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WMO WP-15
Prepared by WMO
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Plenary

WMO EXECUTIVE COUNCIL CONSULTATIVE MEETINGS

(Submitted by WMO)

Summary and purpose of document

To inform CGMS Members of related activities of the Consultative Meetings on High-Level Policy on Satellite Matters and the WMO Executive Council.

ACTION PROPOSED

CGMS Members to note the related activities of the Consultative Meetings on High-level Policy on Satellite Matters and the WMO Executive Council and comments as appropriate.

Appendix: Guidelines for requirements for Observational Data from operational and R&D Satellite Missions

DISCUSSION

BACKGROUND

CGMS-XXVIII was informed of WMO activities resulting in the formation of Consultative Meetings on High-Level Policy on Satellite Matters and that a first session was scheduled for January 2001. CGMS-XXVIII also noted the draft agenda and explanatory memorandum for the first session included:

- An evaluation on the utility of some current and planned R&D missions;
- Draft guidelines for minimum requirements to provide confidence in the availability of operational and R&D observational data;
- An initial draft of a possible configuration for the space-based component of the GOS;
- Needs of developing countries;
- A draft WMO Technical Document on "The Role of Satellites in WMO Programmes in the 2010s".

1. FIRST SESSION OF THE CONSULTATIVE MEETINGS ON HIGH-LEVEL POLICY ON SATELLITE MATTERS

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

1.1 Support by R&D Satellite Missions to WMO Programmes

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.

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.

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.

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.

1.2 Guidelines for Requirements for Observational Data from Operational and R&D Satellite Missions

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.

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

1.3 Review of Configuration for the Space-Based Component of the Global Observing System

The First Consultative Meeting 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 would be agreed upon by both the WMO Executive Council and space agencies.

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.

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.

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.

2. WMO FIFTY-THIRD EXECUTIVE COUNCIL

The fifty-third Executive Council reviewed recommendations from the first session of the Consultative Meeting on High-Level Policy on Satellite Matters and in particular those related to: Support by R&D Satellite Missions to WMO Programmes; Guidelines for Requirements for Observational Data from Operational and R&D Satellite Missions; and a Review of Configuration for the Space-Based Component of the Global Observing System.

2.1 Support by R&D Satellite Missions to WMO Programmes

The Executive Council was informed that the First Consultative Meeting had reviewed the support provided by the present Research and Development (R&D) satellite missions to WMO Programmes. The review highlighted the significant contributions already made by R&D satellite missions in support of WMO Programmes.

The Executive Council agreed with the need to identify those satellite-related data streams which had proven to be successful and of high value to WMO Programmes. The Executive Council 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 was identified as crucial and pivotal in highlighting the potential value of R&D data. 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 would 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. The Executive Council stressed that access to R&D data should be expanded by the satellite operators with the expectation that the impact in operational use would be increased.

Thus, the Executive Council reaffirmed the need to develop persuasive arguments related to the impacts of satellite data justified through feedback from the operational user community. In doing so, it requested the Secretary-General to prepare a report for the next Executive Council, to be reviewed by the Second Consultative Meeting, that would be a synthesis of input from the operational user communities on the utility of existing R&D data including persuasive arguments related to their impacts from R&D satellite missions. Furthermore, it asked the Secretary-General and the Commission for Basic Systems to provide for an active interaction between R&D satellite agencies with missions planned for the near-future and perspective operational users and to inform the Executive Council of the results of the dialogue.

2.2 Guidelines for Requirements for Observational Data from Operational and R&D Satellite Missions

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

The Executive Council 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 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 of the 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 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 Executive Council 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.

The Executive Council reconfirmed the need to strengthen and expand 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. One benefit from the dialogue could be improved regional data access and dissemination especially in view of the anticipated order-of-magnitude growth in the volume of satellite data. The Executive Council stressed that the use of R&D satellite data would enhance capacity building within WMO Members.

Based on the recommendation from the First Consultative Meeting, the Executive Council endorsed the *Guidelines for requirements for observational data from operational and R&D satellite missions* as contained in the Appendix.

2.3 Review of Configuration for the Space-Based Component of the Global Observing System

The Executive Council 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* as contained in the Appendix would be agreed upon by the space agencies as had been done by the fifty-third Executive Council.

In reviewing the basis for the need to propose new configurations, the Executive Council 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 Executive Council 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 Executive Council 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 Executive Council 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 Executive Council was informed that three such Statements of Guidance had already been published as WMO Satellite Activities Technical Documents.

In view of the existing process within WMO to provide a hierarchical set of requirements, the Executive Council 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 Executive Council 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.

Therefore, the Executive Council requested the Commission for Basic Systems to review, as a matter of urgency in order to provide the fourteenth WMO Congress appropriate input, 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.

The Executive Council 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.

The Executive Council 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;

- Improved detection and monitoring of hazardous atmospheric phenomena such as fog and volcanic ash.

3. SECOND SESSION OF THE CONSULTATIVE MEETINGS ON HIGH-LEVEL POLICY ON SATELLITE MATTERS

The second session of the Consultative Meetings on High-Level Policy on Satellite Matters is scheduled for 18-19 February 2002 in Geneva, Switzerland. The draft agenda for the second session includes the following topics:

- Review CBS Progress in Changes to the Space-Based Component of the Global Observing System;

- Review Report n the Utility of Existing R&D Satellite Data from the Operational User Communities;

- Review Proposal for Enhanced Coordination for the Space-Based Component of the Global Observing System;

- Review Draft WMO Technical Document “The Role Of Satellites In WMO Programmes In the 2010s”

APPENDIX

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 publicised 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.

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