Global Terrestrial Observing System

Report of the Global Observing Systems Space Panel

Second Session

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Summary

The second meeting of the Space-based Observation Panel was held in Geneva, Switzerland, October 16-18, 1996.

The Chairman, Mr Morgan, welcomed all participants and defined two primary purposes of this meeting. The first objective is to develop a procedure and schedule to revise the GCOS Space-based Observations Space Plan. The second objective is to develop a strategy for working with CEOS. He stated that due to the enlarged terms of references the Space Plan will need a meticulous quantitative review and be up-dated with regard to user requirements. He further emphasised the need for the revised plan to be expanded to include the requirements from GCOS, GOOS and GTOS. The Chairman stressed the need for co-operation with CEOS Task Force groups. With regard to the new perspective of the GCOS Space-based Observation Panel activities the panel he suggested that the panel be renamed as the Global Observing Systems Space Panel (GOSSP).

In his message, the JSTC Chairman, Prof. John Townshend urged the panel to collaborate with subsidiary panels and to work closely with the CEOS working group on calibration/validation.

In the update of the Global Observing Systems it was pointed out that GCOS feels the revised Space Plan needs to focus principally on long-term space observations and on cooperation among the G3OS and CEOS. Climate-related requirements have been developed for oceanographic observing systems and provided to appropriate organisations. Furthermore, GOOS stressed the importance of regional benefits from satellite remote sensing and the role of numerical models. While the climate component was developed as an early priority, GTOS in the future will focus as well on non-climate components.

The participants concluded there is a clear need for:

- Space Agencies (a) to support the provision of data to fill gaps in temporal or spatial coverage; (b) to guarantee easy access to data for the user community at minimal cost; (c) to guarantee continuity and high quality of data; (d) to adapt quickly to the newest technological requirements;
- Planning future missions to have both a global and a regional perspective, e.g., open ocean and coastal zone;
- User requirements (a) to be well defined, put into easy understandable terminology and prioritised; (b) to be evaluated with regard to socio-economic benefits;
- Support of training and education programmes in developing countries;
- Existing and future databases to be made publically available and widely distributed.

The panel reviewed the space segment requirements contained in Version 1.0 of the Space Plan, and agreed that all requirements should be evaluated by an objective analysis. In order to address the analysis method the panel split into three *ad hoc* working groups to select ‘core’ parameters. The panel members agreed that the revised plan should contain theme-related requirements so as to enhance the impact of a coordinated set of requirements

from the G3OS. It was concluded that if done well and in a timely manner, Version 2.0 of the Plan would provide the space agencies with a baseline set of requirements for their post 2005 planning.

In the discussion about the ground segment requirements the main issues were the cooperation with the Joint Data and Information Management Panel and the work on developing country data and product issues.

The panel noted a number of required actions over the coming year and developed 16 recommendations. These actions and recommendations provide a basis for producing Version 2.0 of the Space Plan, and guidance for the implementation of the G3OS requirements by space agencies.

The second session of the Global Observing Systems Space Panel closed on Friday, 18th October1996.

Report of the Global Observing Systems Space Panel[1]

I. Welcome and Opening Remarks

The Chairman, Mr John Morgan, opened the second session of the Global Observing Systems Space Panel (GOSSP) on Wednesday, October 16, 1996 at the Geneva International Conference Centre (CICG), Switzerland. On behalf of the Joint Planning Office (JPO) for the Global Climate Observing System (GCOS), serving as local host, he welcomed all participants and invited them to introduce themselves (see Annex I). The Chairman briefly reviewed the agenda (see Annex II) which was accepted by the participants.

The Chairman started his introduction with an acknowledgement of the work of the former chairmen, Dr Ryder and Prof. Harries. He noted that considerable time had elapsed since the first meeting, and the primary intention of this meeting was to re-establish panel activities. In the interim since the first meeting, the Joint Scientific and Technical Committee (JSTC) of GCOS invited the Global Ocean Observing System (GOOS) and the Global Terrestrial Observing System (GTOS) to become co-sponsors of the panel. At the Joint Scientific and Technical Committee for the GOOS, J-GOOS-III, joint sponsorship was agreed. *[The Steering Committee (SC) of GTOS, agreed at its first meeting.]* He stressed that one objective of the meeting would be to find a mechanism to integrate the requirements of the three global observing systems in an appropriate manner.

The Chairman invited the Director of the JPO, Dr Spence, to contribute to the opening remarks by outlining the relations between GCOS and the other two observing systems. Dr Spence gave an overview of the status and activities of the steering committees of each programme and highlighted links among them. He also provided an update of GCOS. In addition to this panel, there are other joint panels including the GCOS/GTOS Terrestrial Observation Panel for Climate (TOPC), the GCOS/GOOS/WCRP Ocean Observation Panel for Climate (OOPC), and the G3OS[2] Joint Data and Information Management Panel (JDIMP). Both GOOS and GTOS are establishing other specific panels which may provide input to the GOSSP. For example, a Coastal Zone Panel may be a future joint activity of GOOS and GTOS. Dr Spence pointed out that objectives of GOOS and GTOS other than climate will be part of the remit of the GOSSP, and will be incorporated into future versions of the Space Plan. Focus will principally be on those observational requirements which will require the long-term continuation of space observations. Links to external organisations such as the Committee on Earth Observation Satellites (CEOS) will continue to be an important activity for the GOSSP.

[1] Formerly the GCOS Space-based Observation Panel.

[2] At the first meeting of the Sponsor Groups for the Global Observing Systems, it was agreed to refer to them collectively as G3OS.

Dr Spence read a message from the JSTC Chairman, Prof. Townshend, who was unable to attend. In his message, the JSTC Chairman stressed the importance of the panel's role in translating the multiple needs of the global observing systems into space requirements. He noted that the recommendations of the panel should be firmly embedded in the recommendations of the subsidiary panels such as the OOPC and the TOPC as well as others in place, or to be established by the steering committees of the global observing systems. He encouraged the panel to continue its close collaboration with the CEOS. In particular, he urged closer links with the CEOS Calibration /Validation Working Group (WGCV). A proposal from the "*In situ* Observations for the Global Observing Systems" meeting in Geneva encouraged the global observing systems to take a more strategic oversight for calibration/validation. In this context, Prof. Townshend hoped the space panel would therefore:

- take on the role of coordination on behalf of the global observing systems
- identify a small number of high priority calibration/validation activities for the WGCV to consider at their next meeting
- identify people to attend and communicate these priorities to the WGCV meeting, and report the results back to the global observing systems.

Finally, Prof. Townshend urged the panel to be careful not to apply any methodology which simply emphasises only deficiencies. The panel must also identify those current assets which are crucial to meeting the observing systems' needs. The panel should stress in a positive manner how improvements can ADD to our capabilities and enhance our understanding and ultimately benefit the various governments that participate in space programmes.

