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CONSULTATIVE MEETINGS ON HIGH-LEVEL POLICY ON SATELLITE MATTERS

FIFTH SESSION

GENEVA, SWITZERLAND

24-25 JANUARY 2005

FINAL REPORT

1. ORGANIZATION OF THE SESSION

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

The fifth session of the Consultative Meetings on High-level Policy on Satellite Matters (CM-5) was held at the World Meteorological Organization (WMO) Headquarters in Geneva, Switzerland from 24 to 25 January 2005 under the chairmanship of the President of WMO, Dr A.I. Bedritsky. The session was opened at 09h30 on Monday, 24 January 2005. In Dr Bedritsky's opening remarks, he reminded the session of the progress made at the previous four sessions in terms of important recommendations and guidance to the Executive Council, as well as the Fourteenth World Meteorological Congress and subsequent positive results. He expected that the fifth session would provide for some very constructive discussions towards results that would enable WMO Members to better meet their needs. He noted that there would be several new issues to be discussed such as the International Geostationary Laboratory, the Global an Earth Observing System of Systems (GEOSS) and the Integrated Global Data Dissemination Service (IGDDS) that were of great importance to WMO. He also encouraged the session to express views on how WMO Members and Consultative Meeting space agencies could contribute to mitigating the impacts of disasters, such as the recent Asian Tsunami.

In remarks by the WMO Secretary-General, Mr M. Jarraud noted some major events that were related to WMO and the Space Programme in particular. He was of the opinion that sessions of the Consultative Meetings had the potential of facilitating the adoption of a common set of objectives, leading to better harmonization of programmes, requirements, use of satellite data, products and services, and high-level policy matters, including the allocation of resources. He referred to the Asian tsunami in which more than two hundred thousand people lost their lives. The considerable loss of lives, the economic impact, the challenges to provide humanitarian relief efforts, and the means to establish an effective tsunami alert system, were topics at the forefront of discussions and utmost in the minds of delegates at the recent International Meeting for the Sustainable Development of Small Island Developing States (SIDS), held in Port Louis, Mauritius, 10-14 January 2005, and the World Conference on Disaster Reduction (WCDR) held in Kobe, Japan, 18-22 January 2005. He also described the evolution towards the establishment of a Global Earth Observing System of Systems (GEOSS). At the Third Earth Observation Summit to be held on 16 February 2005 in Brussels, he was confident that the combined efforts of more than 50 countries, the European Commission and many intergovernmental organizations, including WMO, international organizations, regional organization, non-governmental organizations and non-governmental entities would culminate in the signing at ministerial level of a resolution establishing GEOSS. He referred to WMO's very active role in the GEOSS development. He also informed the session of the decision at the fifty-sixth session of the Executive Council to offer to host the GEO Secretariat, if asked and that WMO had been asked. He noted that at the fifth GEO session held in Ottawa, Canada in November last year, WMO had made a presentation on a proposal to host the GEO Secretariat which was strongly welcomed.

With regard to the WMO Space Programme, he recalled that one of the responsibilities for the Consultative Meetings was to oversee and provide guidance to the WMO Space Programme. He believed that the WMO Space Programme had been most active in its first year as a major programme. He also informed the session that Dr Tillmann Mohr had agreed to serve as a Special Advisor to the Secretary-General on Satellite Matters.

In closing, he thanked the participants and their organizations for the contributions they had made over the years, and will continue to make, in support of the objectives of the World Meteorological Organization.

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

In view of the impact and the need to discuss the Asian Tsunami, the session agreed to add a new agenda item for it. The updated 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.

2. ACTIONS DERIVING FROM CM-4

2.1 The session noted that all action items contained in the report from CM-4 were either addressed by EC-LVI or would be addressed during the agenda for CM-5.

2.2 The session recalled 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 also recalled that CM-4 requested further clarity of the required information, in particular in the form of a more comprehensive and detailed template. CM-5 reviewed a draft detailed template for describing potential new contributions to the space-based sub-system of the Global Observing System. CM-5 space agencies agreed to provide comments on the template as well as to enter as much of the information requested in the template as possible to be submitted to the WMO Space Programme Office prior to 30 April 2005. The session noted that relevant information from the CEOS/WMO database could be extracted for use in the template. Once compiled, the complete set of templates would be distributed to WMO Members as a Space Programme Technical Document, as well as made available on the Space Programme web site to increase awareness of available data, product and services. Additionally, the information would also be included in the CEOS/WMO database.

GCOS and related climate matters

2.3 The Chairman of the GCOS Steering Committee presented the session with an overview of the *Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC* that had been completed under GCOS leadership, with broad input from the climate and related scientific communities. The Plan addressed the requirements identified in the *Second Report on the Adequacy of the Global Observing Systems for Climate in Support of the UNFCCC* and, in particular, the Essential Climate Variables and their associated products defined therein. It took into consideration existing global, regional and national plans, programmes and initiatives, including the plans of the Group on Earth Observations (GEO), as well as implementation priorities and resource requirements and indicators for measuring progress. The Plan called for some 131 actions needed over the next 5 to 10 years to address the critical issues related to global observing systems for climate, namely: improving key satellite and *in situ* networks for atmospheric, oceanic and terrestrial observations; generating integrated global climate analysis products; enhancing the participation of least-developed countries and small island developing states; improving access to high-quality global data for essential climate variables; and strengthening national and international infrastructure. A large number of the items involved the space agencies of relevant Parties to the UNFCCC as ‘Agents for Implementation’, many in cooperation with the WMO Space Programme. A number of the actions focused on establishing and maintaining reliable, long-term satellite systems that adhere to the GCOS Climate Monitoring Principles, and on producing the desired global data products from the observations that these systems obtain.

