W O R L D M E T E O R O L O G I C A L O R G A N I Z A T I O N

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CONSULTATIVE MEETINGS ON HIGH-LEVEL POLICY ON SATELLITE MATTERS

FOURTH SESSION

GENEVA, SWITZERLAND

26-27 JANUARY 2004

DRAFT FINAL REPORT

1. ORGANIZATION OF THE SESSION

1.1 Opening of the session *(agenda item 1.1)*

The fourth session of the Consultative Meetings on High-level Policy on Satellite Matters was held at the World Meteorological Organization (WMO) Headquarters in Geneva, Switzerland from 26 to 27 January 2004 under the chairmanship of the President of WMO, Dr A.I. Bedritsky. The session was opened at 09:30 hours on Monday, 26 January 2004. In Dr Bedritsky's opening remarks, he noted the recent decisions by the Fourteenth WMO Congress to establish a new major WMO Space Programme as well as the WMO Consultative Meetings on High-Level Policy on Satellite Matters. He stressed the importance of both decisions for WMO Members towards more effective coordination of an integrated satellite system. He also noted the importance to WMO Members by the Earth Observation Summit initiative inaugurated at the ministerial level conference hosted by the United States of America in July 2003.

In remarks by the WMO Secretary-General, Mr M. Jarraud indicated that the fourth session of the Consultative Meetings on High-level Policy on Satellite Matters would be remembered for its long list of "firsts". It was the first session where the group had met under its new mandate from the WMO Congress. It was also the first session chaired by new President of WMO. Additionally, it was the first meeting for three new space agencies with the potential capability to provide valuable data and products to the space-based component of the World Weather Watch's Global Observing System, namely the German Aerospace Centre (DLR), the Canadian Space Agency (CSA) and the Korea Aerospace and Research Institute (KARI). In closing, he thanked the participants and their organizations for the contributions made over the years in support of the objectives of the World Meteorological Organization.

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

The agenda for the session was adopted and is reproduced in Annex I.

1.3 Working arrangements for the session (*agenda item 1.3*)

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

The list of participants is attached as Annex II.

2. ACTIONS DERIVING FROM CM-3, AND Cg-XIV

2.1 The session noted that all action items resulting from the third session of the Consultative Meetings on High-level Policy on Satellite Matters (CM-3) were either addressed at the Fourteenth WMO Congress (Cg-XIV) or addressed in the documentation for the present session.

WMO Space Programme

2.2 The session recalled in response to the momentous expansion in the availability of satellite data, products and services and in recognition of the increase in responsibilities for WMO, that the fifty-fourth session of the Executive Council (EC-LIV) had agreed to establish a WMO Space Programme as a matter of priority. Cg-XIV, held in Geneva, Switzerland in May 2003, agreed that the WMO Space Programme Long-term Strategy provided an excellent balance to the WMO Sixth Long-term Plan (6LTP) and the Programme and Budget for 2004-2007 and established the WMO Space Programme as a new major cross-cutting Programme as adopted in its Resolution 3.1.6/1 (Cg-XIV).

2.3 Cg-XIV also agreed that the main thrust of the WMO Space Programme Long-term Strategy should be:

> "To make an increasing contribution to the development of the WWW GOS, as well as to the other WMO-supported Programmes and associated observing systems (such as AREP's GAW, GCOS, WCRP, HWR's WHYCOS and JCOMM's implementation of GOOS) through the provision of continuously improved data, products and services, from both operational and R&D satellites, and to facilitate and promote their wider availability and meaningful utilization around the globe."

2.4 The main elements of the WMO Space Programme Long-term Strategy were agreed at Cg-XIV as follows:

(a) Increased involvement of space agencies contributing, or with the potential to contribute to, the space-based component of the GOS;

(b) Promotion of a wider awareness of the availability and utilization of data, products – and their importance at levels 1, 2, 3 or 4 - and services, including those from R&D satellites;

(c) Considerably more attention to be paid to the crucial problems connected with the assimilation of R&D and new operational data streams in nowcasting, numerical weather prediction systems, reanalysis projects, monitoring climate change, chemical composition of the atmosphere, as well as the dominance of satellite data in some cases;

(d) Closer and more effective cooperation with relevant international bodies;

(e) Additional and continuing emphasis on education and training;

(f) Facilitation of the transition from research to operational systems;

(g) Improved integration of the space component of the various observing systems throughout WMO Programmes and WMO-supported Programmes;

(h) Increased cooperation amongst WMO Members to develop common basic tools for utilization of research, development and operational remote sensing systems.

WMO Consultative Meetings on High-level Policy on Satellite Matters

2.5 Cg-XIV considered the progress and results from the sessions of the Consultative Meetings on High-level Policy on Satellite Matters. Congress recalled that it had agreed to build a new and closer partnership under the auspices of WMO between the meteorological and hydrological services and environmental satellite communities. It had agreed that a mechanism for such discussions should be provided through the convening of Consultative Meetings on High-level Policy on Satellite Matters. Congress was convinced that the now established dialogue between WMO and the environmental satellite communities in the sessions of the Consultative Meetings had matured rapidly to the great benefit of all and that they should be continued and institutionalized. Thus, Congress considered it appropriate to institutionalize the sessions as WMO Consultative Meetings on High-level Policy on Satellite Matters in order to establish more formally the dialogue and participation of environmental satellite agencies in WMO matters. Thus Congress adopted Resolution 3.1.6/2 (Cg-XIV) establishing the WMO Consultative Meetings on High-Level Policy on Satellite Matters.

2.6 The session expressed its appreciation for the recognition given by Cg-XIV to the contribution made by satellite systems, both operational and R&D, and their associated data, product and services resulting in the establishment of the WMO Space Programme. In particular,

ROSHYDROMET indicated that their operational geostationary, operational polar-orbiting and R&D satellite plans were now better coordinated internally up to the 2015 timeframe. JMA indicated that full utilization of satellite data and products had a significant impact in the operations of its NMHS, and consequently this would support space agencies' activities. The session also noted the increasing positive impact of satellite data in data assimilation and NWP. It also stressed the importance for the smooth and rapid transition of appropriate R&D satellite data streams into operational use.

3. REVIEW EXPANSION OF THE SPACE-BASED COMPONENT OF THE GLOBAL OBSERVING SYSTEM (*agenda item 3*)

3.1 The session reviewed activities that have occurred as a result of the expansion of the space-based component of the Global Observing System (GOS), including the participation of R&D space agencies, as well as related actions occurring at the thirty first session of the Co-ordination Group for Meteorological Satellites (CGMS-XXXI) and other activities.

Expanded space-based component of the GOS

3.2 The session recalled at CM-3 (February 2003), four R&D space agencies (ESA, NASA, NASDA now JAXA and ROSAVIAKOSMOS) had made formal commitments of their intent to participate in the space-based component of the GOS. At Cg-XIV, the Centre National d'Etudes Spatiales (CNES) made a formal commitment for the participation of Jason-1 and SPOT-5 in the space-based component of the GOS. At CGMS-XXXI held in November 2003, WMO recommended and CGMS agreed to invite CNES as a full CGMS Member. Thus, the nominal space-based component of the GOS comprised of three constellations (operational geostationary; operational polar-orbiting; and R&D satellites) is shown in Figure 1.