II. Statement of the Chairman

The Chairman gave a brief overview of the history and recent developments of the Space-based Observation Panel (SOP). He reported that there has been a rapid evolution in the scope of the panel since its last meeting. Thus, the panel will, in the future, support the space-related activities of GOOS and GTOS, as well as those of GCOS. He noted that as the panel had already benefited from the advice from several GCOS panels and would similarly depend on the appropriate panels of GOOS and GTOS.

In reviewing the current terms of reference for the panel, the Chairman concluded that few modifications would be needed apart from the obvious changes resulting from the new sponsorship and reporting aspects (see Annex III). The panel considered it essential to retain its previous main focus of monitoring the planet over extended periods (15+ years) of

time. Following this recommendation it was agreed that the panel should consider the monitoring requirements for the original (GCOS) climate-related space issues, the climate related space issues for both GOOS and GTOS, and also the long-term monitoring requirements additional to those for climate, for GTOS and GOOS. Additional satellite requirements for process studies or other near-term research should be addressed by other mechanisms.

The Chairman reported on the progress to date of this panel. He noted the publication of Version 1.0, the GCOS Plan for Space-based Observations (GCOS-15). The plan, which had been widely circulated, sets out the requirements for climate-related observations in terms of seven "GCOS Missions", and assesses the current projects and future plans of the space agencies to meet these requirements. He also noted the publication of The GCOS Guide to Satellite Instruments for Climate (GCOS-16), and cited comments from users as to its value.

The Chairman reviewed his expectations for the meeting:

- develop a strategy for updating the requirements and recommendations for Version 2.0 of the Space Plan;
- review the technical requirements for the space and the ground segments and establish priorities and ‘core’ parameters;
- outline an action plan for 1997;
- identify recommendations and responsibilities for future activities.

Dr Spence reminded the panel that there should be a Chairman's report at the next GCOS JSTC meeting and at future meetings of J-GOOS and GTOS SC.

III. Updates on the Global Systems

Global Climate Observing System

The Chairman noted that Dr Spence had already provided an update of GCOS in his earlier remarks.

Global Ocean Observing System

The Chairman invited Mr Withrow, Intergovernmental Oceanographic Commission of UNESCO (IOC), to report on GOOS activities. He reported on the remote sensing programme which had been developed for GOOS, noting that climate-related requirements

had been the purview of the SOP, and that other requirements were being developed by the Ocean Satellite Remote Sensing (OSRS) panel and the international Sea Ocean Colour Group. The results are provided to appropriate organisations, including CEOS, the Coordination Group for Meteorological Satellites (CGMS), and national agencies.

Dr Ryder, the former Chairman of the SOP, contributed to the GOOS update by reporting on the European GOOS activity (EuroGOOS) from a meeting in Den Haag, the Netherlands. EuroGOOS was established to promote the creation of efficient operational oceanographic services for the European seas and the participation of Europe in global ocean monitoring and prediction. Papers from the conference concentrated upon establishing methodologies for implementing such services and upon the associated economic and social benefits. He pointed out this regional, even local, manifestation of benefit from global, satellite remote sensing needed to be understood and articulated in the assignment of priorities by the GOSSP. Because they played such a significant role in assimilating data from satellites and were the main method of generating predictive services, he also noted that the panel needed to keep abreast of developments in the field of numerical modelling for the atmosphere and oceans.

Global Terrestrial Observing System

The Chairman invited Dr Cihlar, Chairman of the TOPC, to report on GTOS. Dr Cihlar pointed out that the main concern of GTOS will focus on those issues of most concern to human activities. While climate will remain a priority, GTOS must also address pollution and toxicity, loss of biodiversity, water resources, and land use and degradation. He noted the first meeting of the GTOS Steering Committee (SC) would be in Rome at FAO in early December 1996. As a result of the significant progress made by the TOPC, he expected that the SC would likely focus on non-climate components as a matter of priority.

Dr Cihlar reminded the panel that GTOS was being invited to become an affiliate of CEOS. *[Editor note: The SC agreed to accept this invitation and recommended that the GOSSP provides a primary link with CEOS]*

IV. Statements from Participants

The Chairman invited each of the individual participants to provide a brief statement, if desired.

Dr Desa described the current space-based observations and the future plans of India. The Ocean Remote Sensing Programme is based on specific missions of the INSAT, IRS-1x and IRS-Px series incorporating other resource satellites (i.e., LANDSAT, SPOT, NOAA, ERS-SAR). Dr Desa stressed the significance of the set-up of the Ocean Colour Validation Programme. Future objectives of the Indian Space Agency will be to provide data to fill data gaps, and to improve instruments which will lead to higher resolution. In

discussion, Dr Desa informed the participants that IRS-1c data can be received and procured from EOSAT (USA) or in India at the NRSA, Hyderabad.

Mr Johannessen gave an overview of the European Space Agency's (ESA) contribution to G3OS. He reported on the current status of the ERS, noting the significant contributions to operational oceanography and gave a future outlook of available instruments. He introduced ESA's Dual Mission Concept for the post-2000 era - called "Earth Explorer" and "Earth Watch". He remarked that the objectives of these missions will address atmospheric issues as well as open oceans and coastal zones. He predicted that the concept will link regional and global issues.

Dr Mitchell reported on work relating to GCOS space-based data requirements and associated priorities sponsored by the National Space Development Agency of Japan (NASDA). He informed the panel on work to date that NASDA had supported in establishing GCOS users' requirements and progress toward a parameter by parameter analysis. To develop priorities, he advocated the methodology of the Ocean Observing System Development Panel (OOSDP) and the Hadley Centre where priority requirements are based on a combination of their fundamental importance (decided by users) and their measurement feasibility (decided by technical experts). At this stage, the principal difficulties are to establish detailed requirements from the user communities and to ensure that these are expressed in a form which allows technical experts to assess their measurement feasibility. The Chairman supported the idea of a prioritisation scheme with regard to the impact of socio-economic benefits.

Mr Ishida summarised the Japanese Earth Observation Satellite Programmes and showed how NASDA supports the global strategy. He provided a report on the recent ADEOS satellite programme, and noted the variety of products which may result. Panellists were impressed with the first ADEOS images, since they gave an indication of the high quality of the data which should follow. The Chairman congratulated NASDA for the successful launch of ADEOS in August 1996.

Ms Gitonga agreed with panel statements about the need for complete data information over the Indian Ocean. She also noted the tremendous importance of programmes of training and education to assist developing countries in exploiting the satellite information.

As a frequent delegate to CEOS from GCOS, Dr Croom updated the panel on its activities. He reviewed the progress of the Long-Term Planning Task Force which is providing an assessment of the user requirements and the space agency capabilities. The Task Force has met frequently, and will report its findings to the CEOS plenary in November. He noted the opportunities for the GOSSP to assist in refining future analysis. For example, differences in definitions and terminologies between CEOS affiliates and CEOS members must be rectified. The Chairman agreed that a large amount of information must be put into convenient well-understood terminology, and volunteered that he would refer to the issue later in the meeting (see Section 6 and Annex IV). Drs Aschbacher and

Hinsman both pointed out that the existing database has been integrated and has in fact become the CEOS dossier.