2.4 The Chairman of the GCOS Steering Committee noted the importance of research missions and programmes in support of the Implementation Plan. Many of the actions assumed a WCRP contribution which was often on-going, but which would require special attention or special efforts in coordination with space agencies. This was particularly the case in the atmosphere for the extension of radiative flux and cloud data records and for the development of new precipitation, cloud and aerosol products. As part of its new strategy, WCRP had established within COPES (Coordinated Observation and Prediction of the Earth System), a Working Group on Observations and Assimilation (WGOA) to promote and co-ordinate the synthesis of global observations from the atmosphere, ocean, land-surface and cryosphere, as well as Global Climate Model (GCM) reanalyses and assimilation activities. This activity responded to a number of GCOS recommended actions, including the improvement or development of global, high-quality climate products exploiting the large satellite and *in-situ* data sets accumulated over the last 20-30 years. This project would require the involvement of climate experts and strong cooperation with space agencies and would be complementary to the activities already undertaken as part of climate reanalyses with GCMs.

2.5 The session noted that the Implementation Plan had been presented to the tenth session of the UNFCCC Conference of the Parties (COP-10) in Buenos Aires, Argentina (6-17 December 2004) through its Subsidiary Body for Scientific and Technological Advice (SBSTA-21). COP-10 had formally endorsed the Plan through a decision which, *inter alia,* "Invites Parties that support space agencies involved in global observations to request these agencies to provide a coordinated response to the needs expressed in the implementation plan". Many CM members were and would be crucial players in responding to the actions identified in the Plan and the invitation to develop a coordinated response to those actions. The Chairman of the GCOS Steering Committee suggested that such a response could present the steps and resources needed to move toward a sustainable satellite constellation which would meet the needs of the Plan and which would at the same time be a major component of GEOSS, meeting the needs of many associated communities.

2.6 The session also noted that there were many issues implied by the GCOS Implementation Plan. First, there was a need for strong space-based research missions with appropriate transitions to operational agencies. The session was of the opinion that sessions of the Consultative Meetings were an appropriate venue for discussions related to such transitions. With regard to GEOSS, the session noted that it was founded on the principle that there should be no duplication and that a consolidated approach for the various participating organizations should be possible. The session agreed that it was important to find the proper coordination role for WMO to be effective while avoiding unnecessary overlaps. The session agreed that it was important to provide guidance in this area and established a task team during the session to provide an appropriate set of recommendations. The task team proposed and the session agreed to the following description towards a consolidated response to the GCOS Implementation Plan:

> With regard to the GCOS Implementation Plan, a single coordinated satellite agencies' response should be facilitated. To this end, the WMO Space Programme working jointly with CEOS SIT that is presently chaired by Dr Furuhama of JAXA should accomplish this task.

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

3.1 The session reviewed activities that had 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-second session of the Co-ordination Group for Meteorological Satellites (CGMS-XXXII), and other activities.

Expanded space-based component of the Global Observing System (GOS)

3.2 The session was pleased to be informed of the formal commitments made by the governments of India and the Republic of Korea to participate in the space-based component of the World Weather Watch's Global Observing System. The session noted that India had a long history of satellites in geostationary orbit. As a result of new technologies, including ADM, it was now possible to make satellite data and products, including GTS data and NWP products, freely available to WMO Members and that detailed information would be provided through correspondence. IMD also announced its plans to meet the WMO requirements for half-hourly imagery in a phased manner with an ultimate goal to be achieved in the next 3-4 years. The session was also informed that the Republic of Korea intended to participate in the space-based GOS with its new geostationary Communications, Oceanographic and Meteorological Satellites (COMS) due to be launched in 2008. The Korean Meteorological Administration (KMA) planned to make meteorological observation available for research, operations and applications without restrictions. Data would be distributed directly from COMS or by alternative approaches such as Internet.

3.3 The session was provided updates in several of the CM space agencies plans. In particular, the Russian Federation described a national decision as contained within the Russian Federation Federal Space Programme for two environmental satellite constellations, three polar-orbiting satellites in the Meteor series and two geostationary satellites in the Electro series, with up to 5 satellites planned through the end of the decade. Additionally, up to eight small satellites for research purposes for earthquakes and volcanoes were planned. The session was pleased to note that the planning for these systems had taken into consideration WMO Space Programme recommendations as well as those from the recent thirty-second session of the Coordination Group for Meteorological Satellites (CGMS-XXXII).

3.4 The session also noted the plans by JMA to launch MTSAT-1R on an H-IIA launcher in February 2005. JMA indicated that the present GOES-9 contingency back-up would continue until MTSAT-1R achieved operational status. JMA also indicated that it was continuing it efforts to develop a long-term contingency strategy. The session noted that NOAA was considering continued sounding operations over the Pacific Ocean by GOES-9 after the termination of its contingency back-up for GMS. The session strongly encouraged NOAA to do this and further suggested that the WMO Secretary-General consider means to indicate its support for such activity.

3.5 The session noted that the People's Republic of China's recently launched FY-2C had entered a preliminary operational phase in January 2005 while positioned at 105 degrees East longitude. China anticipated the launch of FY-2D in 2006 that would enable it to achieve a two geostationary satellite configuration. The new satellite configuration would represent an enhanced contribution by China to the space-based configuration of the WWW's GOS.

3.6 NASA noted its efforts towards commissioning of its new Aura satellite that had been launched in 2004. It also noted that CloudSat and Calipso were expected to be launched in 2006. With regard to TRMM, NASA described its efforts to keep this important mission operational through a space mission extension process. The process would allow for an orderly transition of R&D satellite missions to operational status. The session strongly encouraged NASA to seek means to extend TRMM and further suggested that the WMO Secretary-General consider means to indicate its support for such activity. The session further discussed "transition of R&D satellite missions to operational status" under the agenda item titled "*Continued Utilization of Satellites Scheduled for Retirement*" in the following paragraphs below.

3.7 The session was pleased to note during relief efforts related to the disaster caused by the earthquake and subsequent tsunami in the Indian Ocean in December 2004 that valuable data and products were made available from many space agencies participating in the WWW's space-based component of the GOS as well as from other satellite missions. Rapid access to satellite data was made possible under the aegis of the International Charter on Space and Natural Disasters.

3.8 The session also noted the valuable satellite data and products included those from ISRO's India Remote Sensing (IRS) satellites. The use of the data and products was specifically cited during television weather broadcasts. The session encouraged ISRO to consider to include its satellite systems as part of the space-based component of the WWW's Global Observing System in a fashion similar to other R&D space agencies.

3.9 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.

