appleton Laboratory are the two principal locations for BNSC activities. In October 1988, the government declared that Earth observations was a cornerstone of future BNSC policy (although no increase in funding was provided). This was a response to the House of Lords Select Committee on Science and Technology report on civil space. Commercialization was also highlighted as a key element in British space policy. In late 1988, the UK decided to re-enter the ESA Columbus program, and to establish the Earth Observation Data Centre. The decision was also made to discontinue participation in the Radarsat program.

In ERS-1, the UK participation is at 14.2 percent for Phase C/D. The main instrument contribution is the Active Microwave Instrument (AMI) built by Marconi Space Systems through an ESA contract. The engineering model of AMI was delivered to ESA in January 1989. The flight model is scheduled for delivery in June 1989. RAL leads the UK/Australian consortium responsible for the Along Track Scanning Radiometer (ATSR). The engineering model of ATSR was delivered to ESA in March 1988, with the flight model scheduled for delivery April 1989. UK participation for Phase E is at 16.8 percent. ESA is developing one of the Processing and Archiving Facilities (PAF) for ERS-1 at RAE. There is also a substantial UK scientific involvement in the ERS-1 AO.

The UK is active in the UARS program at NASA. The Improved Stratospheric and Mesospheric Sounder (ISAMS) is led by Oxford University with RAL, and the UK Met Office participation, and is an enhancement of SAMS from NIMBUS. The flight

model is scheduled for delivery in October 1989. MLS, the Microwave Limb Sounder, is the second UARS instrument provided by the UK. In this case, the UK is providing part of the instrument. The UK component of the flight model was delivered to JPL earlier in 1989.

The primary function of the UK Earth Observation Data Centre is to serve as the processing and distribution point for Earth observations data within the UK. The EODC is directed by the government to develop as a commercial facility that will incorporate the present National Remote Sensing Center. The main facility contract was awarded to a consortium led by BAe. A contract for algorithm development for the EODC has been given to Eos LTD, the results of which will be used by the BAe consortium. Other contracts have been awarded to Vega Space Systems (management support) and a consortium headed by Mullard Space Science Laboratory (science team contract).

Regarding ERS-2, an advanced ATSR is under consideration, similar to that developed for ERS-1, but with additional channels for land observation. The UK interest in ERS-2 is strong, and participation is proposed to be similar to ERS-1.

With respect to Columbus, UK participation is at 5.5%, with the interest mainly directed toward polar platform. BAe will be the prime contractor. Further studies of the two platform designs are underway. Studies are being conducted in the UK on possible commercial instruments: an advanced SAR and an optical mapping instrument. The optical mapping instrument was submitted to the NASA and ESA AOs but was not selected by either. It would have 5-meter resolution and stereo capability. AO instruments from the UK that were selected by ESA for Phase A studies include an advanced ATSR and a Doppler Wind Sensor (UK/French consortium). A UK/Norway polar platform ground segment study is underway, led by Logica in the UK, looking at commercial implications. An additional study led by BAe is underway looking at mission scenarios, addressing commercial opportunities. These studies will be presented to ESA and discussed there.

UK plans for Eos include participation in Phase B studies of DLS, SAFIRE, MLS, TES, and SWIRLS as instrument investigations; one UK member of the MODIS team; and two UK interdisciplinary investigations. SAFIRE and MLS are US-led investigations with significant UK participation. In addition, there is UK participation (co-investigators) in TES and SWIRLS, which are led by JPL.

The UK is involved in several research programs at RAE, including data processing (with real-time SAR), imaging mechanisms, new applications, and system and instrument studies. The NRSC provides a focus for promotion and user education in remote sensing. RAL research includes millimeter wave technology, coolers, and detectors. In addition, there is a Remote Sensing Applications Development Unit

located at the NERC Institute for Terrestrial Ecology. This group is also responsible for coordinating airborne programs.

Dr. Croom addressed UK involvement in studies of the environment from space and noted that the political interest in the environment might eventually help these programs. Dr. Croom noted that studies of the environment constitute a major part of the current UK Earth observations instrumentation activity. In the area of ozone layer chemistry and dynamics, the UK has funded ISAMS and part of MLS (both for UARS); has had DLS and DWS accepted for further studies for the NASA and ESA polar platforms, respectively; and is a collaborator in the studies of SAFIRE and EMLS for the NASA platform. For lower atmosphere and ocean surface studies, the UK has funded ATSR (for ERS-1) and AMSU-B, and has had AATSR selected for further study for the ESA polar platform. Dr. Croom described the DLS and DWS instruments and said that the AATSR was aimed at extending the ATSR atmospheric correction technique of ATSR to land studies as well as continuing SST measurements. He also reported that the flight model of ISAMS has now been delivered to RAL for final additions, and that it would be shipped to Oxford next month for final calibration and testing before being shipped to NASA.