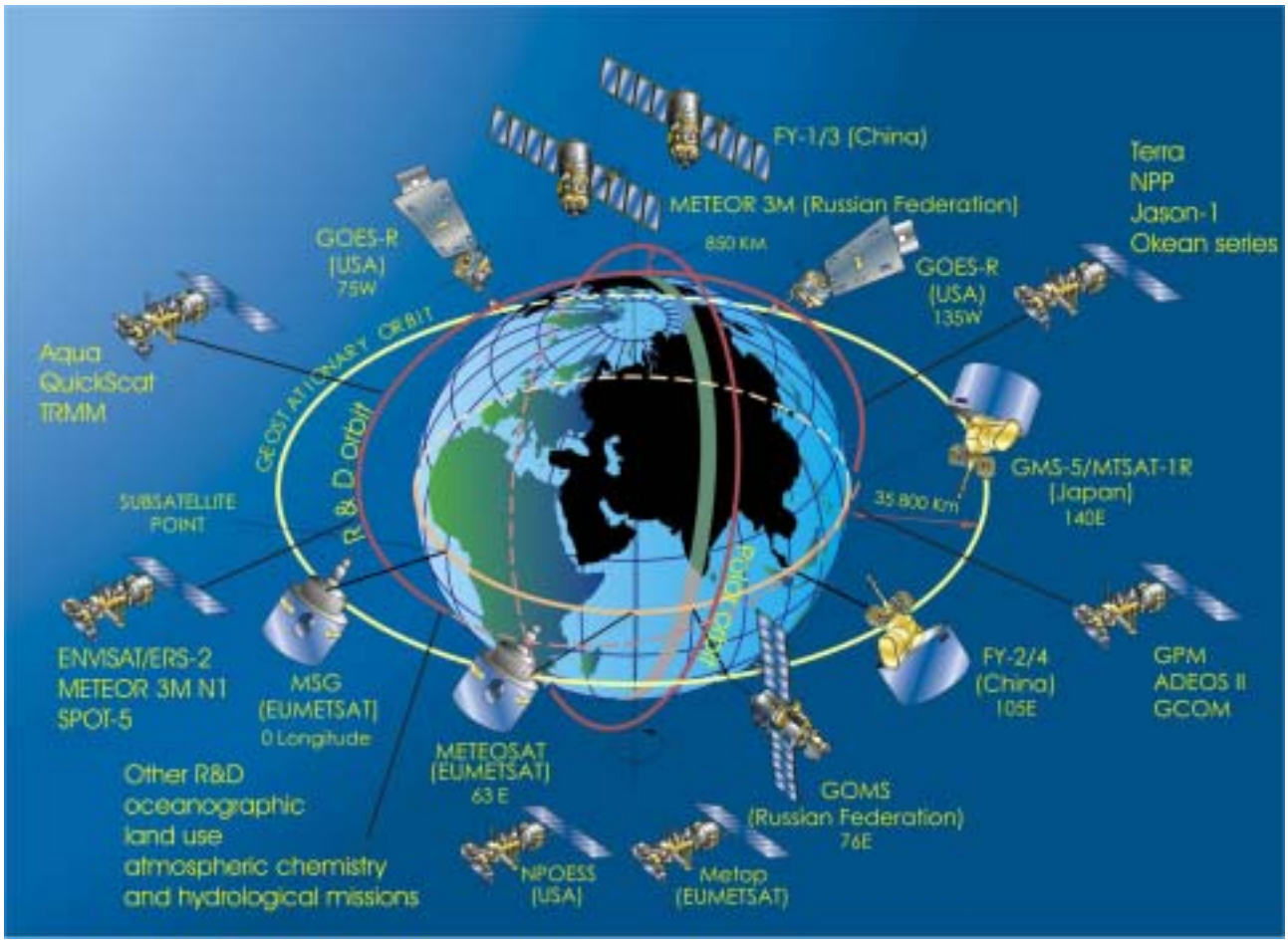

Figure 1 – Nominal Space-Based Component Of The Global Observing System

3.3 With regard to the commitment made by the European Space Agency (ESA) for access to ERS and ENVISAT data, the session noted that a Joint ESA/WMO Announcement of Opportunity (AO) had been mailed to all WMO Permanent Representatives in early 2003. A joint ESA/WMO evaluation board met in mid-2003 and 17 out of 20 proposals were accepted and now enjoy free access to the agreed ESA data. It was recalled that the primary Principal Investigator (PI) for all accepted proposal was the relevant WMO Permanent Representative although he or she could designate an alternate PI. The proposals not accepted had misunderstood the scope of the AO. Additionally, one proposal had been withdrawn. Based on the success of this first AO, ESA has indicated a willingness to consider follow-on AOs in the future.

3.4 The session expressed its appreciation to ESA for a very well organized and implemented AO. ROSHYDROMET noted that data obtained as part of the AO were helping to solve problems and issues by supplementing existing data streams. In a request for the condition that AO data be used for research purposes, ESA indicated that a review was currently in progress within a GMES context and it may be possible that the present limitations of data use for operational purposes could change. ROSHYDROMET also expressed its support for further development of ADM implementation since it had already a six-fold increase in the availability of satellite data at its major data processing centres.

3.5 NOAA informed the session of the ongoing investigation into the NOAA N' accident and that it would continue to work with all its partners in formulating a solution for continuity of satellite data in the PM orbit later in the decade. NOAA noted that it would inform the WMO Secretariat of the solution in order that it could be forwarded to WMO Members. NOAA also stressed the value of the ongoing dialogue with WMO on global contingency planning and that it was important for WMO to continue these efforts.

CGMS-XXXI (November 2003)

3.6 The session was informed of relevant results from CGMS-XXXI. The session recalled at CM-3, the China National Space Administration (CNSA) had expressed the wish to join CGMS. CGMS-XXXI was briefed by the China National Space Administration (CNSA) and the Korea Aerospace Research Institute (KARI) as to their respective satellite plans with a goal towards their eventual inclusion in the space-based component of the GOS, as well as becoming full CGMS members.

3.7 The session was informed that CNSA will continue its dialogue with WMO with a goal to participate in the space-based component of the GOS as soon as possible. KMA described its planned satellite missions to the session and also expressed its interest to contribute to the space-based component of the GOS. Rosaviakosmos noted its ongoing satellite plans including the joint SICH-1M and Monitor-E missions. It indicated that Monitor-E had the potential to be part of a contingency planning. JAXA briefly describe the mission degradation of ADEOS-II and its firm commitment to continue its support to the user communities. Finally, EUMETSAT informed the session that MSG-1 would become operational the next day, 27 January 2004 and be called Meteosat-8 as a continuation of the long Meteosat series.

3.8 The session was also informed that at CGMS-XXXI, the India Meteorological Department (IMD) described its meteorological data and INSAT image broadcast service delivered through World Space satellites. IMD noted that it could be possible to also distribute processed 8-bit satellite data through the World Space communication satellite.

CGMS Global Contingency Planning

3.9 The session also noted that CGMS-XXXI had discussed global contingency planning considered relevant to the space-based component of the GOS.

3.10 CGMS-XXXI noted that the WMO baseline space-based component of the GOS had changed in December 2002. In particular, with regard to the geostationary orbit, there was a new WMO requirement for at least six geostationary satellites. With regard to the polar orbit, there was a new WMO requirement for at least four polar orbiting satellites, two in the AM and two in the PM orbit. Additionally, CGMS recognized that while R&D satellite missions did not require contingency planning themselves, they could provide back-up to operational meteorological satellite missions.

Geostationary satellite contingency planning

3.11 CGMS noted that several satellite operators had already formalized contingency planning for their geostationary satellites in following the CGMS principle to "help your neighbour". EUMETSAT, NOAA, JMA and the Russian Federation had already agreed-upon plans to assure continuity of data, products and services with their neighbouring satellite operator. At the present, three such plans existed and two were being implemented due to difficulties experienced with satellite systems that were providing less-than-optimal performance. CGMS was informed by WMO of the deep appreciation expressed by WMO Members at the recent WMO Congress for this strong willingness by satellite operators to voluntarily meet WMO contingency requirements. CGMS satellite operators were also appreciative of the satellite neighbours' commitment to ensure continuity.

Comparable data content from geostationary satellites

3.12 CGMS discussed the recommendations that: all geostationary imagers should be upgraded to at least the level of SEVIRI by the 2015 timeframe; and frequent IR sounding should be made by spectrometers within the same timeframe. CGMS unanimously endorsed those two recommendations in noting the goal to have comparable data content from comparable instrumentation with common spectral bands from all geostationary satellites. It agreed that as an action item each CGMS satellite operators should inform CGMS XXXII on its plans to achieve that goal within the 2015 timeframe.

Low Earth Orbit satellite contingency planning

3.13 CGMS noted the less-than-optimum equator crossing time plan by CGMS satellite operators. As expressed in previous CGMS meetings, both the ROSHYDROMET and CMA reconfirmed their willingness to consider placing their satellite missions in the afternoon orbit with a view of optimizing temporal coverage of the globe. In particular, CMA noted that if FY-3A (tentatively scheduled for launch in late 2006) was successful, it would consider launching FY-3B into an afternoon orbit when launched, now tentatively scheduled for 2008. ROSHYDROMET indicated with the difficulties being experience with the meteorological payload on Meteor 3M N1, Meteor 3M N2 could be launched in 2005 into a morning orbit. With a launch date in 2008, ROSHYDROMET expressed a willingness to consider placing Meteor 3M N3 into an afternoon orbit. CGMS noted that with these possible shift from AM to PM orbit near the end of the decade, the equator crossing time plan would approach more optimal spacing. CGMS also noted the large gap in the early morning orbit contained in the existing satellite operators plans and that NOAA was the only satellite operator at present seeking to reduce the gap. Given the existing plans, the large gap would only be reduced in 2013.

Alternative Dissemination Methods

3.14 CGMS recalled that a new CGMS Working Group on ADM had been established and that the use of ADM was already being implemented by some satellite operators and that the

capabilities were developing rapidly. CGMS unanimously agreed in principle that ADM should be an integral part of all contingency planning. CGMS encouraged all satellite operators to develop the capability to deliver satellite data and products by ADM and that such systems allow for the exchange of satellite information and in this way help facilitate contingency planning. NOAA noted that it was already investigating means to further exploit ADM that could benefit WMO Members in Regions III and IV.

CGMS Global Contingency Plan

3.15 CGMS noted that while considerable progress had been made, both at this and previous CGMS meetings, there was no consolidated description of the CGMS Global Contingency Plan. It agreed that such a description should be prepared and maintained. Thus, it proposed an action to consolidate CGMS discussions and agreements into a CGMS Global Contingency Plan that would reside as part of the CGMS Consolidated Report.

3.16 JMA noted that although the launch of MTSAT-1R may be further delayed due to H2A problems, the ongoing back-up operation of GMS-5 with GOES-9 would be continued.

Other activities

3.17 The session noted that NOAA had informed CGMS of the potential availability of data and products from US Defense Meteorological Satellite Program (DMSP) satellites for global contingency planning. CGMS had agreed that it would only be appropriate to include systems such as the US Defense Meteorological Satellite Program (DMSP) satellites if there were a formal commitment to WMO to include them in the space-based component of the GOS. Thus, CGMS had indicated that the DMSP systems could be included in its future contingency planning activities if they became part of US contingency plans. CGMS had also noted the potential benefits from the use of R&D data and products by operational entities in anticipation of contingency planning implementation as well as the benefits from such data streams as a precursor of future operational satellite systems. NOAA informed the fourth session that while DMSP data were generally available to the community, the new US polar satellite programme, NPOESS, will combine the instrument capabilities of DMSP, and NOAA's POES programme, and the resultant data will be a contribution to the WMO programme.

3.18 The session also noted that the German Aerospace Centre (DLR) and the Canadian Space Agency (CSA), DLR and CSA had been invited to CM-4 as a potential contributor to the space-based component of the GOS through missions such as CHAMP and SCISAT-1.

3.19 Finally, the session was informed that the WMO Secretary-General had written to all space agencies, as well as potential new contributors to the space-based component of the GOS seeking information on the data and products (format, periodicity, etc.), the means through which WMO Members may access them (direct broadcast, Internet access, ADM, etc,) and any conditions on their use (for research only, for operational use, for education and training, etc.). The session suggested that further clarity of the required information was necessary, in particular in the form of a more comprehensive and detailed template.

3.20 The session encouraged WMO to make all efforts to take a leading role in the further development of a global implementation of the ADM concept.