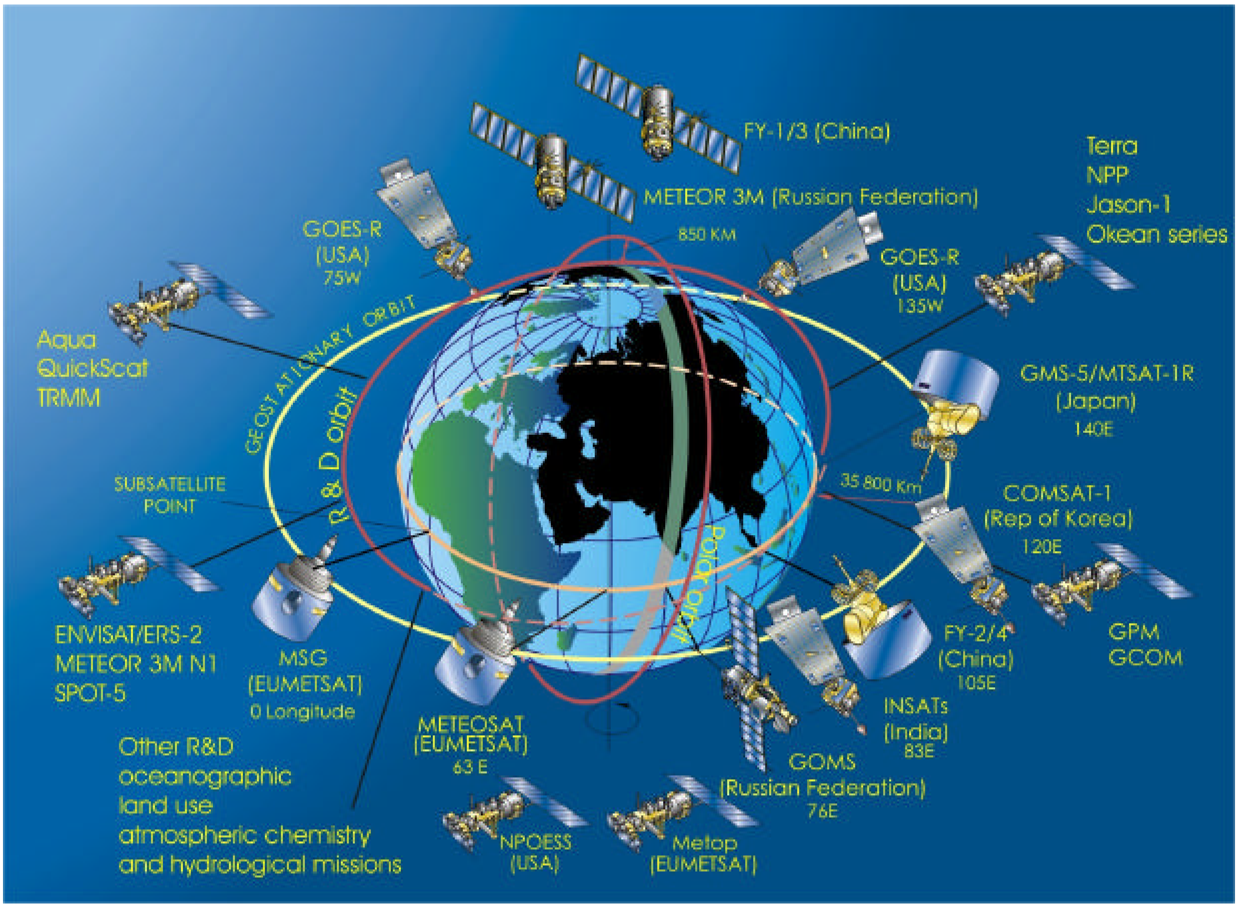

Figure 1 – Nominal space-based component of the Global Observing System

Continued Utilization Of Satellites Scheduled For Retirement

3.10 The session discussed opportunities to improve services to WMO Members through the continued utilization of a satellite(s) that had met an operator's lifetime goal and was scheduled for retirement. It noted that there were four issues that serve to guide the discussion:

- Current operational geostationary satellite separation was not optimal, and some satellites' operational modes did not provide the temporal coverage required by WMO Members;
- Current operational polar-orbiting satellite equator cross-time was not optimal;
- Research satellite data were providing valuable information for the GOS and utilized for operational purposes that would be lost upon termination of the research mission;
- Satellite de-orbiting requirements.

3.11 With regard to operational satellites, the session recalled that the requirement for the polar constellation was for four satellites optimally spaced in time. This requirement was currently not being met and was being reviewed by CGMS as a permanent action item. To maximize the information available from the geostationary satellite systems, they should be placed "nominally" at a 60-degree sub-point separation across the equatorial belt, i.e., the WMO requirement was for six geostationary satellites. This would provide global coverage without serious loss of spatial resolution (with the exception of polar regions); in addition this provided for a more substantial backup capability should one satellite fail. Furthermore, the operational modes of some geostationary satellites made it impossible for users in some applications areas to take advantage of the temporal frequency of the satellite. With current technology, many geostationary satellites surpassed their design lifetimes and as a result their inclination angles had drifted beyond what was considered useful for meeting primary requirements of that satellite operator's user community. In such cases, those satellites would be de-orbited while still having the ability to provide useful information beyond "selected primary requirements". An example of a geostationary satellite that continued to provide useful data, products and services beyond its design life was Meteosat-5 coverage over the Indian Ocean. In this regard, the People's Republic of China expressed its appreciation to EUMETSAT for the services Meteosat-5 provided and suggested that EUMETSAT consider continuing operations over the Indian Ocean.

3.12 With regard to R&D satellite missions, several research satellites provided data for operational use by WMO Members. Data from those satellites, including tropical precipitation estimations, hyper-spectral infrared observations, ozone measurements and sea level winds, had proven particularly valuable for global NWP and are also used for other operational applications including nowcasting and synoptic analysis. Furthermore, many research satellites provided high quality data that could help fill in the optimal spacing gap as needed by a four satellite polar-orbiting constellation, and although those data may be sophisticated for use by some WMO Members, advanced products for use by all WMO Members through an Advanced Dissemination Method (ADM) service would be possible. It was recognized that the major goal of research satellite operators was to advance science and understanding. However, the session agreed that the question of continuing a research satellite's life when the research mission goals had been achieved (or the satellite's designed lifetime has been surpassed) should now be addressed in a new context: the value of that satellite's data to the global community for a variety of applications.

