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FIRST CONSULTATIVE MEETING ON HIGH-LEVEL POLICY ON SATELLITE MATTERS

GENEVA, SWITZERLAND

22-23 JANUARY 2001

FINAL REPORT

1. ORGANIZATION OF THE MEETING

1.1 Opening of the meeting *(Agenda item 1.1)*

The First Consultative Meeting on High-Level Policy on Satellite Matters was held at the World Meteorological Organization (WMO) Headquarters in Geneva, Switzerland from 22 to 23 January 2001 under the chairmanship of the President of WMO, Dr J.W. Zillman. The meeting was opened at 09:30 hours on Monday, 22 January by the Secretary-General of WMO, Prof. G.O.P. Obasi. He noted that WMO Members were impressed with the recommendations resulting from the January 2000 meeting on a mechanism for policy level interaction with operators of environmental satellites. He expressed pleasure that a more formal recognition of the role that both meteorological and research and development satellites play in the activities of WMO would be considered in the meeting. Within the framework of the Integrated Global Observing Strategy, he recalled that there were strong partnerships emerging, partnerships between *in situ* and space-based observing systems; partnerships between users and providers; and partnerships between research and development and operational meteorological satellite operators. He thanked the participants for their level of activity since the meeting last year up to this First Consultative Meeting. He also thanked NOAA's National Environmental Satellite and Data Information Service (NESDIS) for hosting a meeting in October 2000 on discussions for contributions to a future polar observation system in which the importance that all satellite operators placed on WMO and the Consultative Meetings was stressed. In closing, he thanked each represented organization for the contributions made over the years and for their anticipated continuation in support of the World Meteorological Organization. The list of participants is attached as Annex II.

The Chairman welcomed the participants at the First Consultative Meeting and noted that the fifty-second session of the WMO Executive Council had, in part, based its decision to hold Consultative Meetings on its conviction that such meetings would be mutually beneficial for the satellite user and provider communities. He recalled that WMO was a specialized UN agency, and as such, its Members represented sovereign governments, not just their NMHSs. He also noted that both the satellite agencies and NMHSs were under intense pressure to produce greater value for their user communities with less resources. There was no doubt that satellite information has the potential to enhance greatly what the NMHSs deliver to their user community and that this can be best be done in a globally cooperative context. Thus, he was confident that the First Consultative Meeting would provide valuable recommendations and advice to the WMO Executive Council as well as to the satellite agencies.

1.2 Adoption of the Agenda *(Agenda item 1.2)*

The agenda for the meeting was adopted as amended and is reproduced in Annex I.

1.3 Working arrangements for the meeting (*Agenda item 1.3*)

The working arrangements for the meeting were agreed upon. It was also agreed that the work of the meeting would be conducted mainly in Plenary. The working languages of the meeting were English, French, Russian and Spanish, and the documentation and report were in English only.

2. ACTIONS DERIVING FROM EC-LII (*Agenda item 2*)

2.1 The First Consultative Meeting noted the progress since the January 2000 meeting on a Mechanism for Policy Level Interaction with Operators of Environmental Satellites. The First Consultative Meeting was informed that the fifty-second session of the WMO Executive Council (EC-LII) had considered the recommendations from the January 2000 meeting and agreed that a mechanism for discussions should be provided through the convening of "Consultative Meetings on High-Level Policy on Satellite Matters" at one to two year intervals. Furthermore, EC-LII had endorsed guidelines for the Consultative Meetings. The First Consultative Meeting felt it important

to include the guidelines endorsed by EC in its first report as a means to provide direction to future meetings. The guidelines are contained in Annex III.

2.2 EC-LII was also of the view that the Consultative Meetings should give early consideration to:

- Evaluating satellite missions to ensure, *inter alia*, the better use of existing and planned R&D missions in support of WMO Programmes and provide an assessment on their operational utility;
- Reviewing and revising the space-based component of the Global Observing System to take into account both operational and R&D opportunities and the need to maximize cost efficiency and effectiveness of satellite observing programmes.

2.3 EC-LII also noted that the topics for the Consultative Meetings were germane to the needs of all WMO Programmes. In this regard, the Council suggested that the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM), the Global Climate Observing System (GCOS) and the World Climate Research Programme (WCRP) be represented at the Consultative Meetings, thus ensuring the direct consideration of the oceanographic and climate observational needs including research aspects. Thus, the First Consultative Meeting was pleased to note the participation by representatives from JCOMM, GCOS and WCRP.

2.4 The president of CBS informed the First Consultative Meeting of results from the recent session of the Commission for Basic Systems. He noted that the working arrangements of CBS included four Open Programme Area Groups (OPAG) with a group focused on Integrated Observing Systems (OPAG IOS). One task assigned to the OPAG IOS was the coordination of the use of satellite data, products and services for all WMO Programmes. As part of its responsibilities, CBS would provide the infrastructure necessary to support all WMO Programmes. The president reviewed for the First Consultative Meeting the Rolling Review of Requirements process which was guiding the work of CBS, the CBS initiatives to improve the utilization of satellite data and the involvement with improvements to education and training in satellite meteorology. The president stressed that the past successes of CBS have been, in part, due to the direct involvement of the operational satellite operators in the work of the commission and its working groups. He encouraged the First Consultative Meeting to consider recommendations that would include similar involvement of the R&D satellite operators.

3. SUPPORT BY R&D SATELLITE MISSIONS TO WMO PROGRAMMES *(Agenda item 3)*

3.1 The First Consultative Meeting reviewed an evaluation of the utility of some current and planned missions (including both operational and R&D) for some WMO applications areas. It was informed that not all application areas within WMO and WMO supported programmes were included but that the limited set would serve to identify the utility of satellite data from R&D missions. The evaluation was prepared using the methodology in the process developed and approved by the Commission for Basic Systems (CBS), i.e., the Rolling Review of Requirements Process.

3.2 The First Consultative Meeting was informed that the review evaluated how well the combined satellite and *in situ* observing systems met user requirements in six application areas (global NWP, regional NWP, synoptic meteorology, nowcasting and very short-range forecasting, seasonal to inter-annual forecasting, and aeronautical meteorology). Some preliminary conclusions regarding the combined satellite and *in situ* observing system capabilities were:

- Global NWP centres are making use of the complementary strengths of *in situ* and satellite-based observations. They have shown positive impact from enhanced microwave instruments (such as AMSU) and are advancing in the use of 4-D data assimilation systems to benefit from more frequent measurements (e.g., from

geostationary satellites). NWP centres are poised to take advantage of high spectral resolution sounders (such as IASI, AIRS, CrIS) for improved vertical resolution. Increased coverage of aircraft data, particularly from ascent/descent profiles could provide additional benefit. The critical atmospheric parameters that are not adequately addressed or measured by the current or planned observing systems are wind profiles at all levels, surface pressure, snow equivalent water content, precipitation, and soil moisture.

- Seasonal to Inter-annual (SIA) forecasts require complementary atmospheric and oceanic observing systems. SIA forecasts have shown useful skill in regions where there is clearly an atmospheric response to ocean temperature fluctuations such as the El Niño cycle. SIA forecasts have benefited substantially from the input of sub-surface ocean measurements in the tropics and require continued sampling of temperature and salinity profiles on an operational basis. SIA forecasts will benefit from improved accuracy of sea surface temperature measurement in the tropics and from continued topography measurements by altimetry. Assimilation schemes to accept the additional data remain to be further developed. Beyond the requirements for global NWP, upper oceanic profiles of temperature and salinity stand out as the critical parameters likely to be measured by *in situ* sensors in the foreseeable future while sea surface temperature, surface wind stress, and ocean surface topography stand out as the critical parameters likely to be measured by future satellite sensors.