Mr Mignogno presented NOAA's satellite programmes. He gave a general overview about the status of the Geostationary Operational Environmental Satellites (GOES) and the polar-orbiting Polar Operational Environmental Satellites (POES). Mr Mignogno elaborated the LANDSAT programme goals and underlined especially the LANDSAT-7 mission (May 1998 launch). This mission was cited as an interesting one for the ocean community due to the fact that high resolution data, distributed by commercial operators, will be widely available. Panellists asked if international ground stations receiving LANDSAT-7 data will follow US data policy and offer data at the cost of fulfilling user requests (i.e., low cost). In his response, Mr Mignogno clarified that all data must made available on a non-discriminatory basis but prices may be set in accordance with national laws and policies. He pointed out that in the development of requirements or gaps analysis, in the future the panel should consider commercial remote sensing space systems.

Dr Aschbacher discussed the status and prospects of the G7 Environmental and Natural Resources Management Project (ENRM) Virtual Library Prototype Server. This project, conceived by the Centre for Earth Observation (CEO), is driven by the space community to acquire and search for data sources. It has been established to enable users to take an active part in the system which is based on existing infrastructure and standards. The main goal is to develop a global database which is inter-active and on-line to meet public users' needs. At the moment, only meta-information can be accessed.

Dr Cihlar referred to the GCOS/GTOS Plan for Terrestrial Climate-related Observations (GCOS-21) and the ongoing review of the Plan, Version 2.0. Particular emphasis has been given to the hydrosphere and cryosphere in this version. He noted that a mismatch has been discovered between variables and measurements which proves the necessity of a accurate definition of requirements.

Mr Lefebvre introduced a proposal for an integrated strategy for the J-GOOS. It includes space and *in situ* observations as well as modelling and data assimilation as components of an operational system. These three components should work in operational mode and be embedded in a coherent system by the year 2000.
Mr Lefebvre put stress on data availability and user integration. Major points of discussion of the specific components were data continuity and the difficult updating of systems referring to the space component. He recommended additional commitments from both space and other agencies.

Prof. Wingham presented recent scientific results illustrating the use of satellite information in cryosphere studies. In this way, he stressed the value of having high quality data. He proposed that some data sets are of fundamental importance, and that the GOSSP should identify them and stress their significance.

Dr Karpov reported on space projects in the Russian Federation, noting plans for the Stratospheric Aerosol and Gas Experiment (SAGE) project in 1997 and the launch of a new satellite in 1998.

Dr Hinsman gave an overview of the history and status of the World Meteorological Organization (WMO) / CEOS - Database. The start of the WMO database was in 1985, based on requirements contributed by the WMO Technical Commissions, and in 1989, by an Executive Council Panel of Experts. Between 1990 and 1996 there was a rolling review of requirements involving the Commission for Basic Systems (CBS) and a Working Group on Satellites. CEOS was formed in 1985, and in 1990 the user side had been integrated. In 1992, in connection with the Earth Summit in Rio, the Dossier of Instrument and Missions was created. The database developed by user groups has existed since 1993/1994. In 1995, the CEOS task force, in its first report, proposed a detailed database structure. In the same year the databases of instrument performances and requirements were combined to form a single database. Dr Hinsman demonstrated the new updated and on-line version of the database, which is available on disk. The Chairman suggested that the database products should be correlated with priority indices and that requirements should be plotted against each other. Dr Hinsman agreed to update the GCOS Guide to Satellite Instruments for Climate (GCOS-16) and publish it in electronic format.

Dr Halpern illustrated how scientific results can be achieved using existing ESA and Jet Propulsion Laboratory (JPL) data products and personal contacts. The Chairman indicated that the Data Transfer Working Group is at present working on problems caused by the use of different data sources and connections. It is hoped that the GCOS database, consisting of high level products, will serve as a better source of information.

V. Review of Space Plan, Version 1.0

The Chairman invited any comments and suggestions concerning the review of the present GCOS Plan for Space-based Observations. Participants agreed that a thorough review of Version 1.0 was desirable, and should be a priority of the group. After considerable discussion, an outline of the future plan was developed (see Annex VI).

A general comment on the plan was that one should be aware of the limitations in the document since, due to the time constraints under which it was prepared, it was based on limited input from scientists. In a similar fashion, the input from space agencies had not been updated recently, and thus the document was fated to have limited ‘shelf life’. Prof. Wingham suggested that in order to convey adequate impact, the panel should define a new category -- a "goldstar" category -- that would designate data of fundamental importance to climate issues. The maintenance of such data should be a primary goal of GCOS. Relating to a similar concept, Dr Halpern proposed that the plan be developed around principal themes which would find resonance with current research activities. The panel agreed that recommendations arising from important theme-related issues addressing not only climate

relevant parameters, but also parameters of socio-economic benefit, could be important and generate more support for the space programmes of the G3OS.

The panel suggested that the validation of the space systems with *in situ* data should be emphasised in the revised Space Plan. The panel urged the JSTC to build links between *in situ* data, models, and space systems. Additionally, the panel recommended that the calibration sections in the Space Plan address overall system calibration rather than instrument calibration.

The panel also reviewed the recommendations in the current plan. One major point of concern of the panel is that there is no assured data continuity in the morning- polar orbit and no assured data coverage over the Indian Ocean. The panel agreed that, as stated in the first recommendation of the Space Plan, data continuity from the operational meteorological satellites is still vital.

The panel did agree that it was not the best forum in which to discuss data charging policies, but decided that the present variations among space agencies make utilisation of the space data much more difficult than it need be. Also the policy differences among space agencies are certainly impediments to the establishment of an effective and efficient global observing system. The panel therefore recommended that the steering groups of the G3OS make a strong case to the space agencies on this subject.

VI. Space Segment Requirements Review

In its discussion concerning requirement analyses, the panel agreed that its earlier seven-category "GCOS missions" remained valid. It was clear that a comprehensive approach was needed to perform an analysis, but that the results must be presented in a comprehensible manner.

To address this issue, the Chairman presented an analysis concept. He illustrated an objective analysis methodology which he had recently developed for a WMO assessment of requirements and space resources, and then further refined for a more wide-ranging analysis required by CEOS (see Annex IV). The panel agreed that a similar analysis, thoroughly checked by an expert group, should be incorporated in the next edition of the Space Plan. This would be a comparison of the updated requirements, established with the help of the science panels, with the performance of the available space assets. Performance details should be obtained from the relevant space agencies, but carefully checked and approved by expert users before being incorporated in the analysis.

The panel noted that there is need to develop a more complete suite of requirements, in particular from GOOS and GTOS. Because of the current long lead time for planning activities in the space sector, this is an urgent matter. It was recommended that the planning committees of these programmes be informed of the need for them to provide additional

information as soon as it can be prepared.