3.13 The session noted that there were a variety of ways one might keep useful satellites from entering "retirement," especially those in geostationary orbit. There were space agencies in many countries across the globe, not presently participating as a contributor to the space-based component of the WWW's GOS, that had proved capability to operate research satellites (such as Argentina's CONAE, Brazil's INPE, Australia's FedSat). In this regard, the session noted that both CONAE and INPE had been invited to the session and would be in the future. Their participation was based on their potential to contribute to the space-based component of the GOS. The session stressed the need for the space agency membership in the Consultative Meetings to be as inclusive as possible for those with the potential to contribute to the space-based GOS. There was no doubt that several countries had the sophistication to undertake command and control functions of satellites; with training and possibly capacity building, they might be a viable opportunity for the development of partnerships and would be able to take over ownership and operation of other satellites destined for "early retirement". If that capability could be developed, they had the potential to become partners in the space-based component of the GOS in the future by developing systems to complement those of 'existing' operators.

3.14 Another possibility that was presently being explored was the provision of space on operational geostationary satellites for use by other space agencies. This would allow new space agencies to gain experience in space operations without the need for a full space programme including launch. As an example, NOAA noted that with during the 2004 hurricane season and its associated need for dedicated operations over North America, it was not possible to sustain a meteorological mission over South America. If CONAE or INPE or jointly had a dedicated imager for South America manifested on a GOES satellite then both all the Americas would benefit from a complete environmental mission even in times of dedicated operations by NOAA for a hurricane.

3.15 In the research arena, the situation was often complicated by two driving factors: 1) safely de-orbiting a satellite in low earth orbit; and, 2) development of future mission versus available funding for continuing operation of a successful R&D mission. For example, current missions such as TRMM, Terra, Aqua, Envisat and WinSAT provided valuable information, and future missions such as EarthCARE, GPM, EGPM, ADM-Aeolus, etc. were, or would be likely to provide valuable information to WMO Members. Their early termination, from an operationally oriented viewpoint would be very cost inefficient. As has been demonstrated by the WMO Space Programme, there already was a merging of research and operational satellites in the utilization of their data. This fact should be exploited to increase the useful lifetimes of satellites.

3.16 In view of the WMO Space Programme's stated objective to facilitate the transition of appropriate R&D missions from research to operations, the session agreed it was important to provide guidance on the role WMO should play to facilitate transition of R&D missions to operational. Such a strategy would not only extend the availability of the data and products from research missions through continued operations by operational space agencies but would highlight to the user communities the potential for the availability and thus allow the user communities to have more confidence in such availability and make appropriate preparations. The session recalled NASA's description to keep the TRMM mission operational through a space mission extension process. The process would allow for an orderly transition of R&D satellite missions to operational status.

3.17 The session noted that there were many potential benefits from a planned transition of appropriate missions from R&D to operational. As an example, continuity beyond the R&D mission by operational missions would be part of the integrated process and thus provide the user community with assurance of the availability of data. The session that with such an integrated planning process it would be possible to design R&D mission that would facilitate the transition into an operational system while at the same time reduce the operational costs. It was noted that there would be costs incurred and that priorities would have to be established as to which R&D missions should transition. In this regard, the session recalled that as part of the WMO Space Programme, regional meetings would be conducted to allow WMO Members to identify R&D data streams that should transition. This would be a necessary input in priority setting.

3.18 The session strongly agreed with the need to provide for transition of appropriate missions R&D missions to operational. It was also strongly of the opinion that WMO through its Space Programme should act as a catalyst in working with the space agencies to develop a strategy that would lead to a process whereby transition from R&D mission to operational could be planned. The session recalled the guidance it had developed in the "*Guidelines for Requirements for Observational Data from Operational and R&D Satellite Missions*" as recorded in the report for the fifty-third session of the WMO Executive Council. The session suggested that the WMO Space Programme Office review the guidelines in order to suggest at its next session any required changes to reflect transition. Furthermore, the session suggested that the WMO Space Programme Office prepare a draft strategy for transition for consideration at its next session. One area that was of utmost importance with regard to transition concerned the transition of R&D atmospheric chemistry mission to operational. Thus, the session urged the WMO Space Programme Office to give priority consideration to the transition of atmospheric chemistry mission in preparing the draft strategy. In the interim, WMO should interact with relevant space agencies to strongly encourage R&D satellite mission extension where possible based on WMO requirements.

4. SUMMARY OF THE WMO SPACE PROGRAMME ACTIVITIES

4.1 The session reviewed a summary of activities within the WMO Space Programme since 1 January 2004, the official date for the start of activities for the new, crosscutting major Programme. It described the status of the WMO Space Programme Trust Fund and the staffing in the WMO Space Programme Office. It also summarized activities during 2004 by the WMO Space Programme Office towards meeting the goals of the Implementation Plan. Contained within the description of activities was a list of new responsibilities assigned to the WMO Space Programme by CBS, CGMS, EUMETSAT's Climate Monitoring SAF, GCOS, JCOMM, IGeoLab and others.

WMO Space Programme Trust Fund

4.2 The session recalled that a WMO Space Programme Trust Fund had been created to enable space agencies to provide financial support. To date, this had allowed the WMO Space Programme to lead detailed discussions in CGMS with regard to global contingency planning, as well as in the preparation of the WMO-SP Implementation Plan. Additionally, the Trust Fund assisted in the development of the WMO White Paper for the International Geostationary (IGeoLab) concept, including the two test proposals, i.e., GIFTS and GOMAS. Finally, the Trust Fund assisted in the development of a WMO Space Programme strategy on an approach to include the space-component of the integrated WMO global observing system as a core contributor to the space-component of GEOSS.

4.3 The session noted that EUMETSAT had made a substantial contribution to the WMO Space Programme Trust in 2004 similar to that made in 2003 (50,000 Euros per year or approximately CHF 78,000). The session was informed by NOAA of its intention to donate US$ 50,000 to the WMO Space Programme Trust Fund.