- Regional (mesoscale) NWP centres rely more on surface-based and *in situ* observing systems than on space-based systems. Weather radars supply the highest resolution information, but the coverage is spatially limited, vertically and horizontally. Satellites supply information at high horizontal resolution; infrared sounding coverage is limited primarily by clouds. Accurate moisture fluxes are critical for good mesoscale forecasts, especially moisture associated with clouds and precipitation; the forecasts thus rely heavily upon wind and humidity observations. Lower boundary conditions can quickly affect a mesoscale forecast; observations of screen-height (2-metre) air temperature, dew point, wind, and pressure are often good to adequate in coverage and frequency, whereas observations of surface conditions, for example, soil moisture, are not. In many cases, mesoscale observations are not fully exploited in mesoscale prediction, e.g., radar reflectivity, cloud images, and microwave sounders. This is more a problem in data assimilation than in the character or distribution of the observations. The greatest observational needs for regional prediction are: more comprehensive wind and moisture observations, especially in the planetary boundary layer; more accurate and frequent measures of surface and soil properties, in that these influence surface fluxes strongly; more accurate estimates of precipitation are sorely needed; more comprehensive observations of cloud base, cloud thickness, and other cloud properties.

- Synoptic Prediction relies mainly on NWP models, so the most essential data in synoptic meteorology are the data which have the most important impact on NWP; the Statement of Guidance (SOG) for global and regional NWP apply for synoptic meteorology also. Information that best complement the content of data assimilation models (data not entering or not well treated in NWP schemes) are found in satellite images and radar pictures; their usage is reinforced by their good temporal and spatial resolution. Surface data, because of their good representation of the conditions where people are living, are also quite essential. The most obvious concern is coverage of oceanic areas, where significant phenomena like cyclogenesis occur but data are sparse. Another concern is the quality of cloud cover estimates during the night; progress is expected in this area in the next decade.

- Nowcasting and Very Short-Range Forecasting (VSRF) benefits from well defined high spatial and temporal resolution multispectral imagery especially for defining areas of cloud, fog, and severe convective weather. Scanning weather radars (especially Doppler)

provide excellent information critical to improving nowcasting and VSRF of convective and stratiform precipitation with their potential for localised flash floods, tornadoes, hail, low ceilings and visibilities, and high winds. Expansion of AMDAR equipped aircraft providing high resolution wind, humidity and temperature data is an efficient way of improving the analysis of 3-D wind, humidity and temperature fields important for nowcasting and VSRF. Reliable precipitation estimates still remain elusive; however, they will benefit from continuing enhancements to satellite and radar measurement capabilities.

- Aeronautical Meteorology would benefit from local reporting of the full resolution in rawindsonde profiles as upper level temperature and wind forecasts with very high vertical resolution (higher than for NWP) are required for development and verification of turbulence forecast algorithms. Filling in horizontal coverage gaps in the current observing system with AMDAR seems promising in the near term. For meteorological watch purposes, satellite imagery, and higher-level products such as multi-spectral images, provide good guidance for location and intensity of convection, but only scanning radars in networks combined with lightning detection systems only have the cycle times of less than 10 min required for air traffic control. For en-route forecasts for VFR flights, satellite imagery and specialised products have acceptable horizontal resolution, but lack the information on ceiling height for low cloud. Finally, satellite remote sensing has significantly improved the detection of volcanic ash clouds and eruptions.

3.3 The First Consultative Meeting noted that the preliminary conclusions from the limited set of application areas were very informative and helpful to the participants. Thus, the First Consultative Meeting requested that other application areas, including those from GCOS, JCOMM, WCRP and Hydrology be presented to the next Consultative Meeting.

3.4 In discussing the support by R&D satellite missions to WMO programmes, the First Consultative Meeting noted the need to identify those data streams which had proven to be successful and of high value to WMO Programmes. The First Consultative Meeting was convinced of the value in articulating the positive impacts experienced by WMO Members in utilizing data from R&D satellite missions. Feedback from the operational user community to the satellite agencies would be most beneficial. In order to maximize the usefulness of R&D data, early involvement of the users was deemed essential. It was recognized that one of the benefits from utilizing R&D satellite data may be a learning process for future systems. Additionally, it would be necessary, where appropriate, to identify impacts on operations within the NMHSs as well as to find where limitations to data access to R&D data occurred. With regard to oceanographic applications, the First Consultative Meeting was reminded that some oceanographic observational requirements were unique. The First Consultative Meeting also reaffirmed the need to develop persuasive arguments related to the impacts of satellite data.

4. GUIDELINES FOR REQUIREMENTS FOR OBSERVATIONAL DATA FROM OPERATIONAL AND R&D SATELLITE MISSIONS *(Agenda item 4)*

4.1 The First Consultative Meeting noted the need to develop, in partnership with the space agencies providing environmental observation satellites and sensor systems, guidelines for requirements that would be agreed upon in order to provide operational users a measure of confidence in the availability of R&D observational data and data providers with an indication of its utility.

4.2 The First Consultative Meeting recalled that a preliminary draft of guidelines had been circulated for review and comments prior to the meeting. The many responses had been used in preparing a revised set of guidelines for observational data from operational and R&D satellite missions for consideration during the First Consultative Meeting.

4.3 The First Consultative Meeting was also informed that NASA placed substantial importance on the mechanism being established by WMO, endorsed by the fifty-second session of the WMO Executive Council, for high-level policy discussions between satellite operators and senior representatives of the WMO user community.

4.4 NASA suggested that the guidelines for requirements for observational data from operational and R&D satellite missions be expanded to take into account new and evolving requirements for global observations arising from both the scientific research community as well as from a large number of applications sectors. NASA indicated that it would be useful to also consider the advances in global observing technology that have taken place over the last decade. In this regard, NASA felt that the discussions would benefit both satellite operating agencies and the users if the guidelines included some coverage of current (and anticipated) requirements from WMO's various research and applications programmes.

4.5 NASA suggested that it would be useful to consider a hierarchical set of observational requirements, rather than guideline requirements exclusively. It would be appropriate to consider a spectrum of requirements that cross-map against the needs of the disciplines and Earth system components embraced by the WMO, namely: atmosphere, ocean, hydrology and others. Such an approach should also cover, within the constraints of viable technology, the observations needed to improve the monitoring and forecasting/prediction of weather, and climate, and the impacts of weather and climate variability on natural, social and economic resources. Examples of key observational requirements, on a global basis, would include remote sensing observations of tropospheric winds, soil moisture, atmospheric composition and constituents, land/aquatic/ocean ecosystems and biological productivity. NASA suggested an evolution towards a comprehensive GOS that characterized the total Earth/Climate system on a variety of time and space scales, in order to make advances in the collective ability to respond effectively to natural disasters, predict changes in the climate system and better manage natural resources.

4.6 NASA noted their perception of a convergence between research and operational requirements, even though there may have been a divergence between the two in the past. It was anticipated that the "prediction" time-window would be broadened beyond weather time scales (days to a week) to include (quasi-operationally) seasonal-to-interannual (e.g., El-Niño), and decadal (e.g., climate change and impacts) time scales. Thus, a substantially larger number of components and processes of the Earth system would need to be observed and modelled on a global basis. Such a need could be construed as a driving requirement for the improvement of operational observing systems, and also for the transition of research to operational platforms. Global-scale observations would, by definition of the land/ocean distribution, be heavily dependent on space-based systems. It was expected that space-based systems would benefit from improved *in-situ* observational coverage. Furthermore, better observations would be required for sub-surface parameters, e.g., soil moisture, ocean sub-surface temperature and salinity profiles, continental/ocean snow/ice depth/thickness, etc. Accurate, high resolution tropospheric (and ocean surface) winds on a global basis would be important to improve weather forecasts (especially, hurricanes/typhoons). Atmospheric temperature and humidity and surface hydrological parameters, atmospheric chemistry/constituents, ocean circulation, and others would be essential to address climate variability/change questions and environmental resource management issues. The monitoring of water resources (water cycle), ecosystems (and carbon cycle/budgets), snow/ice, and others would be important categories in which observations were needed to improve prediction models and address impacts (and resilience/vulnerability) assessments. These questions/issues had already exceeded the strictly research domain. They were now coming from policy-makers and the general public. Consequently, they had become, *de facto*, operational needs (perhaps, currently, quasi-operational) even if some of them may happen to reside within the research framework at the moment.