In order to develop a set of priority parameters to apply the analysis method, the Chairman proposed three *ad hoc* working groups be set up to identify a small number of critical variables. Participants divided into atmosphere, ocean and land working groups to identify ten or fewer 'core' parameters for each of the seven GCOS missions. Where possible, the working groups were asked to identify the most important parameters out of the ten 'core' variables. The resulting sublist should contain about three parameters. This preliminary identification of variables was to initiate the method, which will need to be verified by relevant science or application panels of the G3OS. The panel considered that this sublist should be treated in a different manner from the list of 'core' parameters and should not be transmitted formally as a requirement, but used internally by the panel to help focus specific recommendations. The 'core' parameters should be first-order variables capable of being observed from space and essential to meet user requirements. The ones finally selected would be published in the updated version of the Space Plan and would be used for CEOS analysis activities. A list of the specified parameters and the report of the working groups can be found in Annex V.

It was noted that as yet there are few quantitative requirements for atmospheric composition and the panel recommended that urgent attention is given to this gap.

The panel discussed how a review procedure can ensure the accuracy of the data requirements. The number of parameters should be sufficiently small, so that enough experts can be found for a review. The panel agreed to the following reviewing mechanism for the first 'cycle' of review: (1) the panel will prepare the first detailed list of parameters and will send the list to selected reviewers; (2) the list and associated comments relating to requirements and corresponding instruments will be used in the analysis process (Annex IV); and (3) the results sent back to the panel. For the second cycle, these decisions will be cross-checked and re-analysed by selected experts. Finally, the list will be returned to the panel.

VII. Ground Segment Requirements Review

One of the main issues raised in the discussion about ground segment requirements was the potential cooperation with the JDIMP. *[Editor note: This panel is now jointly sponsored by the three global observing systems.]* The panel considered the important role it has relating to the generation of basic data by the space agencies, and in the coordination of data dissemination activities. The panel saw its role as complementary and non-overlapping with work of the JDIMP.

The panel discussed its role regarding developing countries. It considered that the guidelines already established by the JDIMP could form the basis for an approach to benefit developing countries, but that the Space Plan should elaborate it further. A first step would be to find ways to frame its recommendations to the space agencies for implementation. It

was recommended that the space panel and the JDIMP find effective mechanisms for working together on developing country data and product issues.

Panellists remarked that archiving, processing, and other data activities related to long-term monitoring should be established as routine processes, but at present they are seriously neglected by many of the responsible agencies and laboratories. One of the major problems will be to obtain commitments from agencies to provide data and products reliably to meet the needs of the observing systems and their user communities.

VIII. Future Observing Systems

The panel noted that the Initial Operational System (IOS) defined by the GCOS JSTC extends to 2005 and that for the space agencies, planning for that period and even beyond is already in progress. It is essential that the requirements of the global observing systems be clearly articulated and understood. This has two aspects. First, the Space Plan must be reviewed and up-dated, partly because of the expanded terms of reference of the panel, but also because requirements can now be better described. This update should then be used as baseline requirements document for the post-2005 planning. Second, careful thought must be given to the process by which the requirements and Space Plan document are updated. The panel agreed that for now, the definition of the process is more important than trying to decide in detail what the requirements might be in 5, 10 or 15 years from now. This was seen as a general problem relevant to nearly all components of the G3OS programmes. The panel proposed that there should be a top-level strategy to systematically review requirements from the science panels through to the cross-cutting panels, on a cycle of a few years.

The panel proposed that instead of specifying individual recommendations, a paradigm should be accepted whereby the end-to-end procedure from observation to product should guide the panel in its evaluation. Recommendations should be allowed to change and evolve with time due to the fact that scientific interest and technical standards change, and new public issues arise. The Chairman agreed that medium-term activities should be embedded in long-term perspectives.

IX. Action Plan

The panel noted with concern that many of its earlier recommendations had not yet been translated into relevant action. For example, there is still an urgent need to provide routine geostationary data over the Indian Ocean. The panel agreed that it should review and clearly restate its earlier recommendations. The panel felt it necessary to make its future recommendations more specific, and if possible, target them to appropriate bodies for action.

The panel agreed that for at least two reasons it had become necessary to make a thorough revision of the first version of the Space Plan. The first reason is linked to the evolution in the panel's terms of reference, now taking into account GOOS and GTOS observing requirements. The second is the rapid evolution of space agency activities, notably the concept of an Integrated Global Observing Strategy (IGOS). The IGOS planning activity, in particular, will require strong inputs from the users. The panel recommended that the revised Plan provide the perspectives of the global observing systems for the IGOS process. The panel recommended that the revision of the Space Plan be its highest priority. Members agreed to actively participate in the revision, and, if possible, to complete a draft of it by mid-1997. In order to meet this challenging deadline, the Chairman, and the Director of the JPO, will outline a work plan which will assign tasks to specific individuals. The participation of other panels and of both GOOS and GTOS experts will be essential.

An essential element of the updated Space Plan would be a review of the requirements, to be made in conjunction with the science panels. The panel agreed to participate with the space agencies and the other CEOS affiliates to harmonise definitions and vocabulary across all user requirements. The GCOS JPO will assume responsibility for communicating between the panel and the affiliates.

The panel determined that an objective assessment of space assets, in comparison with the requirements, should be incorporated in the revised plan. Such an assessment would then form the basis for updating the panel recommendations. The Chairman proposed that the revised Space Plan emphasise the GOSSP ‘core’ parameters for each of the seven G3OS "missions" areas (formerly the "GCOS missions"). These ‘core’ parameters should be reviewed by individual ‘external’ experts, as well. The Chairman proposed the panel adopt a review process which used a step-by-step evaluation method based on requirements for spatial and temporal coverage, accuracy, and frequency of observation. This process, if adopted, could become a standard for the affiliates and the space agencies. Since the results of the evaluation are conveniently represented by means of colour coding, the Chairman identified the method as the ‘colour code’ analysis. The results of applying the method to the ‘core’ parameters would be communicated to the space agencies.

The evaluation process should comprise correspondence with individual experts and the presentation of a first draft describing the selected ‘core’ parameters. The chairman agreed to provide oversight and assistance with this aspect of the process. Furthermore, a test case for few parameters will be prepared to be sent to the individual selected experts.

The panel considered it important to develop an effective way to revise the Space Plan so that its analysis would provide a clear account of the need for space-based observations in terms of critical problem areas, or ‘themes’. Using a ‘theme approach’, users would be invited to show how our understanding of global problems (e.g., sea level changes) depends on observations, and how the collection and analysis of these observations would be effective in addressing the problem. Several ‘themes’, some of which have been articulated by agencies such as WMO, NOAA, and Natural Environment Research Council

(NERC), were discussed by the panel, and were thought to be appropriate for the Space Plan revision. The approach that was adopted would lead from the 'themes' to specific variables needed, an assessment of relevant observational capabilities, to a final set of recommendations to meet the requirements. Finally, a summary chart, possibly using the 'colour code' approach, would be prepared to illustrate the situation with regard to the 'core' parameters.