Organization of WMO Space Programme Office

4.4 The session noted that the Permanent Representative of China with WMO had nominated Dr Liu Jian, Associate Professor at China's National Satellite Meteorological Center for consideration as a senior seconded expert. It was anticipated that Dr Liu Jian would start to work in the Space Programme Office in early 2005. The session also noted that NASA had informally indicated that it would second Dr Lelia Vann, Acting Director, Science Directorate, NASA Langley Research Center, for a 3 month period in early 2005 as part of her SES Training Program. Additionally, the Government of Switzerland, as part of its intern programme, had provided Dr Natalia Archinard to assist the Head of the WMO Space Programme. Finally, the session noted that Mr Yoshiro Tanaka, Junior Professional Officer in the WMO Space Programme Office would return to Japan in June 2005.

WMO Space Programme Implementation Plan Activities

4.5 Specific activities being undertaken by the WMO Space Programme in response to its terms of reference included in the near term: (1) coordination with space agencies in the CGMS and CEOS; (2) organization and meeting preparation for the new Expert Team on Satellite Systems; (3) development of the WMO portions of the 10-Year Implementation Plan for GEO's Global Earth Observing System of Systems (GEOSS); (4) interaction with the WMO Expert Team on Observing System Requirements and Redesign of the Global Observing System toward action on the implementation plan for redesign of the Global Observing System; (5) preparation for WMO constituent body meetings; (6) preparation for the symposia to identify R&D satellite data and products that should transition to operational satellites; (7) RARS and IGDDS activities; and (8) further development of the Global Education and Science Network concept proposed by WMO to CGMS.

4.6 The session acknowledged the great progress made in the WMO Space Programme during its first year. It felt that all primary objectives had been met and that there was good potential for even further accomplishments.

Regional ATOVS Retransmission Service (RARS) Activities

4.7 The session recalled that the WMO Space Programme Implementation Plan contained a description of an Integrated Global Data Dissemination Service (IGDDS). A CGMS/WMO Regional ATOVS Retransmission Service (RARS) workshop had been held on 16-17 December 2004 and hosted by EUMETSAT at its Headquarters in Darmstadt, Germany to discuss possibilities towards the development of Regional ATOVS Retransmission Services (RARS) and IGDDS. At the workshop, a number of currently unfulfilled user requirements for ATOVS data were identified around the globe. In order to meet some of these unfulfilled user requirements, two RARS were proposed during the workshop: South American RARS; and Asia-Pacific RARS. The proposal for a South American RARS was still somewhat preliminary, with a follow-on meeting planned to discuss implementation responsibilities, before any final decisions are taken regarding the architecture. The implementation of an Asia-Pacific RARS was due to start shortly and the outline architecture was further defined during the workshop. At the next APSDEU meeting, tentatively scheduled for May 2005, it was expected that the architecture of the Asia-Pacific RARS would be further consolidated. In the short term, it was likely that a decision would be made to use a combination of the GTS and the Internet for the dissemination of ATOVS data. This solution should meet the immediate needs of the ATOVS user community. However, this dissemination approach was unlikely to be appropriate if the scope of the system were to be expanded to include additional products, such as AVHRR data, with its more diverse user community. This point was emphasised at the workshop, and the need for the architecture of the Asia-Pacific RARS to be compatible with a future evolution to an IGDDS-type dissemination solution was stressed. Currently, in the Asia-Pacific area, no regional dissemination system has been established that is consistent with the IGDDS concept. However, there are some national systems that were moving in this direction (e.g., the Chinese DVB system - which has some similarities with EUMETCast). During the course of the workshop some commercial direct broadcast systems were identified which had a footprint that seemed to cover the Asia-Pacific region.

4.8 Based on the very positive experience of the RARS workshop, it was recommended that the IGDDS project be refined within the WMO Space Programme Implementation Plan to include the objective of co-ordinating and facilitating the establishment of a global network of Regional ATOVS Re-transmission Systems, with a particular focus on:

- inter-regional data exchange;
- standardisation in the areas of:
  - product processing software usage;
  - product formats;
  - quality-tagging of data;
  - service management.
- ensuring consistency with the IGDDS concept.

4.9 It was anticipated that this objective will be achieved through the organization of RARS Workshops, together with technical coordination activities. The session noted that JMA was already preparing to support the establishment of a RARS in the Asia-Pacific area with service to start as soon as possible.

4.10 The session was informed of participation by several space agencies and WMO Members to provide ATOVS data from selected HRPT stations including ones in the Russian Federation (Moscow for the European part of the Russian Federation and Novosibirsk in Siberia), India (Delhi) and the People’s Republic of China (Beijing, Guangzhou and Urumqi, and possibly Lhasa) and others expressed an interest to participate.

4.11 The session deeply appreciated the statement by the People’s Republic of China that its national data dissemination service utilizing DVB technology could support an Asia-Pacific RARS. China also confirmed its willingness to continue participation in the further discussions for the Asia-Pacific RARS.

4.12. The session was of the opinion that the RARS approach was revolution in the history of satellites in which there was a strong emphasis on one of the critical issues with satellite technology, namely increasing availability and use of the data. The RARS approach was entirely consistent with the new WMO model for satellite data dissemination in which there was a balance between a limited number of coordinated ground stations coupled with wide availability of data and products. The session strongly encouraged the WMO Space Programme to continue it active role to establish RARS and an IGDDS. Participation by WMO in the development phases for the various regional implementations was recommended in order to ensure consistency and compatibility when establishing inter-regional data exchanges, and coherence with IGDDS.