4. REVIEW WMO SPACE PROGRAMME IMPLEMENTATION PLAN (*agenda item 4*)

4.1 The session recalled CM-3 had reviewed a WMO Space Programme Long-Term Strategy. CM-3 had also suggested that an associated Implementation Plan should be prepared. The session noted that the WMO Space Programme Long-Term Strategy had been included in the 6LTP at Cg-XIV. The session then reviewed and agreed, as modified in the following paragraphs, to the WMO

Space Programme Implementation Plan for 2004-2007 prepared by the Secretariat as contained in Annex III.

4.2 The session noted that the last section of the WMO Space Programme Implementation Plan for 2004-2007, entitled "WMO Resource Implications", outlined specific areas where space agencies contributing to the space-based component of the GOS could complement the existing infrastructure for the WMO Space Programme Office as well as for Education and Training events.

4.3 The session was of the opinion that the WMO Space Programme Implementation Plan for 2004-2007 adequately described the scope and breadth of the new programme. Some sections such as the description of the integrated global data dissemination service were well structured and appropriately detailed although consideration should be given to dissemination services presently operated by NMHSs and other organizations, e.g., ICAO/WAFS. An opportunity now existed to improve data dissemination while integrating existing mechanisms. Other sections could be structured in a similar fashion. Additional emphasis should be made for satellite data collection systems as well as amplification of the role in oceanography. It was also suggested that a project could be developed for inclusion in the Implementation Plan for assimilation of data from present and future R&D environmental satellites. An additional project could also be included in the Implementation Plan covering reanalyses related to retrospective satellite data from both operational and R&D environmental satellites. The Implementation Plan should also be careful to reflect the role of partner agencies when integrating across WMO supported programmes.

4.4 The session noted the emphasis given by Cg-XIV in the establishment of the WMO Space Programme and additionally resources allocated for training events, workshops and meetings. Additionally, NOAA noted that WMO and its Space Programme could benefit from activities of the newly revamped CEOS Working Group on Education, Training and Capacity Building. However, the session felt that WMO should also consider more staff resources for the WMO Space Programme Office as a matter of urgency and high priority. It recognized that a review of staff and priorities may be necessary to identify possible solutions.

4.5 The session noted the use of the WMO Space Programme Trust Fund that had allowed WMO to lead detailed discussions in CGMS with regard to global contingency planning as well as in the preparation of the WMO Space Programme Implementation Plan. The session was of the opinion that the use of the WMO Space Programme Trust Fund for such purposes greatly enhanced the effectiveness of the Space Programme in supporting WMO Members. Thus, it strongly urged WMO Members and space agencies to consider providing financial resources to the Trust Fund recognizing that such contributions would allow related activities identified in the review of the Implementation Plan as well as for the Plan itself to commence.

4.6 The session was also briefed on NASA's plan for Earth System Science. NASA's mission was to understand and protect Earth; to explore the universe and search for life; and to inspire the next generation of explorers. The session Chairman noted that the challenges facing WMO fit well with NASA's goals. NASA stressed the significant contributions made by international partners. There was a compelling need for international cooperation since the problems and challenges couldn't be met by any one agency or country. NASA saw WMO as a primary mechanism to spread knowledge and experience.

5. REVIEW INTEGRATION OF SPACE COMPONENTS OF VARIOUS WMO PROGRAMMES INTO THE SPACE COMPONENT OF AN INTEGRATED GLOBAL OBSERVING SYSTEM *(agenda item 5)*

5.1 The session recalled that, at earlier Consultative Meetings, the space agency representatives had encouraged WMO to move towards a more integrated framework for the space-based components of the observing systems of the various WMO programmes.

5.2 It was pleased, therefore, to learn that Cg-XIV had specifically assigned as an overall objective of the WMO Space Programme "To review the space-based components of the various observing systems throughout WMO Programmes and WMO-supported Programmes, e.g., WWW's GOS, AREP's GAW, GCOS, HWR's WHyCOS, JCOMM's Implementation of GOOS, etc., with a view towards the development of an integrated WMO global observing system that would encompass all present observing systems."

5.3 The session agreed that the development of an 'integrated WMO global observing system' was particularly timely in the context of the initiative now underway, through the ad hoc GEO mechanism (discussed under Agenda Item 6) to achieve high-level international (intergovernmental and inter-agency) commitment to the implementation, over a ten-year period, of a "comprehensive, coordinated and sustained Earth observation system or systems". An effectively integrated WMO global observing system covering he atmosphere and those aspects of the ocean and land surface that fall within the WMO mandate would go a long way towards providing the nucleus of the more comprehensive earth observation system that is the goal of the GEO initiative.

5.4 The session recognized that the responsibilities of the Consultative Meetings extended only to the space-based component of such an integrated WMO global observing system. It felt satisfied, however, that, given the long history of effective integration of the surface-based and space-based sub-systems of the Global Observing System of the World Weather Watch, a similar level of coordination and integration between the surface-based and space-based components of an integrated WMO Global Observing System would follow naturally from the WMO Processes.

5.5 It was considered that the basic architecture of the space-based sub-system of the WWW GOS would extend logically to the space-based sub-system of an integrated WMO global observing system, and it would consist of three constellations and their associated ground segments based on the WWW sub-system of:

- operational meteorological polar orbiting satellites;
- operational meteorological geostationary satellites; and
- environmental Research and Development satellite constellations.

5.6 The session agreed that the main challenge for WMO in giving effect to the decision of Cg-XIV would be in putting in place effective coordination and integration mechanisms across the various WMO observing systems serving the needs of the wide range of user communities represented by the individual programmes in areas such as agriculture, water resources, oceanographic and marine meteorological services, weather predication and climate research and so on. It considered, however, that this process would be greatly facilitated by the fact that the WMO Space Programme has been constituted not just as a Major WMO Programme but also as a cross-cutting programme with the resulting requirement to take a comprehensive view of the space aspects of all other WMO programmes.

5.7 While recognizing that the detailed arrangements for cross-programme coordination and integration, including those relating to the staffing of the WMO Space Programme Office for this purpose, had still to be worked out, the session lent its support to the concept of the space-based component of an integrated WMO global observing system composed of the space-based components of the observing systems of the various WMO and WMO-cosponsored programmes, grouped in terms of the major user communities they serve.

5.8 Given that, while WMO was responsible for almost all aspects of the observation and information/service provision for the atmosphere, it shared the responsibility for the ocean and land surface (including water resources) with many other international agencies and conscious, in particular, of the cross-cutting nature (ocean atmosphere, ocean and land surface) of the observation needs for natural disaster reduction and climate, the session agreed on the importance of careful and sensitive design of the integrated WMO observing system structure. It welcomed

the fact that, in line with its long established role in coordination of the WWW GOS, the WMO Commission for Basic Systems (CBS) had been assigned the responsibility of WMO lead Technical Commission for the WMO Space Programme.

5.9 The session looked forward, therefore, to CBS development in consultation with all other relevant WMO and co-sponsored bodies, of the space-based component of the integrated WMO global observing system on the basis of [*]space-based observation components for three earth-system domains and two cross-cutting sets of requirements as follows:

(1) the atmosphere, including sub-components meeting the needs of:

   (a) the operational WWW and the various weather, climate and related applications and services based on it, including those of aviation meteorology (articulated through the Commission for Aeronautical Meteorology) and agricultural meteorology (articulated through the Commission for Agricultural Meteorology);

   (b) weather research such as for the World Weather Research programme as articulated through the Commission for Atmospheric Sciences;

   (c) atmospheric chemistry, such as for the Global Atmosphere Watch, as articulated through the Commission for Atmospheric Sciences;

(2) the ocean, to meet the needs of the Global Ocean Observing System (GOOS) and the oceanographic and marine meteorological services and research based on it, as articulated through the joint WMO-IOC Joint Technical Commission on Oceanography and Marine Meteorology (JCOMM);

(3) the land surface and fresh water, to meet the needs of:

   (a) the World Hydrological Cycle Observing System (WHyCOS) and the Hydrology and Water Resource Programme (HWR) as articulated through the Commission for Hydrology (CHy),

   (b) the WMO-co-sponsored Global terrestrial Observing System (GTOS),

   (c) agricultural meteorology as articulated through CAgM,

(4) climate, incremental to, and integrating across, the domain-based observing systems, as coordinated through the Steering Committee for the WMO co-sponsored Global Climate Observing System(GCOS) to meet the needs of:

   (a) climate research, articulated through the WCRP,

   (b) climate policy, articulated trough the IPCC, SBSYA, COP, etc.

   (c) climate monitoring and services, articulated through the Commission for Climatology (CCl), (CAgM), (CHy);

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* An alternative “sub-system” structure would be:
(1) Operational meteorology (CBS, CAeM, CAgM ..)
(2) Operational Oceanography (JCOMM)
(3) Operational hydrology (CHy)
(4) Atmospheric Research (CAS-AREP)
(5) Climate (including Climate Research) (GCOS, CCl, WCRP)
(6) Natural Disaster Reduction

(5) natural disaster reduction, incremental to, and integrating across, the domain-based observing systems and composed of those space-based instruments and missions providing geophysical and related information needed to support the WMO Natural Disaster Prevention and Mitigation Programme.

5.10 The session noted that the practical implementation of the proposed integration would pose significant challenges in matrix management but it was confident that WMO and the entire space-based earth observation stakeholder community would benefit from WMO taking a more integrated and coordinated approach.

5.11 The session was informed that the President of CBS agreed that the proposed integration of the various space-based components reflected the Commission's goals and that an appropriate structure to respond to these challenges would be addressed at the next CBS commission meeting in 2004.

5.12 The session also recognized in order to provide institutional constituent body support with appropriate satellite expertise for the various space-based components of observing systems throughout WMO Programmes that CBS consider as a matter of urgency the following restructuring.