Funding for the AO instruments is not finalized, but has been requested, beginning in financial year 1991. Interim funding may be difficult, but Dr. Thomas was optimistic that this will be worked out, especially in light of renewed interest in the environment. Mr. Schneider expressed NOAA's interest in the Dynamics Limb Sounder, particularly for ozone studies.

NOAA

Dr. Langham chaired the Tuesday morning session of the joint plenary. The meeting resumed with the NOAA presentation, given by Mr. Schneider (Document 8). He gave the status of the Geostationary Operational Environmental Satellite program (GOES). GOES-7 is currently the only operational satellite in the program. In 1990, there will be a block change, and the first satellite of the new block is GOES-I, which will be launched in July 1990. GOES-J will be launched in February 1992, following a policy of launching on 5-year centers, except in the case of premature failures. GOES-I/M will be a three-axis stabilized design built by Ford Aerospace. After GOES-M, NOAA's requirements are being studied. Phase A studies for GOES-N will begin in June 1989, and NOAA's requirements are also being included in the Phase A studies of NASA's Mission to Planet Earth geostationary platforms.

In the polar orbiting environmental satellite (POES) programs, NOAA-11 is now operational in the afternoon orbit. A contract was signed for NOAA-K,L,M in July 1988. THe CDR for AMSU-A is scheduled for August 1989, and the UK has announced the contractor for AMSU-B, which is BAe/Aerojet. Mr. Schneider reviewed the status of all

the current and planned polar satellites through NOAA-M. The last morning satellite is NOAA-L (April 1995) and the last afternoon satellite is NOAA-M (July 1996).

Mr. Schneider briefly reviewed the status of Landsat. The spacecraft design for Landsat-6 is derived from the Tiros spacecraft, a block change from Landsat-4 and -5. Landsat-4 and -5 are still operating. Landsat-6 is funded for a planned July 1991 launch.

In terms of polar platforms, Mr. Schneider described the proposed post-NOAA-K,L,M polar program. This includes procuring a series of new free-flyers to continue afternoon service for the operational payload. This would fly in conjunction with the NASA polar platforms, and the satellites would have interfaces common to the ESA and NASA polar platforms. This new series cannot be ready in time for following K,L,M without a gap. NOAA proposes to fly a NOAA-N which would be a carbon copy of K,L,M to serve as a gap filler. The new series would have 25 percent payload mass contingency to permit payload growth in the future based on developments in prototype operational instruments which will fly on the first NASA polar platform. Mr. Schneider stressed the importance of common interfaces between NOAA, ESA, and NASA. The core payload for operational service in the afternoon orbit is AMRIR, AMSU, GOMR, SEM (augmented), Argos, and Search and Rescue. The plan is to have operational data transmitted to Europe and the US through an arrangement between NOAA and EUMETSAT to ensure availability of global operational data in near-real-time on both sides of the Atlantic. NOAA will also arrange to obtain data from the prototype operational instruments on NPOP in operational time frames for use by NOAA. The prototype instruments are the altimeter, scatterometer, ERBI (CERES), AIRS, an ozone limb scanner (HIRRLS or DLS), and the HIMMS.

The current planning scenario with the separate free-flyers from NOAA was agreed in an exchange of letters between Len Fisk and Tom Pyke. These letters were distributed. Mr. Schneider reviewed the status of advanced instrumentation studies for AMRIR, GOMR, AMSU-A, CCDH, and an advanced HRPT concept. The CCDH study has been deferred and will be incorporated in the Phase A study for the new free-flyer spacecraft. The advanced HRPT concept involves continuing S-band, but using quadraphasing to increase the data transmission capability.

Mr. Schneider gave an overview of the work of the International Polar Orbiting Meteorological Satellite (IPOMS) group. Of particular note, he pointed out that due to delays in launch schedules for the polar platforms from NASA and ESA, the operational community asked NOAA and EUMETSAT to investigate backups, gap fillers, and replacement capabilities to ensure continuity of data coverage. He pointed out that IPOMS adopted a set of data policy concepts that relate to continuation of direct readout and free and open exchange of data for operational purposes. The letters of intent received to date from IPOMS members for contributions to future polar

systems were reviewed. These included proposals for instruments which were submitted in response to NASA and ESA AOs for polar platforms.