The panel agreed that it should, in cooperation with the science panels, identify requirements for calibration and validation as an input to the upcoming CEOS WGCV. The GCOS representative, Dr Croom was invited to suggest that Leaf Area Index (LAI) be considered as a variable to be addressed by the WGCV. The GTOS SC should also be invited to consider LAI and suggest other variables for consideration by the WGCV to establish a working relationship for cooperation.

X. Recommendations Arising from the Meeting

The Chairman invited four participants (Drs Croom, Cihlar, Ryder and Aschbacher) to prepare supplementary recommendations which were accepted by the panel (see Annex VII).

Based on the discussion and findings of the panel, the Chairman prepared a consolidated list of recommendations. The following recommendations were agreed by the panel:

Recommendation 1: The panel advocated that its name become the Global Observing Systems Space Panel (GOSSP).

Recommendation 2: The steering committees of the three global observing systems (GCOS, GOOS, GTOS) should be invited to concur in the evolution of the space panel's role.

Recommendation 3: The space panel should focus on long-term monitoring for climate and other priority areas proposed by the three observing systems.

Recommendation 4: The panel should coordinate an analysis of user requirements based on demonstrated methodology, with meticulous quality control by experts from the data user community.

Recommendation 5: The panel should revisit the extended requirements resulting from its new remit and, in cooperation with the relevant science panels, group requirements according to the seven global observing systems space 'missions'.

Recommendation 6: The panel should define priorities in a structured way, with a balanced set of 'core' requirements, established in conjunction with the science panels for each of the seven global observing system space 'missions'. These 'core' requirements should be the main focus for comparison with the capability and availability of space assets, and should be published in the Space Plan.

Recommendation 7: A sublist of 'core' parameters (about three for each 'mission') should be established for internal use by the panel.

Recommendation 8: Agencies planning operational systems in polar orbit should be asked to move as quickly as possible towards establishing firm, fully-funded, long-term plans. In particular, space agencies should be asked to find a way to provide routine geostationary data over the Indian Ocean to match that in the rest of world.

Recommendation 9: The steering committees of the three global observing systems should make strong representations to the space agencies noting that, in the interests of the health of the planet, there is an urgent need for coordinated and coherent data policies which will facilitate the efficient use by scientists of the entire global satellite observing system.

Recommendation 10: The panel should review previous recommendations and to seek to make future recommendations more specific.

Recommendation 11: The Space Plan should be developed according to a selected set of critical 'themes' as a basis for presenting requirements.

Recommendation 12: An objective compliance analysis should be included in the revised Space Plan.

Recommendation 13: The Space Plan should outline a strategy based on an end-to-end process from the collection and production of basic data by the space agencies from earth observation satellites through the provision of data products and their subsequent dissemination.

Recommendation 14: The panel should revise and update the Space Plan, with a draft available by the middle of 1997.

Recommendation 15: The CEOS WGCV be invited to co-operate with the GOSSP to select and address significant issues. For example, Leaf Area Index, a parameter of importance to both GCOS and GTOS should be considered by the WGCV as a future project in

calibration/validation. Additional parameters should be presented to the WGCV as they arise from discussions among the global observing systems and their panels.

Recommendation 16: The steering committees of the global observing systems should establish and agree to a strategy for a continuing update of their requirements, which should involve all of the science and cross-cutting panels. It is proposed that this may involve a general update every five years after 1997.

XI. Closure of the Meeting

The Chairman closed the meeting at 5 p.m. on Friday, October 18, 1996.

Annex 1: List of Participants

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Annex 2: Agenda

1. Welcome and Opening Remarks

2. Statement of the Chairman

3. Updates on the Global Observing Systems
   3.1 Global Climate Observing System
   3.2 Global Ocean Observing System
   3.3 Global Terrestrial Observing System

4. Statements from Participants

5. Review of Space Plan,Version 1.0

6. Space Segment Requirements Review

7. Ground Segment Requirements Review

8. Future Observing Systems

9. Action Plan

10. Recommendations Arising from the Meeting

11. Closure of the Meeting

Annex 3: Terms of Reference

Recognizing the need for a comprehensive approach to the various space-based observational activities for the global observing systems, the JSTC of GCOS, the Joint Scientific and Technical Committee for GOOS (J-GOOS), and the Steering Committee (SC) for GTOS have established a Global Observing Systems Space Panel (GOSSP).

Terms of Reference:

Based on guidance from the JSTC, J-GOOS, and the SC, the primary tasks of the Panel are:

- To maintain and further develop the plan for the space-based observation components of the global observing systems considering the requirements from the scientific panels;

- To develop, integrate, and promote the space-based observational requirements of the user communities carrying out global studies and providing related advice and services;

- To recommend to the space agencies how these requirements may be met (e.g., through such bodies as the Committee on Earth Observation Satellites or the Coordination Group on Meteorological Satellites);

- To facilitate the participation of the global observing communities, in particular in developing countries, through regional activities;

- To identify and evaluate problems, and advocate solutions;

- To report regularly to the JSTC, GOOS, and GTOS SC.

The GOSSP will be the focus for exploiting space systems in meeting the objectives of the global observing systems. The Panel must continually refine, update, and interpret the implications of the requirements of the user communities carrying out global studies, and provide related advice in terms of space instruments and satellite payloads flown by the data providing agencies.

Chairman: Mr. John Morgan

Last Meeting: 16-18 October 1996, in Geneva, Switzerland

Annex 4: Reports of the Ad Hoc Working Groups[3]

The Chairman proposed three *ad hoc* Working Groups be established to select a small number of high priority variables to be included in preliminary analyses using the objective (colour code) method. Where possible, they were also invited to select three of utmost importance. Working groups were established to discuss atmosphere, ocean, and land surface variables.

1. *Atmosphere Variables*

Members of the Group included Dr Croom, Ms Gitonga, Dr Hinsman, Dr Karpov, Mr Mignogno, Mr Morgan, Mr Ratier, Dr Richter, and Dr Ryder.

The *ad hoc* Working Group discussed three general atmospheric issues: (1) atmospheric dynamics; (2) global radiative properties; and (3) atmospheric composition. The variables were divided into primary and subsidiary measurements, together forming the list of 'core' parameters. The three parameters chosen out of the 'core' parameter list as most important ones are represented in the primary measurements.

(1) Atmosphere Dynamics

Primary measurements include:
Wind profile (for 3 levels)
Temperature profile (for 3 levels)
Humidity profile (for 3 levels)

Subsidiary measurements are:
Total liquid water content
Precipitation rate

(2) Global Radiative Properties

Primary measurements are:
Top of the Atmosphere (TOA) outgoing short-wave radiation
TOA outgoing longwave radiation
Cloud cover

Subsidiary measurements are:
Solar constant

[3] **For some parameters discussed in the Working Groups new terms have been agreed at the WMO-CEOS Database Reconciliation Meeting in Geneva, Switzerland, January 23-24, 1997.**

(3) Atmospheric Composition

There are qualitative requirements, based on straightforward physical principles, and the existence of active research programmes in the field, which point to desirability of measuring:

Cloud composition
Aerosol distribution
Trace gas composition

However, at present these have not converged to quantitative requirements for long-term monitoring specified by the Atmospheric Observation Panel.