- The present Open Programme Area Group on Integrated Observing Systems (OPAG IOS) Expert Team on Satellite Systems Utilization and Products should be renamed the Expert Team on Satellite Utilization and Products and maintain its present Terms of Reference;
- A new OPAG IOS Expert Team on Satellite Systems should be established that would provide the necessary satellite expertise (both for operational and Research and Development satellites) to ensure an integrated WMO global observing system that would encompass all present observing systems. The Expert Team would be comprised solely of representatives from space agencies contributing to the space-based component of the GOS. The Chairman of the new Expert Team would ensure that a member would be designated to represent the Expert Team to each of the various other WMO Programme expert groups. Representatives from the Expert Team would also serve as regional rapporteurs for the various Implementation and Coordination Teams thus ensuring regional influence reflecting WMO needs as well as those of the space agency. While working within the CBS structure, the new Expert Team would support all WMO Programmes as well as provide for direct feedback through the CBS President to the WMO Consultative Meetings providing overall guidance to the WMO Space Programme. The WMO Space Programme Office would serve as the WMO Secretariat for the new Expert Team as it already did for the present Expert Team on Satellite Systems Utilization and Products. Such a structure would provide the nucleus of satellite expertise towards the integration of the space components described above into a single integrated WMO global observing system.

5.13 The session was also informed of the new initiative by the WMO Secretary-General to establish matrix management within the WMO Secretariat. Furthermore, one potential area for matrix management would be for observations. It was presently intended that the World Weather Watch and WMO Space Programme work together towards the consolidation of all observing systems found in the various WMO programmes into an integrated WMO global observing systems. The session noted that this effort towards consolidation of observations, when coupled with the proposed integration of the space-based components of the various observing systems, and co-led by the World Weather Watch and WMO Space Programme would provide the necessary emphasis on the fusion of in situ and satellite data. The session was strongly in favour of such an approach and urged the WMO Secretary-General to seek measures to implement it. It was an important concept and very timely considering activities related to the ad hoc Group on Earth Observations.

The consolidation within the space-based components would help accelerate and align research and development programmes with operational services. With regard to the proposed restructuring of the CBS Expert Team structure, the session strongly supported the core group of satellite expertise approach.

Update of WCRP Space Mission Requirements

5.14 The session was informed of recent activities by the WCRP ad hoc Satellite Working Group. The session noted that the ad hoc Satellite Working Group recommendations included the following near-term priorities:

- Continuation of TRMM operations for as long as possible;
- Final decision to proceed with the GPM mission including the EGPM component,
- Identification of alternative option(s) for the timely implementation of Megha-Tropiques;
- Final decision on GOSAT implementation;
- Provision of continuity for high resolution optical imagery mission of the Landsat / SPOT class;
- Detailed definition and work plan for a strategy for the development of quality climate products with the involvement of CEOS WGISS;
- Involvement of CEOS Cal/Val Working Group for an enhanced Cal/Val programme focusing on sensor cross-calibration;
- Release by space agencies of coordinated Calls for Ideas / Mission concept for climate research and coordinated selection;
- Development of innovative instrumentation for atmospheric chemistry and precipitation measurements from GEO.

5.15 The ad hoc Satellite Working Group reiterated the general recommendations expressed last year at CM-3 and strongly urged that clear mechanisms be identified by space agencies to ensure data continuity for experimental missions whenever appropriate for climate research. This would also be valid for operational missions of importance for climate research although it recognized that continuity of operational missions through contingency planning was already addressed in CBS, the WMO Executive Council and CGMS.

5.16 The ad hoc Working Group proposed, a first step for the generation of global climate products, the systematic re-processing and coordinated re-analyses of relevant climate data sets. The session suggested that reanalysis projects would be a major challenge especially with regard to data in the tropics and that WCRP should consider such a research project. The session also stressed the importance of the continuity of data sets which would be crucial in any reanalysis project. The session also urged that there be close cooperation between WCRP and the CEOS Working Groups especially CAL/VAL and WGISS. EUMETSAT, speaking as the CGMS Secretariat, noted that CGMS members had undertaken similar activities. The session was of the opinion that the WMO Space Programme should serve as a focal point for coordination in these efforts.

5.17 JAXA informed the session of its plans to address some of the needs contained in the WCRP presentation including its contribution to the GPM reference concept and the Greenhouse Gas Observation Satellite (GOSAT).

Second Adequacy Report' and Integrated Global Climate Products

5.18 The session was briefed by the Chairman of the GCOS Steering Committee on the latest relevant developments in GCOS. The session noted that Second Report on the Adequacy of the Global Observing Systems for Climate in Support of the UNFCCC' (the 'Second Adequacy Report')

had been completed in April 2003 and presented, through the UNFCCC Subsidiary Body for Scientific and Technological Advice (SBSTA), to the ninth session of the Conference of the Parties (COP-9) in December 2003. COP-9 adopted a broad-ranging decision (11/CP.9) on 'Global observing systems for climate' aimed, *inter alia*, at facilitating the implementation of many of the report's recommendations. The report had identified a number of 'Essential Climate Variables' (ECVs) which were both currently feasible for global implementation and had a high impact on UNFCCC requirements, and many of which were highly dependent on satellite observations. It had specifically recommended that "Parties with responsibility for space agencies should support the long-term operation of Earth observation satellites; ensure that homogeneous climate data and integrated products are produced; and strive to make them available to all Parties" and that "such Parties should support an internationally-coordinated approach to the development of an initial set of integrated global climate products" related to a specific subset of the ECVs. This recommendation was reinforced in decision 11/CP.9 which invited "the relevant national entities, in cooperation with the sponsoring agencies of the Global Climate Observing System and other international and intergovernmental agencies, to make available on a sustained basis a range of integrated climate products relevant to the needs of the Convention, as identified in the second adequacy report". The session was of the opinion that data from many of the space agencies' satellite systems would be crucial in developing such products, and GCOS looked forward to cooperating closely with them in the planning and their implementation of these products.

5.19 The COP-9 decision had also requested the GCOS Secretariat, under the guidance of the GCOS Steering Committee and taking into account international and intergovernmental mechanisms, to coordinate the development of a phased 5- to 10-year implementation plan for the integrated global observing systems for climate, using a mix of high-quality satellite and *in situ* measurements, dedicated infrastructure and targeted capacity-building. It further requested GCOS and the *ad hoc* Group on Earth Observations (GEO) to collaborate closely in developing their respective implementation plans. GCOS, in cooperation with relevant agencies, organizations and scientists, had already begun the process of developing such a plan in anticipation of this decision and expected to have a draft available for open review by April 2004, leading to submission of a final plan to SBSTA-21 in December 2004.

5.20 Decision 11/CP.9 had also endorsed the GCOS Climate Monitoring Principles, which had been supported by CM-3 and formally adopted by WMO Congress in May 2003 through its Resolution 9 (Cg-XIV). The Chairman of the GCOS Steering Committee thanked the space agency participants at the session, as well as CGMS, in helping to finalizing these guidelines for climate monitoring and the efforts being undertaken by the space agencies to strive to adhere to them.

5.21 The Chairman of the GCOS Steering Committee was of the opinion that interactions with space agencies through the mechanism of the Consultative Meetings was mutually beneficial especially for the development of the integrated global climate products needed by its users.

5.22 The session sought clarification as to how GCOS would ensure a balance between the requirements for COP and the requirements for all the observing systems for climate. The Chairman of the GCOS Steering Committee felt confident that all the observing systems for climate needs were being addressed with the exception of specific needs for process studies such as found in WCRP. When asked about operational climate requirements and their management, the Chairman noted that the development and monitoring of the integrated global climate products would be a major challenge.

WCRP GCOS Coordination

5.23 The fourth session then engaged in a general review on the coordination of observational requirements from WCRP and GCOS. The space agencies represented in the session were of the opinion that it was essential that only a single set of climate observational requirements be maintained. It had already proven difficult to prioritize different sets of climate requirements from

WCRP and GCOS as well as to justify the necessary funding for the related satellite missions. The session strongly urged WCRP and GCOS to develop a single set of requirements to which WCRP and GCOS agreed. The session Chairman noted that there should be an integrated approach to the statement of observational requirements from all WMO Programmes and supported Programmes. EUMETSAT also requested that deliverables also be identified when stating observational data requirements. Additionally, WCRP should seek to exploit fully existing data sets when developing plans for new global integrated products. WCRP was of the opinion that it was natural for it to have observational data requirements for process studies that would be outside the remit of GCOS. The space agencies in the session stressed the importance to identify near-term observational requirements for relevant scientific issues as this allowed proper positioning in longer-term planning necessary to resource satellite missions. The Chairman of the GCOS Steering Committee noted that integration would be an integral part of the GCOS Implementation Plan and that the issue of targeted observations had been debated within GCOS when arriving at the list of Essential Climate Variables.

5.24 It was of the opinion that GCOS should be the integrator for both research and operational climate data requirements. Thus, close coordination with the World Climate Research Programme and other components of the World Climate Programme was absolutely essential. Additionally, it was recognized that GCOS would reflect the policy-related needs of COP, UNFCCC and IPCC.

5.25 The session also addressed the role of GCOS in the sessions of COP. The session stressed that WMO should remain visible in the decisions of COP. The Chairman of the GCOS Steering Committee and the Director of GCOS noted that they always informed COP during the session that it was speaking on behalf of its sponsors.

6. REVIEW ACTIVITIES RELATED TO THE AD HOC GROUP ON EARTH OBSERVATIONS (GEO) (*agenda item 6*)

6.1 The session reviewed WMO activities related to the Earth Observation Summits and associated ad hoc Group on Earth Observations (GEO). The Chairman noted that the GEO initiative was most important and a historical opportunity. Within GEO, integrated observing systems were now of political value. The session also noted that additional resources would be required to fully implement the resulting GEO observing system. It was informed that the WMO Space Programme strategic goals for the GEO initiative were two-fold: first to make all efforts to strengthen relevant WMO Member national as well as intergovernmental space-based observing systems, as well as national support for them; and secondly to position the WMO Space Programme to make the strongest possible contribution to the resulting space-based observing system components within the WMO mandate.