4.7 NASA noted that it had adopted a planning strategy that oriented the observational programme towards answering key scientific and management questions. This objective would be

integrated with parallel efforts to deliver the requisite data, analysis, and information products needed by the scientific community as well as operational managers and policy makers. NASA believed that the definition of requirements for WMO's Global Observing System would benefit from a similar approach. In this regard, NASA submitted to the First Consultative Meeting for its consideration key scientific questions addressed by NASA's Earth Science Enterprise, and the status of potential for the transition of research remote sensing observational platforms to operational systems. See Annex IV. The First Consultative Meeting noted that some of the key scientific questions had been partially addressed by past and present satellite systems.

4.8 The First Consultative Meeting noted that the R&D agencies unanimously supported the general approach put forward by NASA.

4.9 The First Consultative Meeting, in responding to the process described by NASA, recognized that there was an increasing convergence between research and operational requirements for the space-based component of the Global Observing System and that WMO should seek to establish a continuum of requirements for observational data from R&D satellite missions to operational missions. These requirements should be prioritized in the light of both scientific priorities and practicalities and cross-mapped against the needs of the scientific disciplines and Earth system components embraced by WMO, including areas such as the atmosphere, oceans and hydrology, observations needed to improve the monitoring and forecasting/prediction of weather and climate, and impacts of weather and climate variability on natural, social and economic resources. The establishment and maintenance of this continuum of requirements would require a vigorous interactive dialogue fostered by the WMO amongst data users, operational satellite providers and R&D agencies. Commitments to address these requirements would allow an evolution of the space-based component toward a comprehensive Global Observing System that would help characterize the total Earth and climate system on a variety of time and space scales and would also provide for the effective transition of research to operational platforms based on the logical progression of scientific understanding and maturity of required technologies. The global monitoring of water resources (water cycle), ecosystems (carbon cycle), snow and ice and others were important categories in which observations were needed to improve prediction models and address global impacts. Issues and questions related to research categories such as these had proceeded well beyond the research domain and reflected items raised by policy makers and the general public. Consequently, such research categories were becoming, *de facto*, operational needs that would have to be addressed. The existing operational meteorological satellites in geostationary and low earth orbit (LEO) were the best starting point for defining an evolutionary and flexible architecture for the future Global Observing System. The First Consultative Meeting envisaged that such a system should be flexible enough to: (1) accommodate proven and existing operational meteorological and other related environmental observations and services; (2) enhance these capabilities based on evolution of scientific understanding and technological innovations; and (3) adopt new and mature capabilities and provide the associated services mandated by emerging requirements.

4.10 The First Consultative Meeting also addressed several related issues. With regard to continuity, the First Consultative Meeting agreed that the guidelines should also allow for the continuity of calibration in order to provide the long-term data sets required for many climate applications. With regard to long-term data sets, the First Consultative Meeting agreed that the long-term maintenance of data sets and the associated responsibilities were matters of importance. It should also be recognized that there were more extensive and varied requirements for products. The First Consultative Meeting also recognized the need to strengthen the dialogue and enhance the cooperation between the NMHSs and their associated space agencies where appropriate. Such dialogue would occur at national, regional and global levels. Finally, the First Consultative Meeting agreed that the use of R&D satellite data would enhance capacity building within WMO Members.

4.11 The First Consultative Meeting was of the opinion that a dialogue between users and satellite providers in order to share the benefits of satellite data in meeting the user's national mandates would be mutually beneficial. The First Consultative Meeting felt it important that WMO sponsor such activities in all WMO Regions and included specific reference to this in the guidelines.

4.12 The First Consultative Meeting endorsed guidelines for requirements for observational data from operational and R&D missions as contained in Annex V. In so doing, it requested that the guidelines be submitted to both the WMO Executive Council and space agencies for formal approval.

5. REVIEW OF CONFIGURATION FOR THE SPACE-BASED COMPONENT OF THE GLOBAL OBSERVING SYSTEM *(Agenda item 5)*

5.1 NOAA/NESDIS briefed the First Consultative Meeting on the outcome of a panel discussion on the need for enhanced international low-Earth orbiting satellite cooperation, organized and hosted by NESDIS on 17 October 2000, in connection with the 28th Plenary meeting of CGMS at Woods Hole, Massachusetts, USA. Participants on the panel included representatives of CMA, CNES, ESA, EUMETSAT, IGBP, ISRO, NASA, NASDA, NOAA, PLANETA, ROSHYDROMET, and WMO. Panel participants at Woods Hole agreed that satellite and user organizations should work together as partners in contributing towards the development of a more complete polar operational satellite system, with a commitment to long-term observations. While new forms of cooperation, e.g., Jason follow-on should be pursued, panel participants agreed that new coordination mechanisms were not needed; existing mechanisms, including the WMO Consultative Meetings, should be utilized in pursuing next steps toward such development. Of critical importance were streamlining the transition from research and development to operations as well as development of a broader service orientation. The First Consultative Meeting thanked NESDIS for its initiative in hosting the meeting and noted the great importance for such discussions. The First Consultative Meeting also noted, among the potential advantages discussed, that the inter-governmental status of WMO could be more important after a consensus had been reached to share resources in order to maximize the benefits through cooperation amongst the space agencies. The First Consultative Meeting noted that, once a design for the complete system was achieved, it would then be possible for the satellite agencies to make non-binding and voluntary contributions that would meet their national needs while satisfying global requirements. The First Consultative Meeting suggested that the presentation made by NESDIS be also presented to the next session of the WMO Executive Council.

5.2 The First Consultative Meeting then reviewed possible configurations for the space-based component of the GOS that included R&D missions as well as the existing constellations of environmental geostationary and near-polar-orbiting satellites. The configurations were based on the assumption that the guidelines for requirements for observational data from operational and R&D satellite missions contained in Annex V would be agreed upon by both the WMO Executive Council and space agencies.

5.3 In reviewing the basis for the need to propose new configurations, the First Consultative Meeting recalled the requirements setting process within WMO. It noted that WMO followed a process that resulted in a hierarchical set of requirements. At the highest level, WMO was guided by its Long-term Planning Process. The Fifth Long-term Plan was the current plan and spanned the time frame 2000 to 2009. The Plan provided a vision for the twenty-first century and contained overall guidance, objectives, opportunities and challenges for the organization including those for economic development, political developments, demographic dynamics, urban environment, human health, energy production and consumption, fresh water, land use, food security and combating desertification, protection of climate and atmosphere, natural and human-caused disasters. Within each major WMO Programme, i.e., World Weather Watch Programme, World Climate Programme, Atmospheric Research and Environment Programme, Applications of

Meteorology Programme, Hydrology and Water Resources Programme, Education and Training Programme and the Technical Cooperation Programme, there were similar but focused high-level requirements with guidance, objectives, opportunities and challenges. Within the various Programmes, there were Technical Commissions assigned responsibility for a specific area, e.g., the Commission for Hydrology. The First Consultative Meeting also noted, that in the nearer term, the four year Programme and Budget for WMO contained guidance, objectives, opportunities and challenges that were based on the long-term objectives. The work of the Technical Commissions was guided by the WMO Congress approved Long-term Plan and Programme and Budget. The Long-term Plan was reviewed and updated in a four-year cycle. Within the Technical Commissions as well as the various WMO supported programmes, requirements were derived in order to satisfy the long-term goals. These requirements were manifested in a statement of needs for various systems including observations, telecommunications and data processing. The First Consultative Meeting recalled that detailed observational requirements for the various application areas found within the WMO and supported programmes were available. Furthermore, the Commission for Basic System in meeting its mandate to provide the basic infrastructure for all WMO programmes was already considering a redesign of the Global Observing System. The First Consultative Meeting was pleased to note the Rolling Review of Requirements (RRR) process that had been formally approved by the Commission for Basic Systems. The RRR process had four distinct steps: a compilation and review of observational requirements resulting in a consolidated set of observational requirements unique to an application area, development of expected performances for both *in situ* and satellite-based observing systems, an objective comparison of how well the requirements were met by the observing systems, and a Statement of Guidance that was an evaluation of the objective comparison by experts in the various application areas. The First Consultative Meeting was informed that two such Statements of Guidance had already been published as WMO Satellite Activities Technical Documents and that a third Technical Document would soon be available.