Regarding the issue of fluxes, Dr Ryder prepared a statement:

It would be highly desirable for the purposes of the GOSSP to monitor the fluxes of sensible and latent heat, and where significant, momentum across the boundaries between land, atmosphere, cryosphere and oceans. In general, such fluxes are not amenable to direct measurements from space. However relevant secondary measurements can be made from which at least some of the properties of such fluxes can be inferred. At the land, ice, atmospheric boundaries, such measurements can be characterised as time series of multi-spectral (visible, infrared and microwave) imagery, from which momentum of the ice edge, changes in albedo, emissivity, temperature, etc., can be inferred. These measurements are generally required at high spectral and spatial resolution, but low temporal (daily) resolution, provided that diurnal tidal effects can be dealt with.

2. ***Ocean Variables***

Members of the *ad hoc* Working Group included Dr Desa, Dr Halpern, Mr Ishida, Mr Johannessen, Mr Lefebvre, Dr Spence, and Mr Withrow

The Working Group identified the following core ocean parameters:
Geoid
Ice Thickness
Ocean Colour (Biomass)
Ocean Surface Topography
Ocean Surface Wind Vector
Ocean Wave Spectra
Sea Surface Temperature (SST)
Sea Ice Concentration
Sea Ice Cover
Sea Ice Edge
Sea Surface Salinity

Discussions covered SST, ocean colour, surface wind vector, and various sea ice parameters. The feasibility of sea surface salinity was discussed and it was pointed out that

recent efforts indicated that progress had been made recently in the measurement of this parameter. Ocean colour received a lot of interest. It was considered to be important because we do not know how to simulate it, or derive it from other observations. It was pointed out that this parameter could be even more useful when used in conjunction with other parameters such as SST. A system approach would be valuable and the relation between observations and models was critical. There was discussion on the users of the measurements and how the observations could be assembled under a coherent plan. The global coupled ecosystem model was identified as an important goal and eventually the modelling of the global environmental system.

The meaning of 'operational' was discussed, and it was agreed that while 30 days may be considered 'operational' in the ocean sense, there were many things such as algae blooms that required almost synoptic monitoring. SST, sea surface topography, and surface wind vectors were identified as being of importance in relation to long-time series climate parameters. Data relay capability, not highlighted in the first version of the space plan, was identified as an important requirement for future ocean observations. Measurements should require at least 2 Dual Swath Scatterometers or 2 Altimeters (at least one Topography Experiment (TOPEX) / Poseidon class).

The Working Group decided that it was not possible to select a sublist containing the three most important parameters out of the 'core' parameter list for the ocean. The Group believed that the parameters selected will depend heavily on the problem being addressed. A climate problem would bring out a certain sublist while a coastal 'problem' would require another set. In selecting high priority parameters, the crossover between land and ocean may need to be considered. The Group decided that it would be important to add an annex that described the progress made to those improvements. The need to take into account the socio-economic effects of the product is necessary to gain support for future instrument/product development.

3. *Land Variables*

Members of the Working Group included Dr Aschbacher, Dr Cihlar, Dr Kibby, Dr Missotten, Dr Mitchell, and Prof. Wingham

The Working Group adopted a series of six steps to review the lists of parameters:

(1) Start with variables identified by TOPC (except for sea ice) based on the GCOS/GTOS Plan for Terrestrial Climate-related Observations (GCOS-21) (as revised, pp. 60-61; see draft submitted to JSTC-VI) cross-checked with the list of "*In Situ* Observations for the Global Observing System" developed by Unninayar and Schiffer (1996), (Draft Paper available from JPO). In addition, the Group considered only land variables (i.e., they excluded variables related to atmosphere and terrestrial - atmosphere interactions) and the requirements in terms of biophysical information requirements (not in terms of quantities measured by satellite sensors).

(2) From among the variables from step (1), select those for which satellite data could in

principle provide useful information (primarily in view of the limitations of the physics of electromagnetic sensing); (see columns 'Variable' and ' Step 3' below.)

(3) Carry out a cursory review of additional key variables likely to be needed by non-climate component of GTOS (land degradation, biodiversity, chemical pollution, water resources) for which satellite data can in principle provide information (see Step 2).

(4) From among variables that met steps (2) and (3), identify those where a good chance exists now of obtaining a useful long-term global data set with the use of satellite measurements. Assign a rating of 'H' = high, 'M' = medium, 'L' = low (includes variables modelled or inferred using other, more directly observed variables), or 'N' = none (may provide related information but cannot be presently produced to yield the variable as defined by TOPC).

(5) From among the remaining variables in step (4) select 10 to 12 priority variables that should be included in a satellite land mission.

(6) From among the remaining variables from step (5), identify three parameters, i.e., those that are critically important to GCOS/GTOS terrestrial objectives, where satellite-derived products will make an essential contribution, and where a long-term data set can be envisioned at this time. In other words, includes a judgement on the importance of the variable to GCOS/GTOS objectives.

Finally, the Working Group reviewed the specifications of the variables as given in the report "*In Situ* Observations for the Global Observing System" by Unninayar and Schiffer (1996).

The following table shows the list of variables that remained after the above steps:

Variable	Step 2	Step 3	Step 4	Step 5	Step 6
Leaf area index	x		H	x	x
Net primary productivity	x		M-L		
Surface roughness	x		N		
Net ecosystem productivity	x		L		
Biomass-above ground	x		L		
Spectral greenness vegetation index	x		H	x	(intermediate para-meter for LAI, etc.)
Stomatal conductance-maximum	x		M	x	
Vegetation structure	x		H-M		
Fire area	x		H	x	x
Land cover and l.cover change	x	x	H	x	x
Land use	x		L		
Soil moisture	x		L		
Surface water storage fluxes	x	x	M-L	x	
Glaciers mass balance	x		M	x	
Ice sheet and ice caps mass balance	x		H	x	
Ice sheet geometry	x		L		
Lake and river freeze-up and break-up (timing)	x		L		
Snow cover area	x		H	x	x (see comments)
Fraction of photosyn-thetically active radiation	x		M (LAI needed more)	x	
Snow water equivalent	x		M-L	x	
Topography	x		H		(see comments)

Comments:

- The final choice of variables depends on the choice of the questions. The choices made here reflect mainly some aspects of climate change impact and feedbacks from the land surface to climate;

- Leaf Area Index (LAI) is a critical input for Biological Global Climate (BGC) modelling and General Circulation Model (GCM) / Numerical Weather Prediction (NWP) modelling;

- Net primary productivity is estimated using models with inputs of LAI, or models using other satellite-derived variables such as incident solar radiation, Fraction of Photosynthetically Active Radiation (FPAR), etc.;