Mr. Michael Mignogno, Acting Chief, Landsat Transition Program, gave an update on Landsat status (Document 9). On March 15, NOAA rescinded its direction to Eosat to halt operations. EROS Data Center and foreign ground stations were informed that normal operations would continue. Landsat-4 and -5 are still operating, although there have been some failures in communications systems. Landsat-4 uses TDRSS, and Landsat-5 uses the direct downlink capability. In 1988, the US acquired over 25,000 TM scenes and 13,700 MSS scenes. 180,000 TM and MSS scenes were downlinked to foreign ground stations. Landsat-6 development is continuing and is independent of recent budget problems with current operations. Landsat-6 will include a 15-meter panchromatic band in addition to the current TM capabilities. It will be launched on a Titan II. The spacecraft CDR was held in February. The TM CDR was completed in September 1988.

In response to a Congressional direction, NOAA contracted for studies of future remote sensing systems, including analysis of markets, applications, instrumentation, spacecraft technologies, launch options, and financial arrangements. This included government-industry partnerships, participation by other government agencies, and international cooperative partnerships. The National Space Council is developing policy options for the future of the Landsat program, and should report in the summer of 1989. Comprehensive studies were conducted by The Analytical Sciences Corporation (TASC) and KRS Remote Sensing. The Egan Group also did a focused study on financing options. Copies of these reports are available through NTIS. Current funding will carry Landsat operations at least through the National Space Council review, and future funding is contingent on the outcome of this review. NOAA has had exploratory discussions with CNES on future program possibilities, but no formal arrangements or proposals have been developed.

Mr. Mignogno expressed confidence that Landsat-6 will meet the planned July 1991 launch schedule. SeaWIFS is a NASA-Eosat proposed joint venture, but has not yet been finalized.

NASA

Dr. Butler, NASA, gave the first NASA presentation, providing an overview of Earth science and applications activities (Document 10). The major observatories include Eos/polar platforms and GeoEos/Geoplatforms. These are complemented by moderate missions, referred to as Earth Probes, and Space Station attached payloads. Earth Probes are anticipated to be launched every 3 years, pending budgetary approval in the FY91 budget. The Earth Observing System, which includes the polar platforms, Eos attached payloads, and the Eos Data and Information System (EosDIS),

is the OSSA top priority for FY91. Dr. Butler stressed the importance of international and interagency cooperation in Earth science. The US Global Change Program, an interagency activity, is the focal point of the US contribution to the International Geosphere-Biosphere Program and other international Global Change monitoring efforts. International Space Year (ISY) and Mission to Planet Earth are important thrusts in Earth observations. ISY will rely on ongoing, already approved programs, as well as initiatives in data management. ISY is viewed as a precursor to Mission to Planet Earth, allowing the opportunity to coordinate satellite and data exchange activities internationally. Mission to Planet Earth includes Eos, plus geostationary platforms and Earth probes.

The first NASA polar platform is scheduled for launch in late 1996. The slip in launch date from 1995 was due to a reassessment of the time required for instrument development and integration.

Dr. Butler reviewed major Shuttle mission plans i.e., Shuttle Imaging Radar (SIR-C) and ATLAS, which flies an ensemble of instruments as precursors to UARS, Eos, and other missions). He described bilateral and multilateral international cooperative activities. In the interagency arena in the US, Dr. Butler noted the recently signed MOU with the US Geological Survey which gives responsibility for long-term archiving and data management for land-related Eos data (HIRIS, land-SAR) to USGS, and stated that the NASA Central Data Handling Facility for these data will be co-located in Sioux Falls at the EROS Data Center.

The current status of Eos was presented. Eos plans include two US platform series, two series of platforms from ESA, one platform from Japan, attached payloads on Space Station Freedom, and the NOAA free-flyer series. He explained that the NOAA free-flyer decision was based on the fact that the afternoon operational payload is the primary NOAA polar mission, and there are a high number of risk elements associated with the first NASA polar platform. This led to the conclusion that there was too much risk in combining the NOAA operations with NPOP-1. With respect to the morning series, the more conservative ESA approach is viewed as carrying less risk.

Dr. Butler reviewed the status of Eos facility instruments. He noted that NASA has added a copy of the Topex altimeter to the facility instrument complement. Twenty-four instrument investigations, 28 interdisciplinary science teams, and 92 facility instrument team members/leaders were selected in response to the Eos AO. Attached payload investigations will be selected later in 1989. An altimeter science team will be selected competitively in the future. For the near-term, the Topex science team will serve in this capacity. A draft MOU is under discussion with NOAA regarding data management for non-land surface Eos data.