5.4 The First Consultative Meeting recalled that the space-based component of the Global Observing System has evolved since the formation of WMO's World Weather Watch from a first constellation of near-polar-orbiting meteorological satellites to a two constellation (geostationary and near-polar-orbiting) system of operational meteorological satellites. Meanwhile, observational requirements of WMO and supported programmes have greatly expanded, especially in the last decade.

5.5 The First Consultative Meeting noted that there were many observational requirements not presently satisfied by the present constellations (geostationary and near-polar-orbiting) within the space-based component of the Global Observing System. However, it was pleased to note that some of the present R&D satellites were capable of, and already in some cases, were providing the necessary data, products and services. The First Consultative Meeting recognized the productive role played by the Integrated Global Observing Strategy (IGOS) Partnership in gathering data providers and users in a forum where observational requirements could be jointly assessed and commitments could be taken by all Partners with a view to remedying gaps and deficiencies.

5.6 In view of the existing process within WMO to provide a hierarchical set of requirements, the First Consultative Meeting felt that the most appropriate manner to satisfy the full suite of present requirements, while recognizing the capabilities of both operational meteorological and Research and Development satellites, would be to expand the present definition of the space-based Global Observing System to include Research and Development satellites, complementing the existing two operational meteorological satellite constellations (geostationary and near-polar-orbiting). Enhancements to the overall space-based component of the Global Observing System would be incremental as new contributions from the R&D satellites were realized. The First Consultative Meeting agreed that the expansion of the definition should be through a resolution by WMO constituent bodies, especially CBS, thus formalizing the high-level system requirements that would provide the necessary observational data for WMO and supported programmes.

5.7 Therefore, the First Consultative Meeting suggested that the Executive Council request the Commission for Basic Systems to review the space-based component of the Global Observing System with a goal of defining an overall system that included appropriately identified R&D satellite missions. The Commission should be guided by the WMO process for its hierarchical set of requirements in order to ensure that the new space-based component would be justified by WMO needs.

5.8 The First Consultative Meeting also encouraged the Commission for Basic Systems to be forward looking in proposing enhancements to the space-based component of the Global Observing System. It should account for the differences between operational environmental satellites and R&D satellites. There were different levels of maturity within the various R&D satellites. Flexibility and adaptability must be included into the new design.

5.9 The First Consultative Meeting suggested that CBS review and make appropriate changes to the definitions as contained in the Guide and Manual for the GOS for the present polar-orbiting and geostationary satellites. The changes should be flexible enough to: (1) accommodate proven and existing operational meteorological and other related environmental observations and services; (2) enhance these capabilities based on the evolution of scientific understanding and technological innovations; and (3) adopt new and mature capabilities and provide the associated services mandated by emerging requirements such as, but not limited to:

- Improved understanding of the structure and dynamics of the atmosphere through, for example, soundings of temperature and humidity, improved wind profiles and better rainfall estimates;
- Improved knowledge of the ocean structure and circulation through, for example, operational surface wind vectors and ocean surface topography;
- Better knowledge of the chemistry of the atmosphere, for example, through measurement of ozone, carbon dioxide, and other trace gases;
- Better understanding of the changes in the terrestrial and marine ecosystems and their role in the carbon cycle;
- Improved knowledge of the cycling of water and energy through the earth system to enable better management of global fresh water resources;
- Increased emphasis on calibrated instruments with a view to a better understanding of climate change;
- Improved global coverage from geostationary orbit using at least six operational spacecraft.

5.10 ROSHYDROMET informed the First Consultative Meeting that it presently acts as an operator of meteorological and oceanographic instruments onboard Russian Federation satellites. It noted that the Russian Federation had over thirty years experience in the manufacture and operation of meteorological satellites in polar orbit. Since the beginning of operations of the Russian Federation meteorological polar-orbiting space system, 25 satellites in the Meteor-2 series and 7 satellites in the Meteor-3 series had been launched and operated (along with one GOMS/Electro geostationary satellite, 7 oceanographic polar-orbiting satellites of the Okean-01 series and 4 earth resources satellites of the Resurs-01 series). Current planning in the framework of the Russian Federal Space Programme included the launching of two modernized satellites in the Meteor-3M series and one satellite in the Resurs series in the timeframe before 2005.

5.11 ROSHYDROMET also recalled that there had been a positive experience through international cooperation on the installation and operation of other country's (in particular, the USA) R&D equipment for remote sounding of the atmosphere (TOMS, ScaRab, SAGE) onboard Russian satellites. Additionally, ROSHYDROMET had a modern ground complex for reception, processing and distribution of data from the Russian Federation and other country's satellites that consisted of

3 main centres located in Moscow/Obninsk/Dolgoprudny, Novosibirsk, Khabarovsk and also a number of autonomous receiving stations, particularly for HRPT reception.

5.12 In order to keep the Meteor-3M series current with developments underway at NOAA and EUMETSAT for future NOAA and METOP satellites, ROSHYDROMET noted that the Russian Space Agency (ROSAVIAKOSMOS) planned to develop and to install aboard the Meteor-3M series the following instruments:

- **Multichannel Scanning Radiometer MSR** (comparable to the AVHRR, 4 channels, starting with Meteor-3M N2);
- **Atmospheric MW sounder MTVZA** (comparable to AMSU);
- **Atmospheric IR sounder IKFS** (comparable to IASI and CrIS, same purpose as for HIRS/2; starting with Meteor-3M N2).

5.13 However, ROSHYDROMET noted that the above-mentioned instruments would only be experimental. Additionally, even in the event of their successful functioning, there would not be compatibility of measurements (number and arrangement of spectral channels, spectral response functions, absolute calibration algorithm, swath width and scanning geometry, data transmission format) with measurements of the operational instruments (AVHRR, ATOVS) for the NOAA and METOP satellites. ROSHYDROMET was of the opinion that this non-compatibility would not allow the full realization of the possible contribution to be made by the Russian Federation Meteor-3M satellites to the international meteorological community, i.e., in particular, satellite data receiving stations would not be able to process the data obtained from Russian Federation satellites.

5.14 Thus, the ROSHYDROMET proposed that it would be more appropriate if data from the Meteor-3M series satellites would have the same (or similar) composition and structure as on the NOAA and METOP satellites. Augmenting the Meteor-3M series satellite systems towards compatibility with the international polar-orbiting system NOAA/METOP could be considered the first step in the creation of a future international polar satellite observation system on the basis of satellites from the USA, Europe, the Russian Federation and other countries. ROSHYDROMET noted that the ROSAVIAKOSMOS supported the proposal and was ready to perform the necessary actions (including updating of development plans and launch of Meteor-3M series satellites) in order to assist in the successful realization of joint works with other space agencies.

5.15 ROSHYDROMET suggested that it would be appropriate to equip the Meteor-3M series satellites with instruments composed of the common payload accepted by NOAA and METOP, i.e., AVHRR/3, HIRS/4, AMSU-A, SARSAT, SEM (USA), MHS and DCS-ARGOS (Europe), or their Russian Federation analogues, and to install, in addition, new experimental Russian instruments. To realize a first step for such an integration, ROSHYDROMET suggested installing aboard the Meteor-3M N2 satellite the following operational instruments:

- Imager, AVHRR;
- Atmospheric IR sounder, HIRS/3.