- Surface roughness (aerodynamic) is presently derived with Soil-Vegetation-Atmosphere Transfer (SVAT) models;

- Net Ecosystem Productivion (NEP) is derived from Net Primary Production (NPP) and other variables using models;

- Biomass is detectable using remote sensing only at low levels (herbaceous and thin woody stands);

- Spectral Vegetation Index (SVI) is an intermediate parameter between a raw satellite measurement and a biophysical variable such as LAI and FPAR. In less sophisticated models (e.g., for NPP estimation) SVI is used directly. Although SVI is an absolutely essential parameter, it is not included in the final list to maintain consistency in the table (which emphasises biophysical variables, not satellite measurements);

- Stomatal conductance is a function of spectral radiance and SVI;

- Vegetation structure (physiognomy) is presently derived from the knowledge of vegetation type. Potential for direct estimation exists in future data (e.g., laser);

- Fire area is required to reduce uncertainties in the global carbon budget calculations (biomass burning), for use in atmospheric modelling (aerosols), and for trace gas modelling

- Land cover (including land cover change) is essential for many GCOS and GTOS objectives; for GTOS, higher spatial resolution will generally be needed;

- Land use is inferred from the knowledge of land cover;

- Soil moisture data cannot be obtained from satellites except for the near-surface layer (refer to GCOS-21 for discussion);

- Surface water storage fluxes require measurements of changes in both area (image-type data) and depth (altimeter-type data). Since most surface water over land is in small water bodies, such measurements are not presently feasible on a global basis;

- Ice sheet mass balance data are required to predict the contribution of ice sheets to sea level rise; its magnitude is the largest uncertainty in determining the cause of the present sea level change. Meeting this information need, implies measurement of the area extent (image-type data) for small ice bodies and volume (altimeter-type data) for both small and large ice bodies. This variable is not in the final list in order to keep the final list short. Although *in situ* measurements could in principle be used, this is not a practical solution given the vast areas involved;

- Snow Water Equivalent (SWE) is the amount of water within the snowpack per unit area. In principle, SWE can be estimated from passive microwave radiometer measurements. Present understanding does not allow useful estimates in forested areas;

- Snow cover area is important in the determination of cold season albedo, as an indicator of interannual climate variability, for vegetation production in some regions, and for reservoir management in some regions. The SWE distribution is also important; however, it is not presently feasible to produce accurate global data sets of SWE distribution. Snow depth data (reported on Global Telecommunications System (GTS)) are presently used as a surrogate of SWE. Thus it is suggested that if snow cover is required to

improve knowledge of albedo, snow area rates ‘H’; without it, it would not be in the sublist of three out of the ten ‘core’ parameters. Note that albedo can be measured directly from satellites, although it can be difficult to distinguish between snow and clouds;

- FPAR is a measure of the proportion of solar radiation between 400 nanometers and 700 nanometers, which is utilised in the process of photosynthesis. FPAR is a direct input into some vegetation models, and it can also be used to derive LAI estimates. As an information requirement, FPAR is rated lower than LAI because LAI has broader uses;

- Topography is essential for many applications, including the corrections of satellite data before use. It is therefore rated as ‘H’ in importance but it is not included in the final list because topography does not present a monitoring requirement;

- It was noted that the variable specifications given by “*In Situ* Observations for the Global Observing System”, by Unninayar and Schiffer (1996), do not always correspond to the TOPC specifications; this should be corrected.

Caveats:

The above analysis has been carried out as a quick exercise and it is essential that it be critically reviewed by specialists.

Importantly, requirements for GTOS non-climate objectives should be based on the defined information needs and variables for those objectives; these information needs should be specified by GTOS as a matter of priority.

Annex 5: Draft Outline of the Space Plan, Version 2.0

Chapter 1 **Introduction**
Introduction to be rewritten and up-dated

Chapter 2 **Aims and Objectives of The Space Plan** Add discussion of potential integrated strategy, justify using‘theme’approach

Chapter 3 **G3OS Missions and Relevant Space Programme**
Revise and up-date mission approach, but retain seven categories

Chapter 4 **G3OS User Data/Product Requirements**
More fully document user request

Chapter 5 **Initial Operational System and Outlook**
Revisit and reconfirm the priorities, use the relational databases, add the new presentation methodology

Chapter 6 **Ground Segment**
Special attention to preparation of a comprehensive ground segment

Chapter 7 **Involvement of Developing Countries in the G3OS Space-Based Observation Programme**
Revise and up-grade section on the involvement of developing countries

Chapter 8 **Cost-Effectiveness**
Improve and quantify arguments on cost-effectiveness and the ‘theme’ approach

Chapter 9 **Recommendations**
Reformulate and reassess recommendations

Some specific changes for Version 2.0 were identified:

- EUMETSAT/ESA should be encouraged to fulfil the first recommendation in Version 1.0
- Chapter1, p.1, section 1.2 should be reviewed
- Chapter 3, Figure 3-1, p. 6 has to be revised
- Revision Chapter 4, which includes all requirements

- Chapter 5 needs complete revision

- Chapter 6, (p.25, last paragraph) raises the problem of the generation of data products, which must be addressed.

- Chapter 8 should be much more specific. Cost-effectiveness has to be quantitative and figures should be given to the extent possible

- Chapter 9 has to be revised and to be formulated more constructive and recommendations should be more carefully stated.

- There are two standards of data levels (Annex VI, p. 51) which lead to translation problems. Rectification should be agreed.

Annex 6: Specific Recommendations from Participants

In addition to the recommendations in Section 10, several individuals were invited to address their specific concerns:

Dr Croom:

GCOS is essentially concerned with long (15 + year) time series, implying requirements not only for RMS accuracy, but also for long-term bias (which cannot safely be assumed to be zero). However, with very few exceptions (e.g. SST, TOA radiation fluxes) specifications for bias have not yet appeared in the requirements. This need for low levels of long-term bias is what in many areas distinguishes climate needs from those of other disciplines. Panels are therefore urged to consider their needs for long-term bias in formulating their requirements.

Dr Cihlar:

1. GOSSP considered the importance of existing data acquisition and analysis programs for building up time series of data. Based on the input of the GCOS/GTOS Terrestrial Observation Panel for Climate, GOSSP endorsed current global AVHRR data acquisition at full (1 km) resolution and its continuation, through the following recommendation:

Recommendation 1. Continue the acquisition of the global 1 km AVHRR data set and ensure ongoing processing from 1992 to beyond the launch of future satellites (SPOT4, EOS-AM, ENVISAT). Provide sufficient overlap between the AVHRR and the subsequent data sets to ensure consistency in the time series and facilitate the transfer of algorithms (such as those based on vegetation indices) from AVHRR to future sensors.