6.2 The session felt strongly that the space-based sub-system of the WWW's GOS, as described in agenda item 5 above, should be a major component of the space-based component of the resulting observing system agreed upon in the GEO initiative. While the total breadth of user requirements and data utilization structure for the complete GEO observing system were yet to be identified, the satellite systems contained in the present and future space-based component of the GOS had the potential to meet a significant fraction of the future GEO observing system needs. It also represented a near complete set of possible satellite systems and new contributors were actively engaged in joining the GOS.

6.3 The session also noted that external coordination mechanisms for the space-based component of the GOS were robust through CGMS and CEOS activities. Internal coordination and structure were strong with the establishment of the new major WMO Space Programme that has as one of its major goal to make an increasing contribution to the development of the WWW GOS, as well as to the other WMO-supported Programmes and associated observing systems (such as AREP's GAW, GCOS, WCRP, HWR's WHYCOS and JCOMM's implementation of GOOS) through the provision of continuously improved data, products and services, from both operational and R&D

satellites, and to facilitate and promote their wider availability and meaningful utilization around the globe. Since GTOS was also WMO-supported observing system, the space-based component of all four of the major international observing systems (GOS, GOOS, GTOS and GCOS) were within the mandate of the WMO Space Programme. WMO's role in the IGOS Partnership would ensure proactive activities towards identifying observational requirements for present and future theme areas. The proposed CBS Expert Team on Satellite Systems would further strengthen the role of satellite systems in all relevant observing systems, as well as the continued rolling review of requirements for WMO programmes.

6.4 The session strongly urged WMO to take a proactive role in seeking to establish a dialogue with other potential international partners. It suggested that the Secretary-General could contact the heads of other relevant intergovernmental organizations involved in earth observation programmes with a view to obtain agreement to work together in implementing and maintaining a comprehensive, coordinate and sustained observing system of systems while recognizing the respective roles of partners whose mandates would fall outside that of WMO. If such agreement could be made, an offer could be made to Earth Observation Summit II. Furthermore, WMO could discuss GEO activities at its next session of the Executive Council in order to seek agreement by the fuller set of WMO Members. In order to highlight the importance of GEO for WMO, one of the GEO Co Chairs could be invited to address the WMO Executive Council. The session also felt it important that WMO articulate national benefits and outcomes in order to demonstrate to ministers at Earth Observation Summit II the value of the GEO process and any future observing system(s). The session recalled the request from the UN General Assembly in 1961 to explore the potential of satellite systems resulting in the formation of the World Weather Watch and felt that such a request could be directed to the family of UN organizations resulting from decisions made at the Earth Observation Summits.

7. ANY OTHER BUSINESS

The session noted with pleasure that the "The Role of Satellites in WMO Programmes in the 2010s", WMO Space Programme Satellite Report (SP-1), Technical Document WMO/TD No. 1177 authored by Dr G. Asrar, Dr T. Mohr and Mr G. Withee would be distributed in the new future as well as be available at Earth Observation Summit II to be held in Tokyo in April 2004.

8. CLOSURE OF THE SESSION

In closing the session, the Chairman noted that the new WMO Space Programme had received excellent guidance from the fourth session of the WMO Consultative Meetings on High-level Policy on Satellite Matters. The expanded space-based component of WWW's Global Observing System was becoming even more responsive to the needs of WMO Members. He noted that new initiatives, such as GEO, made discussions within sessions of the Consultative Meetings all the more important. The growing awareness of WMO's role in Earth observation programmes would be enhanced by a strong and dynamic WMO Space Programme. He thanked the participants for their efforts in helping to achieve this goal. He then closed the session at 15h55 on Tuesday, 27 January 2004.

ANNEX I

AGENDA

1. ORGANIZATION OF THE SESSION

   1.1 Opening of the session
   1.2 Adoption of the agenda

2. ACTIONS DERIVING FROM CM-3 AND Cg-XIV

3. REVIEW EXPANSION OF THE SPACE-BASED COMPONENT OF THE GLOBAL OBSERVING SYSTEM

4. REVIEW WMO SPACE PROGRAMME IMPLEMENTATION PLAN

5. REVIEW INTEGRATION OF SPACE COMPONENTS OF VARIOUS WMO PROGRAMMNES INTO THE SPACE COMPONENT OF AN INTEGRATED WMO GLOBAL OBSERVING SYSTEM

6. REVIEW ACTIVITIES RELATED TO THE AD HOC GROUP ON EARTH OBSERVATIONS (GEO)

7. ANY OTHER BUSINESS

8. CLOSURE OF THE SESSION

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ANNEX III

WMO SPACE PROGRAMME
IMPLEMENTATION PLAN 2004-2007

BACKGROUND

1. Cg-XIV agreed that the main thrust of the WMO Space Programme Long-term Strategy should be:

> "To make an increasing contribution to the development of the WWW GOS, as well as to the other WMO-supported Programmes and associated observing systems (such as AREP's GAW, GCOS, WCRP, HWR's WHYCOS and JCOMM's implementation of GOOS) through the provision of continuously improved data, products and services, from both operational and R&D satellites, and to facilitate and promote their wider availability and meaningful utilization around the globe."

PURPOSE AND SCOPE

2. The purpose of this Implementation Plan is to describe the implementation arrangements for the WMO Space Programme (WMOSP) for the 4-year period starting in January 2004.

3. The principal starting points for this implementation plan are:

- the 6th Long-Term Plan (6LTP);
- the WMOSP Long-term Strategy.

4. To aid traceability, the implementation arrangements are organized according to the eight elements of the WMOSP Long-term Strategy as contained in the 6LTP:

(a) Increased involvement of space agencies contributing, or with the potential to contribute to the space-based component of the GOS;

(b) Promotion of a wider awareness of the availability and utilization of data, products – and their importance at levels 1, 2, 3 or 4 - and services, including those from R & D satellites;

(c) Considerably more attention to be paid to the crucial problems connected with the assimilation of R&D and new operational data streams in nowcasting, numerical weather prediction systems, reanalysis projects, monitoring climate change, chemical composition of the atmosphere, as well as the dominance of satellite data in some cases;

(d) Closer and more effective cooperation with relevant international bodies;

(e) Additional and continuing emphasis on education and training;

(f) Facilitation of the transition from research to operational systems;

(g) Improved integration of the space component of the various observing systems throughout WMO Programmes and WMO-supported Programmes;

(h) Increased cooperation amongst WMO Members to develop common basic tools for utilization of research, development and operational remote sensing systems.

5. Following a discussion of the implementation arrangements, the proposed WMO Space Programme Office, which could eventually coordinate and manage the implementation of the WMOSP, is described. However, until the necessary human resources have been identified and in place, a description of specific projects that should be implemented in the interim is also described.

6. Finally, based on a comparison between the resources available within the WMOSP budget and the activities proposed in this Implementation Plan, areas where contributions from space agencies would be most beneficial are identified.

IMPLEMENTATION ARRANGEMENTS

"Increased involvement of space agencies contributing, or with the potential to contribute to the space-based component of the GOS"

7. The increased involvement of space agencies will be primarily achieved through:

(a) the progressive enlargement of the space-based component of the GOS to include relevant R&D satellite operators;

(b) structured discussions on the future evolution of the space-based component GOS.

Enlargement of the space-based component of the GOS

8. R&D Space Agencies have been encouraged to participate in the space-based component of the GOS, provided that an R&D Space Agency:

(i) had the potential to contribute to WMO and supported programmes;

(ii) was willing to follow the relevant guidelines *(Guidelines for Requirements for Observational Data from Operational and R&D Satellite Missions)*.

9. Once WMO was satisfied that these two criteria were met, WMO would propose to CGMS that the particular R&D Space Agency be included as a full member of CGMS. The full CGMS membership of any satellite operator contributing to the space-based component of the GOS requires the agreement of all CGMS members.

10. WMO will, through its members, continue to provide CGMS satellite operators with operational and pre-operational evaluations of the benefits and impacts of their satellite systems. WMO would also act as a catalyst to foster direct user interactions with CGMS satellite operators through available means such as conferences, symposia and workshops.

Future Evolution of the Space-based Component of the GOS

11. All satellite operators (both meteorological and R&D), that are part of the space-based component of the GOS, will be expected to play a key role in the discussions on the future evolution of the space-based component of the GOS.

12. In this respect, it is recalled that the WMO/CBS/OPAG IOS Expert Team on Observational Data Requirements and Redesign of the Global Observing System (ET-ODRRGOS) has been tasked with the following activities:

- assessing the capability of present and planned observing systems to meet the observational requirements of all WMO programmes (Rolling Review of Requirements);
- making recommendations to the Commission for Basic Systems (CBS) of WMO on the "re-design" of the Global Observing System (GOS).

13. These activities are expected to have an important impact on the future evolution of the space-based component of the GOS.

14. Additionally, WMO has been involved in several key area themes within the IGOS Partnership. These themes are Atmospheric Chemistry, Global Water Cycle and Global Carbon

Cycle. Guidance resulting from the process to develop the Theme Reports will be important to WMO structures, such as the Commission for Basic Systems and Commission for Hydrology. The WMO structures will utilize the guidance produced during the IGOS process. WMO's participation in the IGOS process is relevant to many WMO supported programmes and should be continued as part of the WMO Space Programme for those portions that are relevant.

15. Through the mechanisms of CGMS and the Consultative Meetings, satellite operators will have the opportunity to provide their views on the vision for the future evolution of the space-based component of the GOS. Of particular importance will be their assessment of the likely impact of future technological developments on the evolution of the space-based component of the GOS.

"Promotion of a wider awareness of the availability and utilization of data, products – and their importance at levels 1, 2, 3 or 4 - and services, including those from R & D satellites"

16. WMO will continue to make use of the following means to promote the wider awareness of the availability of data, products and services from satellite operators within space-based component of the GOS:

- user conferences, symposia and workshops;
- training events;
- WMO publications;
- WMO Space Programme web-site (with links, as appropriate, to the web-sites of satellite operators).

17. With the inclusion of R&D satellite operators within the observing system, it is appropriate to revisit the structure of the WMO Space Programme web-site to check that it meets the needs of the enlarged range of users that are expected to make use of the site.