High Profile Training Event

4.13 The session was informed of activities within the WMO Space Programme in support of the WMO Strategy for Education and Training in Satellite Meteorology. In particular, the session was informed of progress in the Virtual Laboratory for Education and Training in Satellite Meteorology (VL) and its associated VL Focus Group (VLFG). It recalled that the VL was established in May 2001 as a joint initiative by WMO and CGMS as one means of improving the utilization of satellite data and products by WMO Members. VL activities were overseen by a Focus Group that reports to CGMS and, via the Chair of the CBS OPAG IOS, to WMO. In the last four years, VLFG had provided guidance and sharper focus for the content, educational direction and planning of WMO satellite training events. The session also noted that the CM space agencies had other training activities that complemented those of WMO

4.14 The session noted that the next training event in Costa Rica March 2005 would trial the development and use of an electronic notebook (laptop computer) for the students to use during the workshop and in their country for training more people on what was learnt during the workshop. The course participants would be supported on their return home by the online discussion group. Due to the amount of material generated for and at the training events, by the way of lectures and workshops, and the need for digital data and applications, it was no longer feasible to just produce CDs or DVDs for course participants if they are then expected to train their in-country staff on return home. By providing a pre-configured notebook with all the lectures, data and applications to the participants, it should make the training event and follow on training much more streamlined and effective. In many ways this was just a continuing evolution from providing course participants with written material (pre-1990s) to floppy discs (pre-1995) to CDs and DVDs but did imply additional cost (approximately $US2000 per person). In order to minimize the impact of the additional cost, sponsors were being sought for the electronic notebook. For example, there were ongoing discussions with IBM. For the Costa Rican training event, the Cooperative Institute for Research in the Atmosphere (CIRA) had already decided to provide the electronic notebooks as a gift to the WMO through a donation to the WMO Space Programme Trust Fund.

4.15 The session noted that in the expectation that the notebook experiment in Costa Rica was successful, in late 2006 the VLFG and WMO planned to have a period of 3 to 4 days when all the VL Centres of Excellence would simultaneously (on the same day at least) provide online training sessions to the NHMSs in their region, as well as interact with at least one of the neighbouring Centres of Excellence for near real time image discussions and possibly joint lectures.

4.16 The session strongly supported the WMO Space Programme activities and urged space agencies and WMO Members to consider possible funding sources and opportunities towards the purchase of 200 notebooks for the high profile global training event scheduled for 2006. The session noted the annual training events on satellite processing, interpretation and use in operational and research activities, organized by SRC Planeta, supported by EUMETSAT and WMO, for Baltic countries and other countries of the former USSR.

5. DISCUSSION OF IGEOLAB AND PLANNING THE WAY FORWARD *(agenda item 5)*

5.1 The session discussed the concept for an International Geostationary Laboratory (IGeoLaB). In order to demonstrate the concept, two test proposal were described. The IGeoLab concept was based on partnership and sharing of the benefit of a geostationary demonstration mission across several space development agencies, operators of operational meteorological satellites, and satellite data users. The WMO Space Programme had been requested by CGMS to act as a catalyst to further the concept and provide for a discussion within a session of the Consultative Meetings. An IGeoLaB Task Team meeting had been held in Geneva and the results and recommendations of the meeting were included in the discussion. The Task Force had strongly felt that there should be an early indication of intent by space agencies to commit to partnering in the IGeoLab process. The indication of commitment must precede any technical work. All space agencies attending the Task Force meeting supported the concept while noting that a successful IGeoLab programme would be a valuable asset for implementation of the space component for the Global Earth Observation System of Systems (GEOSS). Both test proposals (GIFTS, Geo MW) represented important collaborations for enhancing the GOS with capabilities identified as crucial in the evolution of the WWW/GOS. Three space agencies (Rosaviakosmos, NOAA and CMA) attending the Task Force meeting had indicated a specific interest in furthering the GIFTS test proposal.

5.2 The session strongly supported the IGeoLaB concept and in particular agreed that IGeoLab: (1) represented an expansion of the existing agreement for open sharing of remote sensing data to include sharing development of new remote sensing capabilities; (2) would speed up the realization of and familiarization with new measurements, (3) would offer resource savings through partnering and thus open opportunities for demonstrations in several areas simultaneously, (4) would not constrain industrial developments for operational systems in any Space Agency procurements, and (5) most importantly would assure successful transfer from research to operations in the most cost effective and timely fashion.

5.3 The session noted the responses from several space agencies. In particular , it was informed that there would be discussion within the Russian Federation in the near future to consider the possibilities to manifest GIFTS on an Electra satellite. NOAA expressed a willingness to contribute to the concept but could not provide a launch. CMA strongly supported the concept in stating that it was the right moment to accelerate technical developments. CMA further noted that both test proposals were consistent with China's plans. Thus, CMA indicated a possibility to collaborate within IGeoLaB activities. EUMETSAT noted that the concept provided for necessary and appropriate collaboration and had the potential to reduce both expenses and risks. EUMETSAT cited the GERB instrument onboard MSG as an example of R&D capabilities manifested onboard an operational satellite. NASA noted the advantage from geostationary orbit for better temporal resolution. Geostationary orbit was a sentinel for many application areas. NASA suggested that the utilization of innovative approaches was very attractive. Possibilities existed for participation in the concept through the Earth System Pathfinder project. There would be challenges to be overcome with regard to technology transfer but solution should be possible. The session noted that there were many ways in which a space agency could contribute to the concept, for example through the provision of the ground segment. IMD indicated that it supported the concept and would seek potential participation through India's Department of Space for the possible provision of a launch if a formal request is made by WMO.

5.4 In summary, the session felt that the IGeoLab was of utmost importance to CM space agencies and WMO Members as well. There was strong support to further the discussion on the concept both for the long-term in general as well as for the two test proposals in the shorter term.

5.5 Thus, it suggested the WMO Space Programme undertake two activities:

- For long-term planning, to further develop the IGeoLaB White Paper in consultation with CM space agencies. Long-term planning for IGEOLAB would involve many complex issues. A more detailed description of the concept should be presented to the next CM session;

- For the short term, two focus groups should be established, one for each of the test proposals, with Space Agency nominated members. Terms of reference for the focus groups are attached as Annex III.

5.6 The session noted that focused meetings would be required for each of the above activities and that the WMO Space Programme would continue its role as a catalyst in organizing and progressing the discussions. It is recommended that each focus group report in a timely fashion for each programme to all CM participants through correspondence within six months.

6. REVIEW OF ACTIVITIES RELATED TO THE AD HOC GROUP ON EARTH OBSERVATIONS *(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) that had occurred since CM-4 as described below.