5.16 In order to maximize the impact of data from R&D missions and to make operational use of such missions, future Russian Federation polar-orbiting system Meteor-3M satellites would be available for installation of R&D instruments from both the Russian Federation (i.e., Atmospheric IR Sounder IKFS) and other countries.

5.17 The obligations and contribution of the Russian Federation (ROSHYDROMET and ROSAVIAKOSMOS) would include:

- Providing a platform of Meteor-3M series satellite or smaller one;
- Launch of Meteor-3M N2 satellite into a sun synchronous orbit;

- Installation of the Atmospheric MW sounder MTVZA, Atmospheric IR Sounder IKFS and other R&D instruments;
- Centralized control and operation of the satellite system;
- Installation, maintenance and operation of a radio engineering complex for data collection from DCPs;
- Operation of ground complex of data reception, processing and distribution; and
- Installation of necessary servicing systems, organization of data dissemination in HRPT/LRPT formats.

5.18 The ROSHYDROMET proposal would be available for immediate implementation (for the period 2001-2007) and corresponded with the Russian Federal Space Programme for the period until 2005. Further prospects for cooperation would be considered after approval by the parties and Government of the Russian Federation of a project for Russian Federation space systems integration into the international meteorological polar-orbiting system and definition of participation and contribution of the Russian Federation in the creation of this system.

5.19 In connection with the increasing role of meteorological and environmental satellites in WMO Programmes, the First Consultative Meeting noted the proposal by ROSHYDROMET to discuss the need for an international meteorological/environmental space programme to include enhanced coordination amongst space agencies in order to create the most effective possible space system. The First Consultative meeting was of the opinion that the topic was important but needed more complete preparation before it could be properly discussed. Thus, the First Consultative Meeting suggested that a small group, comprised of a representative from the Russian Federation, NESDIS, EUMETSAT and WMO, work together through correspondence, including electronic mail, in the interim period in order to prepare relevant material for consideration by the Second Consultative Meeting.

6. NEEDS OF DEVELOPING COUNTRIES *(Agenda item 6)*

6.1 The First Consultative Meeting recalled that it was asked to review the needs of developing countries with regard to their utilization of satellite systems in order to ensure that they can keep up with advances in satellite data, products and services. Matters for special attention should include the need for access to satellite data, products and services and appropriate education and training.

6.2 The First Consultative Meeting noted that the needs of developing countries have been a focus within the existing WMO structures for many years. Two examples highlighted the activities and success of this focus. First, the Executive Council approved a Strategy for Education and Training in Satellite Matters. The Strategy has resulted in the co-sponsorship of six “centres of excellence” interconnected through a Virtual Laboratory that has already had a major impact in the ability of WMO Members to improve the utilization of satellite data and products. Secondly, several satellite operators (EUMETSAT and JMA) have actively participated in projects to improve the access to data, EUMETSAT through the Preparation for Use of MSG in Africa (PUMA) and JMA through development and distribution of processing software for the LRIT data stream from its soon-to-be launched MTSAT-1R. Thus, the First Consultative Meeting felt it appropriate that an additional focus for developing countries needs should be through new data and products available from R&D satellite missions.

6.3 At present, the First Consultative Meeting felt that most developing countries do not have access to data and products from R&D missions and consequently have little education and training in methods to exploit such data.

6.4 Therefore, the First Consultative Meeting suggested that those R&D agencies who propose that their experimental satellite missions become part of the new component of the space-based Global Observing System also consider undertaking pilot projects with developing countries

whereby the data would be provided with the necessary tools for utilization and that an operational evaluation would be provided. It was further suggested that a project cover the time span between Consultative Meetings and that the success of the pilot project be evaluated by the next Consultative Meeting. Such an evaluation would help identify future implementations as appropriate.

6.5 The First Consultative Meeting was informed of current WMO activities to meet the needs of developing countries. It noted that during the evolution of the former EC Panel of Experts on Satellites into the CBS Working Group on Satellites and now into the CBS Open Programme Area Group on Integrated Observing Systems, two strategies had emerged with regard to developing countries and satellite data, products and services. The first strategy was the Strategy for Education and Training in Satellite Matters. The Strategy had its genesis in 1992 and has steadily grown in its impact for WMO Members. Based on the success of the Strategy for Education and Training, a new overarching strategy was developed in 1998. The overarching strategy encompassed the Strategy for Education and Training in Satellite Matters, but expanded as a Strategy to Improve Satellite System Utilization by addressing not only education and training but also data access and applications.

6.6 With regard to the Strategy for Education and Training in Satellite Matters, the First Consultative Meeting noted that the WMO had strongly supported the proposal that each satellite operator or group of satellite operators participating in the space-based component of the Global Observing System (GOS) cooperate with at least one of the specialized satellite applications training centres ("centres of excellence") strategically located around the globe with regard to the satellite training programme, facilities and expertise required. The First Consultative meeting noted that the satellite operators had recently completed co-sponsorship of an initial set of “centres of excellence” to strengthen further the training in satellite system utilization. Six such centres were now sponsored by the satellite operators and thus provided a world-wide nucleus of Regional Meteorological Training Centres (RMTCs) in Niger and Kenya for RA I, in China for RA II, in Costa Rica and Barbados for RA IV as well as the Australian Bureau of Meteorology Training Centre (BMTC) for RA V. The First Consultative Meeting was pleased to note that the increased attention given to satellite technology in WMO training activities as evidenced by the Strategy for Education and Training in Satellite Matters had had a large impact. During the time period 1995-1999, more than 300 participants had benefited from WMO and satellite operator sponsored training events in satellite meteorology and hydrology, a 50% increase since Twelfth Congress, and the trend continued to increase. In addition to the number of personnel trained under the Strategy for Education and Training in Satellite Matters, the Strategy had undergone a further evolution to take advantage of new technological advances. This was manifested in the concept of a Virtual Laboratory for Training in Satellite Meteorology. WMO had recognized the potential for expansion of the training component by linking the RMTCs and recommended the establishment of close coordination and interaction between RMTCs by involving relevant science groups in a systematic manner and by using the idea of a Virtual Laboratory (VL) for Training in Satellite Meteorology. With regard to the VL for Training in Satellite Meteorology, it would be a global network of specialized meteorological training institutions and their sponsoring satellite operators.

6.7 With regard to the Strategy to Improve Satellite System Utilization, the First Consultative Meeting noted that CBS had strongly endorsed a new Strategy to Improve Satellite System Utilization and a set of recommendations to improve satellite system utilization. In 2000, CBS had approved preliminary guidelines that would be used as part of a rolling review of the Strategy to Improve Satellite System Utilization. The rolling review process would be initiated by the issuance of a biennial questionnaire. An analysis of the questionnaire would provide one input to the guideline for the Strategy to Improve Satellite System Utilization. The Strategy was based on three cornerstones: data access, data use and education and training. The questionnaire would be analyzed with regard to each cornerstone in seeking problem areas and solutions that would enable increased utilization of the satellite system. A first analysis of the questionnaire for 1999

was prepared and published as the "Status of the Availability and Use of Satellite Data and Products by WMO Members" (SAT-23, WMO/TD-No. 994).

6.8 The First Consultative Meeting recalled that CBS had also evaluated specific pilot projects and made recommendations for projects and activities recently (or soon to be) implemented, in particular with regard to maximizing equipment life and data use. One project reviewed was the Preparation for the Use of MSG in Africa (PUMA). The First Consultative Meeting noted that the European Commission had recently approved funding for the PUMA project. The PUMA project, bilateral and WMO trust fund arrangements would provide high resolution MSG receivers for all Members of RA I starting in 2003 and thus achieve 100% implementation for ground receiving stations.