18. As a starting point, the user categories of the web-site will be updated to reflect the enlarged scope of the observing system.

19. For each category of user, it will then be verified that the structure of the website provides an efficient framework for meeting their anticipated information requirements including, where appropriate, training opportunities.

20. Extensive use will continue to be made of links to satellite operator web-sites and it is envisaged that, where such links are utilized, a dialogue will take place with satellite operators to ensure consistency of data content and format.

"Considerably more attention to be paid to the crucial problems connected with the assimilation of R&D and new operational data streams in nowcasting, numerical weather prediction systems, reanalysis projects, monitoring climate change, chemical composition of the atmosphere, as well as the dominance of satellite data in some cases"

21. Currently, there are a number of fora where organizations that assimilate satellite data within environmental models can address data assimilations issues:

- regular bilateral meetings between satellite operators and environmental modelling entities;
- inter-regional fora (e.g., North America/Europe Data Exchange Meetings);
- the CBS Open Programme Area Groups on Information Systems and Services (ISS) and Integrated Observing System (IOS);
- CGMS standing working groups (e.g., International TOVS Working Group, Precipitation Working Group and the Winds Workshop):

- International TOVS Study Conference (ITSC) - which is co-sponsored by WMO;
- International Precipitation Working Group (IPWG) – which is co-sponsored by WMO.

22. These discussion frameworks tend to focus on operational satellite data streams and their assimilation within NWP, Nowcasting and Re-analysis models.

23. In order to increase the impact of satellite data, the challenge for the WMOSP in this area is to widen these discussion frameworks to place more emphasis on:

- assimilation issues relating to the use of both R&D and new operational data streams;
- the assimilation of satellite data in support of a broader range of environmental modelling applications (e.g., atmospheric, oceanographic, climatological).

24. In order to achieve this, the WMOSP will:

(a) act as a catalyst to encourage the systematic establishment of bi-lateral relationships between satellite operators and the environmental modelling entities who make use their data, or who have the potential to make use of their data;

(b) encourage environmental modelling entities to participate in the relevant fora with satellite operators;

(c) review the current participation and mandate of the relevant CGMS standing working groups and propose modifications, as appropriate, to ensure that there is a balanced participation from both environmental modelling entities and satellite operators.

25. The underlying objective behind all these activities will be to facilitate a structured dialogue between satellite operators and the environmental modellers who assimilate their data (or who would potentially benefit from assimilating it).

26. It should also be noted that some of the traditional problems associated with the assimilation of R&D data, and new operational data, should be solved/mitigated with the proposed introduction of an Integrated Global Data Dissemination Service (which is described in a subsequent section of this plan).

27. In particular, the introduction of this service is expected to mitigate some of the known problems with data timeliness, data availability and the lack of standardization in the area of data formats.

“Closer and more effective cooperation with relevant international bodies”

28. In order to promote closer and more effective cooperation with international bodies WMO will continue to place particular emphasis on its participation in:

- CGMS;
- Consultative Meetings.

29. These two fora, together with any subsidiary working groups, will play a central role in the coordination and implementation of the WMOSP, and in discussions on the future evolution of the space-based component of the GOS.

30. Concerning the implementation of the WMOSP, these two bodies are expected to play a fundamental role in coordinating and implementing the Integrated Global Data Dissemination Service, which is described in a subsequent section, and is one of the pillars of the WMOSP within the next four years.

31. In order to ensure the maximum degree of international alignment with the objectives of the WMOSP, WMO will continue to place considerable emphasis on its participation in CEOS and IGOS.

32. On a more technical level WMO will continue to participate in the Space Frequency Co-ordination Group (SFCG), International Precipitation Working Group and the International TOVs Working Group (ITWG).

"Additional and continuing emphasis on education and training"

Current Approach

33. The current WMO Strategy for Education and Training in Satellite Matters is firmly based upon the recommendations made in the final report of the WMO EC Panel of Experts on Satellites (March 1993) and endorsed by WMO EC in June 1993. The strategic goal outlined in 1993 was:

> "Systematically to improve the use of Satellite data for meteorological and hydrological applications over the next 10 years in all Member countries, with a focus on meeting the needs of the developing countries"

34. The three strategic objectives considered critical to the success of the strategy were identified as:

(i) To build on the existing infrastructure in a way which ensures that the timescale and manner in which initiatives for improving satellite data utilisation are introduced, are consistent with the capabilities of the users to absorb and sustain them independently in their own operational environment;

(ii) To focus on the developing countries, directing particular attention to systematically improving the level of expertise of instructors at all RMTCs in the utilisation of satellite data;

(iii) To anticipate future trends in satellite data applications and in education and training techniques, so that new developments can flow through to operational users quickly and efficiently.

35. The EC also noted its strong support for "*the proposal that each satellite operator or group of satellite operators participating in the space-based sub-system of the Global Observing System (GOS) cooperate with at least one of the specialized satellite applications training centres.*"

36. In order to meet these strategic directives the CGMS/WMO Virtual Laboratory for Education and Training in Satellite Meteorology (VL) has been developed. The VL, and its associated Focus Group, provides a coordinating mechanism between the training centres ("centres of excellence") and satellite operators and also encourages the sharing of resources between the various parties.

37. The core of the Virtual Laboratory is the Resource Library. Each "centre of excellence" has an internet connection to the Resource Library and thereby has access to a wide range of teaching resources such as: course material; lectures; keynote presentations; imagery; software; publications, etc. This Resource Library acts as a place where comprehensive descriptions of available material (also known as resource Meta-data) is stored. This Meta-data allows effective cataloguing and searching for material which matches the requirements of students or trainers alike.

38. The six "centres of excellence" for education and training consist of:

- five WMO Regional Meteorological Training Centres (RMTCs) in: Nanjing in China; Nairobi in Kenya; Niamey in Niger; San Jose in Costa Rica and Bridgetown in Barbados;
- the Bureau of Meteorology Training Centre (BMTC) in Melbourne Australia.

39. The RMTCs in Nairobi and Niamey are sponsored by EUMETSAT, San Jose and Bridgetown RMTCs by NOAA, Nanjing RMTC by CMA, and BMTC Australia by JMA.

40. In addition to regular ongoing courses, each “centre of excellence”, in conjunction with either its parent satellite operator, and/or WMO, also runs intensive short courses (approximately two weeks in duration) for staff from neighbouring countries specifically on satellite meteorology.

41. The funding for these courses is usually from either WMO or the satellite operator and the courses are notionally held in each “centre of excellence” every four years. Additionally, WMO is a CEOS Associate and could benefit from activities of the CEOS Working Group on Education, Training and Capacity Building.

42. Participants in WMO-funded training are selected on the basis that they will provide ongoing training within their own organization upon return from the training event (the “train the trainer concept”). Thus, the WMO-funded training events have a critical role in not only providing high quality training and resource material during the actual course, but also linking into ongoing resources such as the Virtual Resource Library (which is a component of the Virtual Laboratory) for the participant trainers to use within their countries on return from the event.

43. The WMO Space Programme Office has funding allocated to allow one training event every year for the next four years. Each training event currently involves about 20 participants from neighbouring countries and requires funding of the order of 80,000 CHF per event. WMO funding currently covers training in Costa Rica, Barbados, Nanjing and BMTC (Australia). EUMETSAT provides funding for the training events in the two African centres of Niamey and Nairobi on a yearly basis.

Limitations of the Current Approach

44. The following limitations have been identified with the current education and training approach:

- currently, no “centre of excellence” has offered any remote learning to neighbouring countries using tools such as VISITView;
- the current six “centres of excellence” cover four of the six official WMO languages (English, French, Spanish and Chinese), but do not cover Arabic or Russian. Geographically, Eastern Europe and the Western Asia section of WMO Region II are not covered by any of the existing “centres of excellence” and many of the NHMSs in these areas do not have the appropriate internal resources to provide their own satellite meteorology education and training programmes;
- there is a lack of any follow-up support and training for course participants (e.g., follow-up tutorials or discussion fora using the Internet and online collaboration using tools such as VISITView);
- some “centres of excellence” have a limited capability to download near real-time data (due to bandwidth limitations) which is necessary for training events, and there is a need to standardize on appropriate data formats and display and manipulation tools;
- the difficulty in locating training material distributed across a number of physical locations.

Future Implementation of the Education and Training Component of the WMOSP

45. The proposed future implementation of the education and training component of the WMOSP builds on the current education and training strategy and is driven by three main considerations:

- the need to address the identified limitations with the current education and training approach;
- the expansion of the space-based component of the GOS to include R&D satellites;
- the need to adapt the education and training approach to meet the changing needs of WMO Members.

46. With these considerations in mind the following specific implementation approach is proposed:

- Maintain the current education and training strategy, in particular the concepts of the satellite operator co-sponsored “centres of excellence”, and, the selection of course participants on the basis that they will acts as trainers within their own NHMS upon completion of the training event;
- Adapt the content of education and training events to reflect:
  - the needs of WMO Members (as expressed through their returns to the Rolling Review of Requirements);
  - the requirements of other WMO programmes for training on the use of satellite data and products;
  - the evolving capabilities of both R&D satellites and operational satellites within the Global Observing System;
  - the increased availability of data resulting from the proposed introduction of an Integrated Global Data Dissemination Service - where possible using the direct reception of this data within training events;
  - the application areas relevant to the course participants (i.e., ensure that, in general, course content focuses on the application of satellite data and products to these application areas, including an appropriate mix of remote sensing, image interpretation theory and practice, incorporating the use of near real-time data as a positive reinforcement of how to use satellite data and products in a real time situation)
  - feedback from participants on training events.

- Enhance the capabilities of the WMO Virtual Laboratory:
  - invite the R&D space agencies to participate in the WMO Virtual Laboratory Focus Group to create the necessary training material on the use of data from R&D satellites;
  - improve data access and introduce common formats and tools at “centres of excellence” to allow effective sharing of resource material and sessions between “centres of excellence”;
  - develop a semi-automated indexing mechanism to enable subject-specific searches over multiple web sites;
  - hold a high-profile training event with the aim of increasing the effectiveness of the Virtual Laboratory.