GEO-3 (February 2004)

6.2 The session noted that GEO-3 was hosted by the government of South Africa in Cape Town, South Africa, from 23 to 27 February 2004. There were four major accomplishments at GEO-3: approval of a draft Communiqué; approval of a draft Framework Document; agreement on Terms of Reference for an Implementation Plan Task Team (IPTT) and approval of the report from all five Sub-Groups. WMO's mandate was given prominence in the draft Framework Document as well as the universally recognized contributions made by the World Weather Watch in the draft Communiqué.

GEO-4 (April 2004)

6.3 The session was informed that GEO-4 was hosted by the government of Japan, 23-24 April 2004. GEO-4 reviewed a draft 10-Year Implementation Plan Outline and agreed to prepare three tiers of documentation for the 10-Year Implementation Plan: a Communiqué, an Executive Summary of the 10-Year Implementation Plan (to be called the 10-Year Implementation Plan) and the Implementation Plan Technical Blueprint.

EOS-II (April 2004)

6.4 The session noted that the second Earth Observation Summit (EOS-II) was hosted by the government of Japan on 25 April 2004 in Tokyo. EOS-II had been opened by Mr Junichiro Koizumi, Prime Minister of Japan. The WMO Secretary-General made two statements at EOS II, the first describing WMO's experience in observations and its commitment and potential contribution towards the goal to establish a comprehensive, coordinated and sustained Global Earth Observing System of Systems (GEOSS). The second was a joint statement on behalf of the Executive Heads of FAO, UNEP, UNESCO, including its IOC, and WMO to identify modalities for increased integration and coordination of a resulting enhanced UN-based observing system, and to seek approval from their respective governing bodies. The Executive Heads had also offered to work within the GEO process and resulting intergovernmental coordination mechanism in order to ensure the success of GEOSS. EOS-II culminated with the agreement of a Framework Document for GEOSS, as well as a Communiqué, endorsed at ministerial level.

Future Development of GEOSS Agreed at EC-LVI

6.5 The session was briefed on discussion occurring at the fifty-sixth session of the WMO Executive Council (EC LVI). EC-LVI was strongly of the opinion that GEOSS was one of the most important and key initiatives which would enable WMO to address the challenge of the coming decades. GEOSS was a significant opportunity to provide key benefits in many societal and economic areas world-wide and make data available to a broad range of user communities through improved observational systems. EC-LVI strongly agreed that WMO's long-term experience in operational observing and telecommunications systems clearly demonstrated to those involved in the GEO process that WMO can provide effective leadership in the implementation and operation of GEOSS. EC-LVI also acknowledged that the GEO Implementation Plan was not yet finalized nor approved. EC-LVI was strongly of the opinion that several WMO components would be candidates for GEOSS and certainly be a significant contribution if not the core to GEOSS. Those components would include WMO's unique systems, e.g., WWW GOS and GDPFS, GAW, WHYCOS, GTN-H, FWIS and cosponsored systems, e.g., GCOS, GOOS and GTOS. With regard to FWIS, EC-LVI noted the requirement for GEOSS to establish a new data exchange and dissemination component and that FWIS could serve as an initial system requiring expansion as appropriate to accommodate other GEOSS related data and products. EC-LVI also recalled its considerable experience in providing the venue for important and related secretariats within the WMO Building, e.g., the Intergovernmental Panel on Climate Change (IPCC) Secretariat, the Global Climate Observing System (GCOS) Secretariat and the World Climate Research Programme (WCRP) Joint Planning Staff. Such co-location had proven to be of great benefit to all the involved sponsors. Thus, EC-LVI agreed that the Secretary-General, if asked by GEO Members, should indicate a strong willingness to provide the venue for any future GEOSS Secretariat under conditions comparable to those enjoyed by the present co-located secretariats. EC-LVI also noted that WMO provided the necessary administrative infrastructure for Trust Funds supporting the working of co-located secretariats and this service could also be made available to any future GEOSS Secretariat under similar conditions. At the GEO Special Session on Governance held in Brussels, Belgium, 27-28 September 2004 and hosted by the European Commission, the Secretary General was invited by the Director General for Research Directorate-General of the European Commission to express WMO's willingness to host the GEOSS Secretariat as evidenced in the exchange of letters. The reaction of GEO Members and participating organizations at the Special Session was most supportive. GEO-5, held in Ottawa, Canada 29-30 November 2004, reviewed a proposal by WMO to host the GEOSS Secretariat and reached consensus in principle to consider an Agreement describing the WMO offer at GEO-6 to be held in Brussels, 14-15 February 2005.

6.6 The session reviewed a discussion paper, as contained in Annex IV, on how the WMO Space Programme can be a core contributor to the space component of GEOSS. With regard to the GEOSS space component, the similarities of objectives of GEOSS and WMO fully justified the willingness of WMO, through its recently established WMO Space Programme, to play a significant driving role in the GEOSS process. It agreed that the WMO Space Programme was well placed to participate in GEOSS activities and that WMO should strongly support actions that address the following four axioms and recommendations strongly endorsed by the session.

Recommendation 1: With the creation of GEOSS, there is a significant risk of duplication with pre-existing similar (although less ambitious) initiatives and, eventually, of superposition of systems capabilities. Due, in particular, to its strong links with a user community and its focused approach, WMO, through its Space Programme, should play a significant role in order to establish and maintain a strong coordination with the various stakeholders and users of GEOSS and to strengthen the coordination needed to warrant the interoperability of existing systems and the progressive integration of future ones.

Recommendation 2: GEOSS should benefit from WMO's experience of the space-based component of the GOS as a model for integrating independent space observation capabilities into a single system. The following actions initiated through the WMO Space Programme should be further supported in order to be progressively migrated into GEOSS:

- Integration of the space-component of the various observing systems throughout WMO programmes and WMO-supported Programmes;
- Contingency planning;
- Integrated Global Data Dissemination Service.

Recommendation 3: The multiple benefits gained from the integration of a space-based component in the Global Observing System of the World Weather Watch (global, fair, cost-effective) should be used to promote the potential benefits that GEOSS will bring to society.