6.9 With regard to the status of satellite ground receiving stations, the First Consultative Meeting was briefed on the degree of implementation of WWW goals within all WMO Regions.

6.10 It was noted that a comprehensive JCOMM programme for Capacity Building, including satellite matters, was to be considered by JCOMM-I. Relevant issues are altimetry and scatterometry, in particular for countries with coastlines prone to tropical cyclones and storm surges. Further, applications of ocean colour data are expected to attain wider interest.

6.11 The First Consultative Meeting was of the opinion that a dialogue between the users within developing countries and the satellite providers would be mutually beneficial. It was reminded of the tremendous success experienced by EUMETSAT during the evolution of the EUMETSAT User Fora. The First Consultative Meeting suggested that WMO sponsor similar activities in all WMO Regions and use the EUMETSAT User Fora as a guide in how to structure the dialogue. Thus, the First Consultative Meeting suggested that the WMO Executive Council address the necessary modalities to allow such regional activities. The regional activities should include the Regional Associations as well as the appropriate satellite operators.

7. REVIEW DRAFT WMO TECHNICAL DOCUMENT "THE ROLE OF SATELLITES IN WMO PROGRAMMES IN THE 2010S" *(Agenda item 7)*

7.1 The First Consultative Meeting noted that the last authoritative WMO technical document describing the role of satellite in WMO Programmes was published in 1977 and authored by D.S. Johnson and I.P. Vetlov. In view of the increased use of satellite data and products throughout WMO Programmes, especially that from R&D missions, the First Consultative Meeting endorsed the initiative underway to update the 1977 technical document. The First Consultative Meeting noted that the update would be prepared by three primary authors: Dr G. Asrar, Dr T. Mohr and Mr G. Withee. It was envisioned that the final manuscript will be completed prior to the next Consultative Meeting.

8. ANY OTHER BUSINESS *(Agenda item 8)*

8.1 The Meeting recommended that the Second Consultative Meeting take place in January 2002 during the week of the WMO Bureau. The Meeting recommended that the agenda for the Second Consultative Meeting include: feedback from the Commission for Basic Systems on activities related to matters discussed during the First Meeting; results of activities by the small group to discuss the need for an international meteorological/environmental space programme, and the preparation of Statements of Guidance for JCOMM, GCOS and WCRP and Hydrology.

9. CLOSURE OF THE SESSION *(Agenda item 9)*

9.1 The Chairman thanked the participants, including the satellite agencies and user groups, as well as the members of the WMO Bureau and Executive Council. The Chairman closed the meeting at 15h30 on Tuesday, 23 January 2001.

ANNEX I

AGENDA

1. ORGANIZATION OF THE SESSION

    1.1 Opening of the session
    1.2 Adoption of the agenda
    1.3 Working arrangements for the session

2. ACTIONS DERIVING FROM EC-LII

3. SUPPORT BY R&D SATELLITE MISSIONS TO WMO PROGRAMMES

4. GUIDELINES FOR REQUIREMENTS FOR OBSERVATIONAL DATA FROM OPERATIONAL AND R&D SATELLITE MISSIONS

5. REVIEW OF CONFIGURATION FOR THE SPACE-BASED COMPONENT OF THE GLOBAL OBSERVING SYSTEM

6. NEEDS OF DEVELOPING COUNTRIES

6. REVIEW DRAFT WMO TECHNICAL DOCUMENT “THE ROLE OF SATELLITES IN WMO PROGRAMMES IN THE 2010s”

7. ANY OTHER BUSINESS

8. CLOSURE OF THE SESSION

ANNEX II

LIST OF PARTICIPANTS

Chairman

Dr J.W. Zillman
President of WMO
Bureau of Meteorology
GPO Box 1289K
MELBOURNE
Victoria 3001
Australia
Tel: (61-3) 9669 4558
Fax: (61-3) 9669 4548
Email: wmo@bom.gov.au

Mr J.-P. Beysson
First Vice-President of WMO
Météo-France
1 quai Branly
75340 PARIS Cédex 07
France
Tel: (33) 1 45 56 70 01
Fax: (33) 1 45 56 70 05
Email: jean-pierre.beysson@meteo.fr

Dr Ali M. Noorian
Second Vice-President of WMO
Islamic Republic of Iran Meteorological Organization (IRMO)
P O. Box 13185-461
TEHRAN
Islamic Republic of Iran
Tel: (98-21) 600 40 41
Fax: (98-21) 602 50 44
Email: ali_noorian@hotmail.com

Mr A. J. Dania
President of Regional Association IV
Meteorological Service
Seru Manuma
CURAÇAO
Netherlands Antilles and Aruba
Tel: (599) 98 39 3367
Fax: (599) 98 68 3999
Email: adania@meteo.an

Dr M.S. Mhita
President of Regional Association I
Tanzanian Meteorological Agency
P.O. Box 3056
DAR ES SALAAM
United Republic of Tanzania
Tel: (255) 22 211 0231
Fax: (255) 22 211 0231/211 2471
Email: mhita@meteo-tz.org

Mr N. Salazar
President of Regional Association III
Instituto Nacional de Meteorologia e Hidrologia (INAMHI)
Iñaquito 700 (36-14) y Corea
Casilla Postal 16-310
QUITO
Ecuador
Tel: (5932) 433 934
Fax: (5932) 433 934
Email: nelsond@inamhi.gov.ec

CBS

Dr G.B. Love
President of CBS
Bureau of Meteorology
GPO Box 1289K
MELBOURNE
Victoria 3001
Australia
Tel: (61-3) 9669 4217
Fax: (61-3) 9669 4548
Email: g.love@bom.gov.au

CMA

Mr Li Huang
Deputy Administrator
China Meteorological Administration
46 Zhongguancun South Street
BEIJING 10081
People's Republic China
Tel: (8610) 6840 6221
Fax: (8610) 6217 4239
Email: HL@rays.cma.gov.cn

Dr Zhang Wenjian
Deputy Director-General
National Satellite Meteorological Centre
China Meteorological Administration
46 Baishiqiaolu Road
BEIJING 10081
People's Republic of China
Tel: (86) 10 6840 6226
Fax: (86) 10 6217 2724
Email: wjzhang@cma.gov.cn

Mr Zheng Yunjie
Division Director
China Meteorological Administration
46 Zhongguancun Nandajie
BEIJING 10081
People's Republic of China
Tel: (86) 10 6840 6662
Fax: (86) 10 6217 4797
Email: yzheng@cma.gov.cn

CNES

Dr J.-L. Fellous
Assistant Director
Earth Science and Applications
CNES-DPI/EOT/D
2 place Maurice Quentin
75039 PARIS Cedex 01
France
Tel: (33) 1 44 76 75 90
Fax (33) 1 44 76 78 67
Email: jean-louis.fellous@cnes.fr

ESA

Dr S. Briggs
Head
Earth Observation Applications Department
European Space Agency
Case postale 64
via Galileo Galilei
00044 FRASCATI (ROME)
Italy
Tel: (39 06) 9418 0400
Fax: (39 06) 9418 0402
Email: sbriggs@esrin.esa.it

Dr E. Oriol-Pibernat
ESA
Case postale 64
via Galileo Galilei
FRASCATI 00044
Italy
Tel: (39) 06 941 80 408
Fax: (39) 06 941 80 402
Email: eoriol@.esa.int

EUMETSAT

Dr T. Mohr
Director-General
EUMETSAT
Am Kavalleriesand 31
D-64295 DARMSTADT
Germany
Tel: (49) 6151 807 600
Fax: (49) 6151 807 830
Email: mohr@eumetsat.de

Dr D. Williams
Head
Strategy and International Relations
EUMETSAT
Am Kavalleriesand 31
D-64295 DARMSTADT
Germany
Tel: (49) 6151 807 603
Fax: (49) 6151 807 830
Email: dwilliams@eumetsat.de