- Enhance/increase the training opportunities offered by “centres of excellence”:

- Introduce a range of online follow-on/follow-up activities after each course hosted by a “centre of excellence” to allow consolidation and reinforcement of the course training material;
- offer remote learning capabilities to neighbouring countries.

- Consider expanding the number of “centres of excellence” with the creation of additional centre(s) to cover Eastern Europe and the Western Asia section of Region II;

- Invite funding for additional training events (80,000 CHF/event) or co-sponsorship of additional “centres of excellence”.

47. It is proposed that the enhancement of the WMO Virtual Laboratory is implemented as a specific WMOSP project.

“Facilitation of the Transition from Research to Operational Systems”

48. Recently, the spaced-based component of the GOS has evolved rapidly with the inclusion of R&D satellite operators. One of the main challenges arising out of this evolution is the management of the smooth transition between R&D and operational systems.

49. In order to facilitate the transition from research to operational systems, WMO will:

- promote awareness of the availability and potential uses of R&D satellite data and products (through user conferences, symposia, workshops, training events, the WMO Web-site and WMO publications);
- facilitate access to R&D satellite data and products to potential users;
- provide consolidated user feedback on the usefulness of R&D satellite data and products.

50. The inclusion of R&D satellite products and data within the proposed Integrated Global Data Dissemination Service will facilitate access to a large range of potential users. The introduction of this service will also help to remove some of the traditional barriers to the use of this type of data (e.g., timeliness and data format).

51. The provision, by WMO, of consolidated user feedback to R&D operators will take two forms:

- the fifty-fourth session of the WMO Executive Council (EC-LIV) has agreed that the *Report on the Utility of Existing R&D Satellite Data from the Operational User Community* be prepared on a biennial basis;
- two regional workshops will be organised within a four year period to identify those R&D datasets that have had an operational impact and therefore merit an operational status.

52. Any WMO proposals for an R&D system that should be transformed into an operational system will also be discussed within the CGMS, as well as by the Consultative Meetings.

53. The next candidate for transformation to an operational system is likely to be an oceanographic mission, as the agreement to launch JASON-2 will secure the continuation of the valuable altimeter data provided by JASON-1.

"Improved integration of the space component of the various observing systems throughout WMO Programmes and WMO-supported Programmes"

54. Three areas have been identified where improved integration of the space-based component of the GOS would provide considerable benefits:

- Overall design of the space-based component of the GOS;
- Integrated Global Data Dissemination;
- Contingency Planning.

Overall Design of the Space-based Component of the GOS

55. One of the pre-requisites for optimizing the overall design of the space-based component of the GOS is the availability of a consolidated system-wide view of the observational requirements, together with the appropriate traces to the existing/planned observing systems that meet, or will meet, these requirements. From this consolidated viewpoint it is then possible to identify potential areas of duplication, and areas where the observing system needs further strengthening.

56. The WMO/CEOS database is a tool which provides such a view, and emphasis will be placed on maintaining this tool and using it to propose areas where the overall design of the observing system could be further improved or optimised.

57. Currently, three issues have been identified where the design of the space-based component of the Global Observing System could be optimised to better meet WMO observational requirements:

- equator crossing times for polar orbiting satellites;
- positions of geostationary satellites;
- satellite instrumentation.

58. Concerning equator crossing times, the WMO requirement is for four optimally-spaced satellites to provide global coverage. The current plans of satellite operators will result in an uneven distribution of equator crossing times, which in turn means that it will not be possible to achieve global coverage. Therefore, it is proposed that WMO, acting within the framework of the CGMS and the Consultative Meetings, works with satellite operators to adjust their planning so as to meet the WMO requirement of optimal global coverage.

59. Regarding the position of geostationary satellites, the WMO requirement is for the availability of at least 6 satellites, near equally spaced around the equator. Whilst currently not quite equally spaced, the coverage provide by the geostationary satellites is felt to be adequate to meet WMO's observational requirements. WMO, with the help of CGMS, will continue to monitor the situation and make recommendations, as appropriate to further harmonise the coverage around the equator.

60. Although the geostationary coverage is generally satisfactory, the current plans of satellite operators over the Indian Ocean may result in five geostationary satellites being located in this region by 2005 (Meteosat, KALPANA, GOMS N-2, FY-2 and GIFTS). This issue will be addressed within the framework of CGMS with aim of optimizing the coverage in this area and ensuring that no frequency interference problems are likely to arise.

61. A preliminary analysis of the instrument complement of geostationary satellites has identified issues of homogeneity in the performance of these instruments. In order to achieve a more uniform observational capability across the geostationary satellite systems, it is proposed that WMO, through CGMS and the Consultative Meetings, initiate a debate on a suggested baseline complement for instruments, together with their expected performance.

Integrated Global Data Dissemination Service

62. Bearing in mind the requirement for cost-optimized access to meteorological data/products, and the planned increases in associated data volumes, the concept of Alternative Dissemination Methods (ADM) has been developed.

63. With this approach, access to satellite data and products by WMO Members would be through a composite system consisting of both Direct Broadcast (DB) from meteorological satellite systems and ADM. ADM would be the baseline while DB reception would serve as a limited backup, as well as for those WMO Members unable to take advantage of the ADM service.

64. As the composition of the space-based Global Observing System evolves, the ADM concept will allow for the seamless inclusion of data/product sets from polar and geostationary operational satellites, as well as from relevant R&D environmental satellites. It is expected that the most demanding application utilizing this composite service would be NWP, and that NWP requirements could thus be taken as a benchmark for sizing the data communications infrastructure.

65. The advantages of the ADM approach include:

- Scalability – the communications infrastructure can be progressively upgraded to match the planned increase in data volumes;
- Accessibility – the availability of standard user terminals, which make data access affordable for a larger number of users. This greater accessibility could also alleviate the need for the internal redistribution of very large volumes of data;
- Flexibility – because of the separation of the observing satellite and the dissemination platform the dissemination scheme can be modified/enhanced without impact on the observational satellite. For example, it would allow the seamless addition of data and products from the relevant R&D environmental satellites to complement the existing operational data and products;
- Transition planning – the transition between different generations of observing satellites will be facilitated as the same user terminals could be utilised for both generations;
- Robustness - in the event of contingencies on observing system satellites the ADM component would be unaffected in the event of problems with the DB components of the observing system satellites;
- Extension of observing system satellite lifetimes – in some cases the lifetime of observing system satellites is constrained by inclination limits associated with direct broadcasting. As ADM would be the prime dissemination mechanism, in such cases, the useful lifetime of the observing system satellite could be extended.

66. Several satellite operators have implemented, or have plans to implement ADM. For the time being the most advanced implementation appears to be EUMETCast by EUMETSAT. EUMETCast already disseminates data from polar and geostationary satellites, as well as from other meteorological data sources. By using K_u- and C-band, DVB services provide a dissemination service at very reasonable cost to both EUMETSAT and the users.

67. In order to ensure that these initiatives result in a dissemination system that is optimized with respect to the needs of the global user community, it is appropriate to consider the possible shape of an Integrated Global Data Dissemination Service; which builds upon this ADM concept.

68. Indeed, the creation of an Integrated Global Data Dissemination Service is central to the vision of an integrated space-based component of the GOS, as it will facilitate the access, in a seamless manner, to the complete range of data and products from this component of the GOS.

69. It is envisaged that the Integrated Global Data Dissemination Service would be constructed from dissemination services provided in five or six discrete dissemination service areas which, taken together, would provide an integrated data dissemination service to all WMO members around the globe.

70. To minimize data exchange and data dissemination volume requirements, it is proposed that each dissemination service area be delineated by a longitude band; with the longitude band centred close to the orbital position of an operational geostationary meteorological spacecraft.

71. A starting point for the configuration of a five dissemination service area system could be:

Dissemination Service Area	**Approximate Centre of Service Area**
Europe, Africa and Eastern Atlantic	0^{o}
Western Atlantic, North-East America, South America and Eastern Pacific	75^{o} W
North-West America and Eastern Pacific	135^{o} W
Eastern Asia, Australia and Western Pacific	140^{o} E
Western Asia and Indian Ocean	76^{o} E

72. In order to cope with the future data volume requirements, and the geographical distribution requirements, it is expected that data dissemination service providers would predominantly make use of commercial communications satellites for dissemination, augmented as appropriate by terrestrial means (e.g., the Internet).

73. It is expected that the precise communications architecture used to provide a particular data dissemination service would depend on the availability of the communication services. Based on the current availability of commercial satellite communications services, it is unlikely that the dissemination requirements for a particular dissemination service area could be met by one communications satellite. Instead, in order to meet the coverage requirements, it is expected that the communications architecture would consist of a mosaic of satellite communications services, augmented, as appropriate, by terrestrial means (e.g., the Internet).

74. Because of this dependency on the availability of commercial services it would not be appropriate to be prescriptive concerning the precise longitude domains for each dissemination service area.

75. Instead it is proposed that, based on “expressions of interest from satellite operators” for providing dissemination services for all, or part of, one of the five dissemination service areas, the CGMS would be invited to:

- Identify the precise boundaries of the dissemination areas, considering that:
  - the centre (in terms of longitude) of each dissemination service area should be close to the position of an operational geostationary meteorological satellite;
  - every WMO member should be adequately covered by an ADM service;
  - the boundaries of existing dissemination services need to be considered.

- Consolidate the data dissemination requirements in each dissemination service area, taking due account of:
  - the requirements for regional satellite observational data defined by the relevant WMO Regional Associations;

- any other regional satellite observational data requirements for which a dissemination service is currently provided, or planned to be provided;
- the WMO requirements for global satellite observational data;
- any relevant obligations stemming from the Future WMO Information System (FWIS) concept. For example, satellite operators providing a dissemination service may have to fulfil the role of a Data Collection or Product Centre (DCPC). The adoption of this role could have implications in the following areas:
- catalogue/metadata standards to ensure catalogue interoperability;
- protocols;
- the inclusion within the dissemination scheme of regional observation data not derived from satellites (e.g. data currently broadcast via the GTS).