FINAL VERSION
May 15, 1989

The baseline planning scenario for Eos was presented and reviewed. The size and mass of the NASA platforms is driven by the available launch options. The Space Shuttle is not capable of supporting Eos polar launch requirements, leaving Delta-2 and Titan IV as the only options. Delta-2's shroud is not big enough to accommodate the larger facility instruments, leaving only the Titan IV, which can carry 4000 kg of payload (in addition to the mass of the bus) to polar orbit. Dr. Butler explained the nature and objectives of each of the instruments proposed to fly as part of Eos. He noted the importance of having both AIRS and AMSU together, and stressed the operational potential of AIRS, which was an important consideration in the selection of its design. There is a Canadian instrument proposal which was selected to measure carbon monoxide, although it has some technological risk. Decisions on competing instrument concepts will be made in 1990.

Dr. Butler explained the concept for the communications package that was modified following the change in NOAA plans. NASA strongly supports the need for direct downlink capability on NPOP to support near-real-time requirements for prototype operational instruments (X-band at 1 Mbps) and for high rate image data to support field experiments in remote locations (at 100 Mbps). The transmission system may be provided by Canada through a cooperative agreement which is currently under discussion. SAFIRE, SWIRLS, and MLS provide the data continuity for UARS along with additional new measurement capability. The payload as presented is more than can in fact be accommodated, and selections will have to be made from within these choices. Dr. Butler corrected the listing of ESA instrumentation, noting that AMI-2 may in fact be a combination of scatterometer and SAR capability. He pointed out the great contribution to Eos objectives provided by the ESA and Japanese proposed platforms and payloads.

Data systems work is of high priority within NASA Earth science programs. Two parallel Phase B studies are underway for the Eos Data and Information System (EosDIS). The data system Phase C/D procurement will be an extremely large effort, possibly on the order of $500 million. The first Eos Investigator Working Group meeting was held in March 1989, and established several panels to address specific requirements and planning work. A study is underway through the US Interagency Working Group on Data Management for Global Change for a national data system for global change.

Dr. Thomas noted that the ESA proposed payload listing with AMI-2 is only one of four competing concepts. He also questioned the implication of competitiveness among the various pairs of instruments that were grouped together on the baseline list. NOAA proposes to fly only single copies of operational instruments on EPOP if there are 3-year launch centers. This is under discussion among NOAA, EUMETSAT, and ESA. With respect to solar-terrestrial payload candidates, Dr. Butler noted that POEMS has been selected, and a flight opportunity is being pursued, even though it may not

ultimately be on a NASA polar platform, but on some other appropriate spacecraft. SEM and IPEI are both space physics instruments as well. NPOP-2 also carries GOS, a magnetometer, and an X-ray imager. Thus, there is a substantial particle and fields complement in the Eos payload.

Dr. Duchossois clarified the situation for the ESA platform payload. He stated that there are seven instruments that have been identified for Phase A study. These are radar altimeter, scatterometer, MERIS, AMI (Active Microwave Instrumentation)-2, SAR-C, Atmospheric Lidar (ATLID), and MIMR (Multiband Imaging Microwave Radiometer). These were selected from 20 proposals. Four different payload options are being studied at the direction of ESA delegates. These include subsets of the seven core facility instruments under Phase A study. Studies of the payload options will start in June 1989. With respect to SAR, ESA initially considered a separate scatterometer and second generation C-band SAR instruments. Both would have some enhancements compared to ERS-1 instruments. In discussions with delegations, and in view of the short time available before EPOP-1 launch, the concept of an integrated second generation AMI should be retained as an option. A final decision will be made in approximately 1 year's time, after the results of the Phase A instrument and system studies are available. The ESA AO results and the science package must be added to the scenario for ESA. MIPAS, a mid-IR limb sounder, is a Category 2 instrument which may become an ESA instrument. There are additional proposed national instrument contributions which are being considered. AMIR, GOMAS, and a Doppler wind sensor are instruments proposed in response to the ESA AO that will be finalized in May 1989. The science payload is also being actively studied and Phase A studies are beginning.

Dr. Readings asked a question about the possibility of long-term attached payload use for Earth observations. Dr. Butler stated that the science objectives for Earth observations require long-term data continuity, not short-term experiments. If Earth science is provided an attach point on Space Station Freedom, there is no intention to change out instruments, but to provide long-term continuity of observations with any changes being driven by upgrades or replacement to ensure continuity. With respect to JPOP and LAWS, NASA is supportive of a lower altitude for JPOP (to 550 km at a minimum). In addition, LAWS is being considered for flight as an attached payload on Space Station Freedom.