Mr P. Counet
International Affairs
EUMETSAT
Am Kavalleriesand 31
D-64295 DARMSTADT
Germany
Tel: (49) 6151 807 603
Fax: (49) 6151 807 830
Email: counet@eumetsat.de

GCOS

Dr P.J. Mason
Vice-Chair GCOS Steering Committee
Meteorological Office
London Road
BRACKNELL
Berkshire RG12 2SZ
U.K.
Tel: (44) 1344 854 604
Fax: (44) 1344 857 909
Email:pjmason@meto.gov.uk

INDIA
Mr R.R. Kelkar
Permanent Representative of India with WMO
India Meteorological Department
Mausam Bhavan
Lodi Road
NEW DELHI 110 003
India
Tel: (91) 11 461 1842
Fax: (91) 11 469 9216
Email: rrkelkar@imd.ernet.in

ISRO
Mr J. Ninan
Deputy Director
International Cooperation
Indian Space Research Organization
Antariksh Bhavan
BANGALORE 560 094
India
Tel: (91) 80 341 6361
Fax: (91) 80 341 3580
Email isroic@vsnl.com

JCOMM
Mr J. Guddal
Co-President of JCOMM
Norwegian Meteorological Institute
Allegaten 70
N-6007 BERGEN
Norway
Tel: (47) 56 23 66 26
Fax: (47) 56 23 67 03
Email: j.guddal@dnmi.no

Dr D.P. Kohnke
Co-President of JCOMM
Bundesamt für Seeschiffahrt und Hydrographie
Postfach 301220
Bernhard-Nocht-Strasse 78
D-20305 HAMBURG
Germany
Tel: (49) 40 3190 3400
Fax: (49) 40 3190 5000
Email: kohnke@bsh.d400.de

JMA
Mr N. Sato
Director
Numerical Prediction Division
Forecast Department
Japan Meteorological Agency
1-3-4 Ote-machi
Chiyoda-ku
TOKYO 100 8122
Japan
Tel: (81) 3 3211 8408
Fax: (81) 3 3211 8407
Email nsato@met.kishou.go.jp

NASA
Dr G. Asrar
Associate Administrator
Office of Earth Science
NASA Headquarters
300 E Street SW
WASHINGTON, DC 20546
USA
Tel: (1-292) 358 2165
Fax: (1-292) 358 3092
Email: gasrar@hq.nasa.gov

Mr A. Condes
Director for Earth Science
Office of External Relations
NASA Headquarters, Code IY
WASHINGTON DC 20546
USA
Tel: (1 202) 358 0793
Fax: (1 202) 358 2798
Email: acondes@hq.nasa.gov

NASDA
Mr N. Saki
Director
Earth Observation Systems Engineering Department
National Space Development Agency of Japan (NASDA)
2.4.1 Hamamatsu-cho
Minato-ku
TOKYO 105 8060
Japan
Tel: (81) 3 3438 6349
Fax: (81) 3 5401 8702
Email: Saki.Nobuo@nasda.go.jp

Mr N. Matsuura
Associate Senior Engineer
Earth Observation Planning Department
National Space Development Agency of Japan (NASDA)
2.4.1 Hamamatsu-cho
Minato-ku
TOKYO 105 8060
Japan
Tel: (81) 3 3438 6342
Fax (81) 3 5401 8702
Email: matsuura.naoto@nasda.go.jp

NOAA/NESDIS

Mr G. Withee
Assistant Administrator for Satellite and Information Services
NOAA/NESDIS
1315 East-West Highway
SILVER SPRING
Maryland 20910
USA
Tel: (1 301) 713 3578
Fax: (1 301) 713 1249
Email: gwithee@.noaa.gov

Mr Robert O. Masters
Chief, Satellite Activities Branch
International and Interagency Affairs Office
NOAA/NESDIS
E/IA, Suite 7311
1315 East-West Highway
SILVER SPRING
Maryland 20910
USA
Tel: (1-301) 713 2024
Fax: (1 301) 713 2032
Email: Robert.Masters@noaa,gov

NOAA/NWS

Dr M. Yerg
Chief
International Activities Office
National Weather Service
NOAA
1325 East-West Highway
SILVER SPRING
Maryland 20910
USA
Tel: (1-301) 713 0645
Fax: (1-301) 587 4524
Email: martin.yerg@noaa.gov

ROSHYDROMET

Mr A.I. Bedritsky
Permanent Representative of Russian Federation with WMO
Russian Federal Service for Hydrometeorology and Environmental Monitoring
12 Novovagankovsky Street
123242 MOSCOW
Russian Federation
Tel: (095) 252 13 89
Fax: (095) 255 22 16
Email: bedr@mecom.ru

Dr A. Gusev
Chief of Technical Department
Russian Federal Service for Hydrometeorology and Environmental Monitoring
12 Novovagankovsky Street
123242 MOSCOW
Russian Federation
Tel: (095) 205 4813
Fax: (095) 255 2414
Email: gusev@mecom.ru

WMO Secretariat

Prof. G.O.P. Obasi, Secretary-General
Mr M.J.P. Jarraud, Deputy Secretary-General
Dr M. Coughlan, Director Coordinator, Climate Activities Programmes
Mr A.J. Askew, Director. Hydrology and Water Resources Department
Dr D. Carson, Director, World Climate Research Programme
Dr A. Thomas, Director, Joint Planning Office for the Global Climate Observing System
Mr E. Sarukhanian, Acting Director, World Weather Watch-A
Dr D.E. Hinsman, Senior Scientific Officer, WMO Satellite Activities

ANNEX III

GUIDELINES FOR
CONSULTATIVE MEETINGS ON HIGH-LEVEL POLICY ON SATELLITE MATTERS

(i) ***Background***

In the opening decade of the new millennium, a major opportunity to support and enhance WMO Programmes could be obtained through existing and planned satellite programmes. At the same time, there was a need to demonstrate the value of those satellite programmes to all concerned and to ensure that future plans take into account WMO needs. Within the above context, the satellite operators and WMO propose that regular consultative meetings to discuss high-level policy matters would be beneficial to all parties concerned. Such meetings would build on the good relationships that existed today between satellite operators and WMO and would enhance the working relations already in place through existing mechanisms. Those meetings would promote the achievement of further efficiencies in the satellite observing system and would ensure a common understanding of objectives and lead to better harmonization of programmes, requirements, usage of satellite data products and services, and high-level policy matters.

High-level policy matters could have a substantial impact on satellite operators, and on most, if not all, WMO Members as well as on the allocation of resources. For WMO, the relevant decision-making authority was the Executive Council; for the satellite operators, the equivalent decision-making organ would be their relevant governing bodies.

(ii) ***Purpose***

The purpose of the Consultative Meetings on High-Level Policy on Satellite Matters would be to discuss matters of mutual interest between the satellite operators and WMO. One outcome of the meetings would be to ensure a better understanding of issues. A second, and more important objective, would be to agree on recommendations to be forwarded to the WMO Executive Council and/or satellite operators.

(iii) ***Organization and resource implications***

It was anticipated that the meetings would be attended by the directors of satellite operating agencies, members of the WMO Bureau, the president of the WMO Commission for Basic Systems, and sufficient members of the Executive Council to adequately reflect the broad interests of WMO Members (including consideration of regional balance, user representation and the role of the Permanent Representatives of those Members with satellite operating agencies). The satellite operators would attend those meetings at their own expense and the timing would be harmonized with WMO Bureau sessions. Preparation for the meetings would be assured by existing secretariat staff of all parties as part of their normal duties, and the meetings would normally be called by WMO.