- Identify the Satellite Operator(s) that will provide the dissemination service for each dissemination service area, noting that within one dissemination service area, responsibility for providing the service may be shared between satellite operators or, indeed, one satellite operator may cover more than one service area.

- Based on the identified dissemination service area boundaries, the satellite operators who have opted to provide a dissemination service would then be responsible for:
  - acquiring and disseminating regional data;
  - exchanging global data with other operators of the integrated global data dissemination service.

- Define the global architecture of the five dissemination services that, taken together, constitute the Integrated Global Data Dissemination Service (including a description of the communications means by which each WMO member will receive data from the service).

- When defining the global architecture, it is considered essential that:
  - the underlying requirement for standard, affordable user receptions stations is respected;
  - a co-ordinated approach is taken to:
  - communication standards;
  - data format standards;
  - encryption mechanisms;
  - user station operating systems.

- Identify actions that will enable global networking so as to ensure the smooth exchange of data and products between dissemination service operators, noting that:
  - the requirements for data exchange are expected to be restricted to satellite data;
  - data ownership and data protection issues may need to be addressed.

- Produce an overall schedule for the introduction of the Integrated Global Data Dissemination Service.

76. Once these detailed implementation arrangements have been established by CGMS, progress towards the full introduction of the service would be monitored within both the CGMS and the Consultative Meetings.

77. It is proposed that the co-ordination of the design and implementation of an Integrated Global Data Dissemination Service is handled as a specific WMOSP project.

Contingency Planning

78. Contingency planning is an essential element in the strategy for meeting the reliability and continuity requirements for the space-based component of the GOS at a realistic cost.

79. In order to optimize the use of the observing system resources, contingency planning needs to be carried out at two levels:

- regional contingency planning;
- global contingency planning.

80. Recently, the development of contingency plans has become more complex due to:

- the expansion of the space-based component of the GOS:
  - new WMO requirement for at least 6 GEO satellites;
  - new WMO requirement for at least 4 LEO satellites (2 am, 2 pm);
  - inclusion of R&D satellites which, by themselves require no contingency arrangements, but could form part of a back-up arrangement for an operational satellite;
  - the expectation that Jason-2 Ocean Surface Topography Mission will also become part of the space-based component of the GOS, and hence the Jason series will de facto provide an important oceanographic operational service - and hence contingency planning will need to be considered.

- the proposed introduction of an Integrated Global Data Dissemination Service, and the additional flexibility it introduces for contingency planning.

81. With the above considerations in mind WMO, with the help of CGMS, will co-ordinate this contingency planning effort with the aim of:

- ensuring the existence of appropriate regional contingency plans (preferably in a standardized format);
- creating two overarching global contingency plans:
  - a geostationary global contingency plan which is consistent with the regional geostationary contingency plans and, additionally, addresses possible inter-regional contingency arrangements;
  - a global contingency plan for polar orbiting spacecraft, which would take account of the possible contribution of R&D satellites.

82. It is proposed that the creation of the global contingency plans is implemented as a specific WMOSP project.

“Increased cooperation amongst WMO Members to develop common basic tools for utilization of research, development and operational remote sensing systems”

83. In order to promote the increased cooperation amongst WMO Members in the area of common, basic tools for remote sensing, WMO will:

- discuss with WMO Members their requirements for tools;
- initiate a dialogue with CGMS members to determine what basic tools could be made available to WMO Members and what related training could be provided;

- investigate the possibility of utilizing the Virtual Laboratory for Education and Training in Satellite Matters as a mechanism for making such tools available to WMO Members.

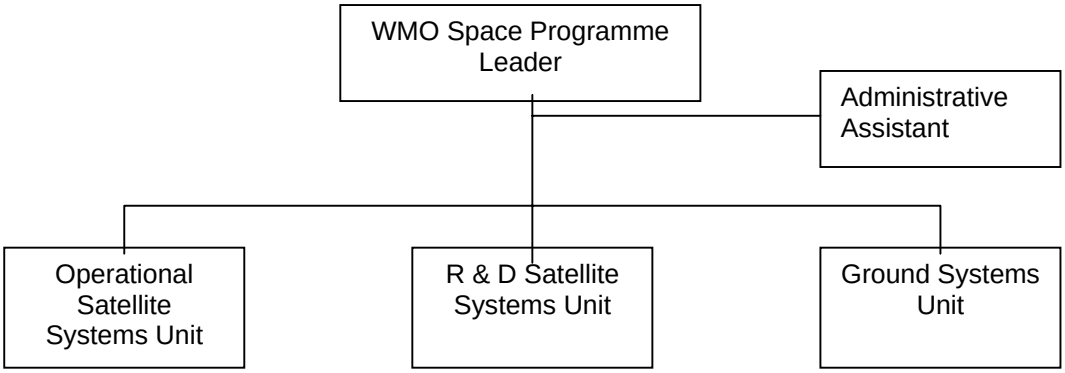
84. The incorporation of a core set of tools within the Virtual Laboratory would help to ensure that training on the use of these tools, where required, could be included within training events.

WMO SPACE PROGRAMME OFFICE

85. In order to ensure the successful implementation of the activities defined within this implementation plan, an appropriately sized and skilled WMO Space Programme Office is required.

86. When considering the appropriate shape and size of the programme office, it is important to recognize that a key component of the duties of this programme office will be internal coordination across WMO and supported programmes. The purpose of this internal coordination activity is to obtain a consolidated WMO position on all issues related to satellites.

87. Based on the activities proposed in this implementation plan, together with the need for internal coordination across WMO and supported programmes, the following structure is envisaged for the WMO Space Programme Office:



88. The **WMO Space Programme Leader** will be responsible for:

- coordination of the implementation of the WMO Space Programme;
- supervision and coordination of all staff in the WMO Space Programme Office;
- providing a single focal point, on satellite matters, for all WMO and supported programmes;
- interactions with external satellite-related organizations (including CEOS, CGMS, IGOS, SFCG, IPWG, International Winds Workshops, ITWG and the Virtual Laboratory Focus Group);

89. **The Operational Satellite Systems Unit** will be led by a specialist in matters related to operational meteorological satellite systems. This specialist will be responsible for relevant observational data requirements and the satellite systems that meet them. Specific duties will include:

- generation of proposals, as appropriate, to optimise the space-based component of the GOS;
- supporting the maintenance of the CEOS/WMO database;
- coordination of the generation of a global contingency plan for the space-based component of the GOS;

- contributing to a vision of the future evolution of the space-based component of the GOS.

90. **The Research and Development Satellite Systems Unit** will be led by a specialist in research and development environmental satellite systems. This specialist will be responsible for observational data requirements in support of research related WMO programmes. Specific duties will include:

- monitoring of technological developments that could have an impact on space-based observational systems;
- provision of consolidated feedback on the usefulness of R&D satellite data and products;
- fostering dialogue, on the assimilation of data, between R&D agencies and the relevant environmental modelling entities;
- contributing to a vision of the future evolution of the space-based component of the GOS.

91. **The Ground Systems Unit** will be led by specialist in reception, dissemination and production systems required to meet WMO Members' requirements. This specialist will be responsible for all maters related to the ground segment of both the operational and research and development satellite systems. Specific duties will include:

- implementation of the education and training component of the WMOSP, including co-ordination of:
  - the progressive adaptation of the contents of training events;
  - the enhancement of the training opportunities offered by "Centres of Excellence";
  - the further development of the Virtual Laboratory and associated Virtual Resource Library (including the incorporation of basic tools for remote sensing applications);
- coordination and monitoring of the introduction of the proposed Integrated Global Data Dissemination Service;
- reviewing and updating, as necessary, the WMO satellite activities web-pages and maintaining their consistency with the information contained within the VL;
- monitoring of frequency coordination issues.

92. The staff of the programme office will also be augmented by Junior Professional Officers as they become available, and consultants when needed.

WMO RESOURCE IMPLICATIONS

93. The implementation arrangements, proposed in this plan, have resource implications for both space agencies and WMO.

94. The budgetary provisions available for WMO's participation have already been determined, and when the proposals contained within this implementation plan are compared with the available WMO budget, resource shortfalls are evident in two main areas:

- funding of Education and Training activities;
- staffing of the WMO Space Programme Office.

95. In accordance with the discussions at the 3rd Consultative Meeting, space agencies participating in the space-based component of the GOS are invited to make contributions to resolve these resource shortfalls, which are summarised in the following table.

Area	Resource Shortfall	Estimated Cost Implication
WMO Space Programme Office	1 Operational Satellite Systems Specialist	TBD
	1 R&D Satellite Systems Specialist	TBD
	1 Ground Systems Specialist	TBD
	Consultancy Support (2 man-years per year (TBC))	TBD
Education and Training	Creation and co-sponsorship of additional "centres of excellence"	TBD
	Funding of Additional Training Events (including a major VL Training Event)	80,000SF/Event

96. Also, in recognition of the time needed to establish the WMO Space Programme Office, five interim projects have been identified within this plan. Space agencies are invited to second experts to implement these specific projects; pending the full establishment of the WMO Space Programme Office.

97. For each project the corresponding role within the WMO Space Programme Office (that will eventually take over the implementation of the project) is indicated in the following table.

Project	Corresponding Role in the WMO Space Programme Office
1) Enhancement and Evolution of the Capabilities of the WMO Virtual Laboratory	Ground Systems Specialist
2) Co-ordination of the Design and Implementation of an Integrated Global Data Dissemination Service	Ground Systems Specialist
3) Creation of Global Contingency Plans for Geostationary and Polar Orbiting Spacecraft	Operational Satellite Systems Specialist
4) Assimilation of data from present and future R&D environmental satellites	R&D Satellite Systems Specialist
5) Reanalyses related to retrospective satellite data from both operational and R&D environmental satellites	R&D Satellite Systems Specialist and Operational Satellite Systems Specialist