2. GOSSP acknowledged the expanded calibration/validation programme of CEOS as an important step in making space observations a high quality data-gathering tool which will provide critical global information for the observing systems. Two specific recommendations were made to CEOS in the area of calibration/validation. The request for quality calibration information has two elements; 1) obtaining the calibration data and 2) making them available to the user community. Although progress in this area has been made, deficiencies remain. It is recognised that increased effort has been made by many space agencies in ensuring proper calibration of sensors under construction, but increased effort is required for sensors currently operating (e.g., AVHRR and LANDSAT). The second recommendation is a proposal for a pathfinder case in the relatively new area of product validation and its international coordination. CEOS has an important role to play, and its willingness to undertake these activities through the WGCV is acknowledged.

Recommendation 2a. Continue efforts in maintaining accurate knowledge of post-launch

sensor calibration, especially for the active AVHRR sensors and for LANDSAT, and make calibration information for present and future satellite sensors accessible to the user community on Internet.

Recommendation 2b. Initiate coordinated global validation efforts for Leaf Area Index (LAI) products and Fraction of Photosynthetically Active Radiation (FPAR) products derived from satellite data.

3. GOSSP discussed the present difficulties in obtaining effective access to high resolution satellite data, principally due to the high costs of most of the data products. This issue is highly relevant to the global observing systems which are designed primarily to provide information for public good. It was pointed out that this is not a new issue and that it has been discussed by various meetings and groups, but it was accepted that this issue is an important one for the initial global observation strategy being considered by CEOS.

Dr. Ryder:

The panel found it difficult to fully represent the requirements of the science panels in its recommendations, in the absence of guidance on the way in which specified measurements would be processed to generate useful products and services.

The difficulty is manifest at the level of individual derived products where the availability of complimenting in-situ measurements and data assimilation by numerical models can increase the value of the combination in a powerful manner, and hence the priority to be attached to the space-based component.

The panel also found the absence of a clear articulation of an agreed overall paradigm (or paradigms) for the research and operational activities which is expected to deliver economic and social benefits, to be a distinct disadvantage and source of confusion for its work.

Recommendation: When expressing requirements for observations, the science panels should make it clear how and for what purpose they will be used in the generation of products and services. Further, the G3OS steering committees should devise and promulgate their vision of the end-to-end system of research and operations by which they expect to deliver the benefits to justify investment in the GOSSP.

Dr Aschbacher:

Information about the availability, accessibility and quality of remote sensing data, products and algorithms should be easily accessible in a timely way to scientific, governmental and inter-governmental organisations concerned with the observation of the Earth's climate, terrestrial and oceanic environment. Emphasis should be put on the further development of earth observation data and information exchange systems, covering both the space and non-space (*in-situ*) domain.

Recommendation: NASA, NASDA and EC, *inter alia*, should be encouraged to assure a

long-term operational service of their respective Earth observation data and information exchange systems (i.e., NASA's EOSDIS, NASDA's EOIS and EC-CEO's EWSE/ES). Coordination across these systems, and expansion to other remote-sensing data providers should be encouraged in order to develop an integrated, comprehensive and up-to-date global meta-information system including all major Earth observation data and information providers.

Annex 7: Acronyms

ADEOS	Advanced Earth Observing Satellite (Japan)
AVHRR	Advanced Very High Resolution Radiometer
BGC	Biological Global Climate (models)
CBS	Commission for Basic Systems (WMO)
CEC	Commission of European Communities
CEO	Centre of Earth Observation (CEC)
CEOS	Committee on Earth Observation Satellites
CGMS	Coordination Group for Meteorological Satellites
CICG	Geneva International Conference Centre
ENRM	Environmental and Natural Resources Management Project
EOIS	Earth Observation Data and Information System (NASDA)
EOSAT	Earth Observation Satellite Company (USA)
EOSDIS	Earth Observing System Data and Information System (NASA)
ERS	European Remote Sensing Satellite
ESA	European Space Agency
ESTEC	European Space Research and Technology Centre
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
EWSE	European-wide Service Exchange
FAO	Food and Agriculture Organisation (UN)
FPAR	Fraction of Photosynthetically Active Radiation
G3OS	Global Ocean/Climate/Terrestrial Observing Systems
GCM	General Circulation Model
GCOS	Global Climate Observing System (ICSU, IOC, UNEP, WMO)
GEO	Geosynchronous Orbit
GOES	Geostationary Operational Environmental Satellite
GOOS	Global Ocean Observing System (ICSU, IOC, UNEP, WMO)
GOSSP	Global Observing Systems Space Panel (GCOS, GOOS, GTOS)
GTOS	Global Terrestrial Observing System (FAO, ICSU, UNEP, UNESCO, WMO)
GTS	Global Telecommunication System (WMO/WWW)
ICSU	International Council of Scientific Unions
IGBP	International Geosphere-Biosphere Programme (ICSU)
I-GOOS	IOC--WMO-UNEP Intergovernmental Committee for GOOS
IGOS	Integrated Global Observing Strategy
INSAT	Indian Satellite
IOC	Intergovernmental Oceanographic Commission (UNESCO)
IOS	Initial Operational System (GCOS)
IRS	Indian Remote-Sensing Satellite
JDIMP	Joint Data and Information Management Panel (G3OS)
J-GOOS	Joint IOC-WMO-ICSU Scientific and Technical Committee for GOOS
JPL	Jet Propulsion Laboratory
JPO	Joint Planning Office (GCOS)

JSTC	Joint Scientific and Technical Committee (GCOS)
LAI	Leaf Area Index
LANDSAT	Land Satellite
LEO	Low Earth Obit
NASA	National Aeronautics and Space Administration
NASDA	National Space Development Agency of Japan
NEP	Net Ecosystem Production
NERC	Natural Environment Research Council (UK)
NOAA	National Oceanic and Atmospheric Administration (USA)
NPP	Net Primary Production
NRSA	National Remote Sensing Agency (India)
NWP	Numerical Weather Prediction
OOPC	Ocean Observation Panel for Climate (GCOS, GOOS, WCRP)
OOSDP	Ocean Observation System Development Panel
OSRS	Ocean Satellite Remote Sensing
POES	Polar Operational Environmental Satellite
RMS	Root Mean Square
SAGE	Stratospheric Aerosol and Gas Experiment
SAR	Synthetic Aperture Radar
SC	Steering Committee
SOP	Space-based Observation Panel (G3OS)
SPOT	Système pour l'Observation de la Terre
SST	Sea Surface Temperature
SVAT	Soil-Vegetation-Atmosphere Transfer
SVI	Spectral Vegetation Index
SWE	Snow water equivalent
TOA	Top of the Atmosphere
TOPC	GCOS/GTOS Terrestrial Observation Panel for Climate
TOPEX	Topography Experiment
TOR	Terms of Reference
TRMM	Tropical Rainfall Measuring Mission
UNEP	United Nations Environment Programme
UNESCO	United Nations Education, Scientific and Cultural Organisation
UNOOSA	United Nations Office of Outer Space Affairs
WCRP	World Climate Research Programme (ICSU,IOC,WMO)
WGCV	CEOS Working Group on Calibration and Validation
WMO	World Meteorological Organization
WWW	World Weather Watch (WMO)