(iv) ***Possible meeting topics***

The meetings could focus on an initial list of topics including:

- Discussion with satellite operators on WMO Programmes and WMO-sponsored Programmes, on meteorology (including climatology), oceanography and hydrology. That would provide WMO with a forum to present its requirements for meteorological and environmental satellites (operational, research, and technology programmes) in a coordinated fashion;

- Consideration of the evolutionary design of the space component of the Global Observing System to take account of future technological developments and the evolution of the present day *in situ* networks. WMO would become more proactive in providing a vision on future state-of-the-art systems;

- Preparation for the implementation of the transition between research and operational programmes through: (a) development of a WMO position for better convergence and transition of appropriate R&D instruments, missions and their corresponding new products and services into operational use; (b) demonstration of the use of new capabilities by WMO Members and work with satellite operators to evaluate the contributions towards meeting societal needs; and (c) WMO assessments of new satellite systems from a user perspective to provide formal evaluation results to the satellite operators;

- Consideration of the ways and means to reduce costs, including standardization of equipment, taking into account the efficiency and effectiveness of the total observing system (including ground systems), as well as consideration of the needs for the compatibility among satellite systems, particularly ground stations and product requirements;

- Maximizing the benefits to be derived from existing and planned satellite products and services in order to improve utilization of existing satellite data, products and services, and to provide for better coordination of these benefits for all WMO Members.

(v) ***Interests of developing countries***

In all deliberations, the meetings should take into account the needs of developing countries to ensure that they keep up with advances in satellite products and services. In particular, attention should be given to the access to satellite data, products and services and appropriate education and training programmes, especially those at the WMO Regional Meteorological Training Centres (RMTCs).

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ANNEX IV

Key Scientific Questions addressed by NASA's Earth Science Enterprise

Table 4.1: Hierarchy of Science Questions

Overall: ***How is the Earth changing and what are the consequences for life on Earth?***

- ***How is the global Earth system changing?(Variability)***
  - How are global precipitation, evaporation, and the cycling of water changing?
  - How is the global ocean circulation varying on interannual, decadal, and longer time scales?
  - How are global ecosystems changing?
  - How is stratospheric ozone changing, as the abundance of ozone-destroying chemicals decreases and new substitutes increases?
  - What changes are occurring in the mass of the Earth's ice cover?
  - What are the motions of the Earth and the Earth's interior, and what information can be inferred about Earth's internal processes**?**

- ***What are the primary forcings of the Earth system? (Forcing)***
  - What trends in atmospheric constituents and solar radiation are driving global climate?
  - What changes are occurring in global land cover and land use, and what are their causes?
  - How is the Earth's surface being transformed and how can such information be used to predict future changes?

- ***How does the Earth system respond to natural and human-induced changes?(Response)***
  - What are the effects of clouds and surface hydrologic processes on Earth's climate?
  - How do ecosystems respond to and affect global environmental change and the carbon cycle?
  - How can climate variations induce changes in the global ocean circulation?
  - How do stratospheric trace constituents respond to change in climate and atmospheric composition?
  - How is global sea level affected by climate change?
  - What are the effects of regional pollution on the global atmosphere, and the effects of global chemical and climate changes on regional air quality?

- ***What are the consequences of change in the Earth system for human civilization?(Consequences)***
  - How are variations in local weather, precipitation and water resources related to global climate variation?
  - What are the consequences of land cover and land use change for the sustainability of ecosystems and economic productivity?
  - What are the consequences of climate and sea level changes and increased human activities on coastal regions?

- ***How well can we predict future changes to the Earth system?(Prediction)***
  - How well can weather forecast duration and reliability be improved by new space-based observations, data assimilation, and modelling?
  - How well can transient climate variations be understood and predicted?
  - How well can long-term climatic trends be assessed or predicted?
  - How well can future atmospheric chemical impacts on ozone and climate be predicted?
  - How well can cycling of carbon through the Earth system be modelled, and how reliable are predicted future atmospheric concentrations of carbon dioxide and methane by these models?

ANNEX V

GUIDELINES FOR REQUIREMENTS FOR OBSERVATIONAL DATA FROM OPERATIONAL AND R&D SATELLITE MISSIONS

Preamble

Whilst there is a distinction between operational and research satellite programmes, there is an increasing convergence between their requirements for the space-based component of the Global Observing System and WMO should seek to establish a continuum of requirements for observational data from R&D satellite missions to operational missions. These requirements should be prioritized in the light of both scientific priorities and practicalities and cross-mapped against the needs of the scientific disciplines and Earth system components embraced by WMO, including areas such as the atmosphere, oceans and hydrology, observations needed to improve the monitoring and forecasting and prediction of weather and climate, and impacts of weather and climate variability on natural, social and economic resources. The establishment and maintenance of this continuum of requirements require a vigorous interactive dialogue fostered by the WMO amongst data users, operational satellite providers and R&D agencies. Commitments to address these requirements should allow an evolution by the space-based component toward a comprehensive Global Observing System that should help characterize the total Earth and climate system on a variety of time and space scales and should also provide for the effective transition of research to operational platforms based on the logical progression of scientific understanding and maturity of required technologies. The global monitoring of water resources (water cycle), ecosystems (carbon cycle), snow and ice and others are important categories in which observations are needed to improve prediction models and address global impacts. Issues and questions related to research categories such as these have proceeded well beyond the research domain and reflect items raised by policy makers and the general public. Consequently, such research categories have become, *de facto*, operational needs that should be addressed. The existing operational meteorological satellites in geostationary and low earth orbit (LEO) are the best starting point for defining an evolutionary and flexible architecture for the future Global Observing System. It is envisaged that such a system should be flexible enough to: (1) accommodate proven and existing operational meteorological and other environmental observations and services; (2) enhance these capabilities based on evolution of scientific understanding and technological innovations; and (3) adopt new and mature capabilities and provide the associated services mandated by emerging requirements.

Guidelines

1. In order to maximize the impact of data from operational and R&D missions and the associated expenditures in resources (manpower and financial) by operational users, there should be agreed upon guidelines in the form of requirements that must be met by space agencies responsible for potential R&D missions that would contribute to the space-based component of the Global Observing System. These requirements need further definition but, as a preliminary set, should include considerations relating to:

    (a) data dissemination,
    (b) user preparation for R&D data, and
    (c) data continuity for sufficient periods of time.

2. The agreed Guidelines for the Requirements for operational and R&D missions that contribute to the space-based component of the Global Observing System are, in outline, that:

    (a) data dissemination should be:

        (i) available to WMO Members taking into consideration user and provider data policies,

(ii) in data formats (standardized where possible but well publicized in all cases to allow data access),
(iii) timely,
(iv) readily accessible from supported infrastructures (capabilities beyond current GTS capabilities must be established) (If possible, use the existing dissemination procedures of the meteorological satellite operators),
(v) based on a dialogue, encouraged and facilitated by WMO, between users and satellite agencies concerning data dissemination on a regional basis.

(b) user preparation for R&D data implies that:

(i) resources to enable use of research data must be provided,
(ii) training new users of new data and products must be organized and financially supported,
(iii) on-line training systems, such as the Virtual Laboratory concept, should be used,
(iv) international working groups should be used as fora for information,
(v) spending on technology must be supplemented with resources for utilization,
(vi) WMO programmes using satellite data should put in place systems to provide early operational evaluations and feedback to satellite operators concerning the utility and benefits they have derived from usage of the data,
(vii) WMO should encourage activities that focus on a dialogue between users and the satellite agencies concerning data usage on a regional basis.

(c) data continuity for sufficient periods of time requires that:

(i) a clear path for research capabilities to be adopted by operational agencies must be identified,
(ii) political high level agreements must be encouraged,
(iii) more active participation of research satellite agencies in operational coordination and planning groups must be encouraged and expanded,
(iv) opportunities need to be fostered for satellite remote sensing capabilities to evolve,
(v) R&D satellite operators must identify and confirm an intention to provide data for an identified period of time,
(vi) there be continuity of calibration of data sets (bias estimations),
(vii) responsibility for long-term maintenance of data sets be identified.