Regarding the data system, NASA and NOAA are working closely together. EosDIS is responsible for platform operations and management, as well as data processing, archiving, and distribution. Support to Eos investigators is also part of EosDIS. The system is being designed in an open architecture to facilitate international access and coordination, in accordance with agreements to be reached through ICWG. NOAA's system is driven by operational requirements, as well as correlative research activity support. The US approach is to have the agencies whose operational

missions are consistent with Eos data applications be responsible for long-term maintenance of the Eos archives (i.e., USGS and NOAA). The Eos objectives are to ensure the easiest and widest possible distribution in support of scientific and operational requirements on a global basis, consistent with interagency and international agreements. Mr. Schneider stressed that NOAA's timeliness requirements for operational data is considerably shorter than NASA's requirements for research, and this leads to the need for different systems.

ATLAS-1 includes a reflight of Spacelab-1 instruments that did not get the length of flight initially promised.

The NASA Space Station presentation was made by Mr. Scull (Document 11). He noted that the scope of his review was broader than just the polar platforms of the Space Station. With respect to attached payloads, Mr. Scull noted that there has not yet been an assignment of instruments to attach points. Within the Space Station Program, the User Operations Panel (UOP) will make those assignments, within the allocations agreed through the international structure established in the Space Station MOUs and IGA. Mr. Scull reviewed the international participation in the Space Station Program. The NASA-Japan MOU was signed in March 1989. The Intergovernmental Agreement was signed in September 1988 by the US, ESA, and Canada. It is hoped that the IGA will be signed by Japan soon. The new Program Director at Level II (E. Ray Tanner) is conducting a technical audit of the entire program, including the technical content of each Work Package and the current baseline. Commercial infrastructure proposals for Space Station are under consideration, and guidelines for their assessment are being developed.

The draft charters for the System Operations Panel and the User Operations Panel have been prepared and are in review by the international partners. Joint program plans and joint program requirement documents are being drafted for review. Progress is being made on the other documentation and planning defined in the MOUs and IGA. Mr. Scull presented the current Space Station Program schedule. The first element launch is scheduled for the first quarter of 1995, followed by a 3-year assembly process. The current organization and staffing of the Office of Space Station was presented. Among the recent proposed changes at Level II are the assignment of the Technical Management Information System (TMIS) to the Program Support Office, and to assign the Space Station Information System (SSIS) and the Software Support Environment (SSE) to System Engineering and Integration.

Mr. Scull presented the status of the first polar platform. Work Package 3, under GE Astro-Space Division, includes attached payloads accommodation equipment, integration and launch support for NPOP-1, development of NPOP-1, and options for integration and test of the NPOP-1 payload and development of a second integrated polar platform. The Phase C/D contract was signed in September 1988. Platform

subsystem preliminary design has begun. Accommodation studies are underway for the Rev. 3 payload. General payload interface specifications have been outlined and draft specifications are in process. Titan IV has been baselined as the launch system. PDR for NPOP-1 is scheduled for May 1990. Key design trades in the electrical power system and data management system are in process. Studies are underway to determine the proper level of subsystem commonality with the manned base.

Concept studies of servicing have been conducted. The results were inconclusive, and showed basically no difference between serviceable and replicable approaches. The mission will be designed to be serviceable, meaning that the design of NPOP will be "scarred" so as not to preclude servicing. The start of the follow-on Common Instrument Interface Study (CIIS) with ESA has been slowed by the delay in selecting the EPOP design baseline. Safe de-orbiting requirements are included in the NPOP baseline. The penalty associated with this requirement is on the order of one metric ton of propellant. The serviceability is built in to the current platform design through the use of orbital replacement units with Standard Interface Connectors (SICs) and the standard Module Interface Connectors (MICs) at the end of the platform to permit add-on carrier docking. Room for alleyways between ORUs and payloads is also being considered.

This presentation concluded the joint plenary session. The group adjourned and reconvened as the IFEOS Plenary.

IFEOS/CEOS Joint Plenary Session
April 3-4, 1989
Ottawa, Canada

Documents Distributed

1. ESA Report (Dr. Pfeiffer)
2. EUMETSAT Report (Mr. Morgan)
3. Canada Report (Dr. Langham)
4. Australia Report (Dr. Graham)
5. FRG Report (Dr. Langner)
6. Japan Report (Mr. Tanaka)
7. UK Reports (Dr. Thomas and Dr. Croom)
8. NOAA Report (Mr. Schneider)
9. Landsat Report (Mr. Mignogno)
10. NASA Earth Science Report (Dr. Butler)
11. NASA Space Station Report (Mr. Scull)