<u>Recommendation 4</u>: The most straightforward mean of including the space component of the integrated WMO Global Observing System as a core contributor to the space component of GEOSS will be to assist the GEO Secretariat in the implementation of actions and activities identified in the GEOSS Implementation Plan, i.e., agreements to make systems interoperable and to share data; collective optimization of the observation strategy; cooperative gap filling; commitments to observational adequacy and continuity; data transfer and dissemination; collaboration on capacity building; and harmonization of methods and application of observation standards. The co-location of the GEO Secretariat on the premises of WMO in Geneva should greatly facilitate this effort.

THORPEX, A Component Programme of the WWRP

6.7 The session was informed of the establishment of THe Observing System Research and Predictability Experiment (THORPEX): a Global Atmospheric Research Programme as a part of the World Weather Research Programme (WWRP) under the auspices of CAS (www.wmo.int/thorpex). THORPEX aimed to accelerate improvements in short-, medium- and extended-range (up to two weeks) weather predictions and to demonstrate the social value of advanced forecast products. The THORPEX International Science Plan defined four main research topics: global-to-regional influences on the evolution and predictability of weather systems; global observing system design and demonstration; multi-model ensemble predictions, targeting and assimilation of observations; and social and economic benefits of improved weather forecasts.

6.8 Anticipated impacts resulting from THORPEX were:

(a) An increased fundamental understanding of the dynamics and predictability of the atmosphere. Advance the knowledge of global-to-regional influences on the initiation, evolution, and predictability of high-impact weather;
(b) Design of the strategy for interactive forecasting and targeted observations thus contributing to the process of evolving the WMO Global Observing System (GOS), which is recognized as a core component of future Global Earth Observation System of Systems (GEOSS). The TIP identifies THORPEX as a user of the GEOSS;
(c) Advanced systems for the assimilation of targeted observations from satellites and in situ measurements;
(d) Accelerated improvements of the accuracy of weather forecasts; test and demonstrate effectiveness of a multinational multi-model multi-analysis global ensemble forecasting system (THORPEX Interactive Grand Global Ensemble – TIGGE);
(e) The development of a much improved global and regional forecasting system, with the active involvement of developed, developing and least developed nations by fully exploiting advances in numerical prediction, observations, communications and data assimilation techniques;
(f) Significant quantifiable improvements in decision-making skills and consequent measurable reduction in societal distress. Improved decision support tools, which utilize advanced forecasting products, in the most representative social and economic sectors.

6.9 Although all four major sub-programmes have components that are of interest to space agencies, the session noted the following that deserved special consideration.

6.10 Observing System Tasks (TIP chapter 5) summary and major goals:

Goals / **Projects**	**Time Scale (Years)**		
	2	**6**	**10**
New Delivery Systems	Assess current observing system strategy Examine, develop and test new delivery platforms for targeting	Assess viability of observing system with new global NWP strategy	Deliver new operational observing system Inform future satellite sensing systems and operational strategy
Field campaigns	Complete Observing System Tests (see Chapter 10) Complete forecast impact studies Support observational needs of other THORPEX research components	Complete Observing System Tests (see Chapter 10) Complete forecast impact studies Support observational needs of other THORPEX research components	Complete Observing System Tests (see Chapter 10) Complete forecast impact studies Support observational needs of other THORPEX research components
Design Observational networks	Develop techniques for the optimal design of observing networks	Test and evaluate network design	Redesign of the Global Observing Network
Refine Targeting and adaptive observing Strategies	Determine targeting and adaptive observing strategies using OSEs and OSSEs	Evaluate impact of strategies on forecast error	Determine role of targeting and adaptive observing in Redesign of the Global Observing Network
Generalise existing strategies	Develop a generalised observing strategy for flow regimes dominated by physical processes	Test and evaluate observing strategies in TReCs (See Chapter 11)	

6.11 With its focus on improving weather forecasts through a systematic approach, including research in all major components of the forecast process (observations, data assimilation, numerical forecasting, and socio-economic applications), THORPEX was ready to become a major contributor to the success of the GEOSS, by effectively becoming the global weather forecast component of the GEOSS programme.

6.12 The session discussed the need within the THORPEX process for satellite sensor development. In the evaluation of active targeting for observations in selected geographic areas, THORPEX anticipated that satellite sensor development could be a priority area for consideration by space agencies. The CM space agencies described the need for an early indication of specific needs for sensor development since there were long lead times required in the planning process of new instruments and missions. Thus, they urged THORPEX to conduct the evaluations as early as possible with the expectation they would be informed of new requirements for satellite sensor development.

IGACO, A Plan for a Global Integrated Observing System for Chemical Climate and Weather Variables

6.13 The session was informed of the approval by IGOS Partners of the Integrated Global Atmospheric Chemistry Theme Report that assessed past, present and future current state of global air composition observations, the requirements and priorities in the next 15 years.

6.14 The session noted that the IGACO report was prepared by an expert international group convened by the World Meteorological Organization (WMO) and the European Space Agency (ESA) was reviewed independently by eminent scientists including two Nobel Prize winners. IGACO was a highly focused strategy for bringing together ground-based, aircraft and satellite observations of 13 chemical species in the atmosphere using atmospheric forecast models that assimilate not only meteorological observations but also chemical constituents. Socio-economic issues related to climate change, ozone depletion/ UV increase and air quality benefit by having such a system in place.

6.15 The IGACO report critically assessed, the requirements on accuracy/precision and spatial/temporal resolution, and the current state of modelling chemical cycles in forecast and climate models. It had recommended specific steps to be taken in a phased approach over the next 15 years led by the WMO Global Atmosphere Watch (GAW) programme in cooperation with the WMO space programme and other key WMO programmes, the space agencies and the global air chemistry/meteorology/climate research community.

6.16 The session was strongly supportive of activities since the approval of the IGACO Report and noted the future importance of atmospheric chemistry data for both GCOS and GEOSS. The session was also informed that CMA has recently established a "Centre for Atmospheric Watch and Services" with the aim of providing atmospheric chemistry observations, air quality forecasting and services.

7. TSUNAMI ALERT SYSTEM

7.1 The session discussed the implication from the Asian Tsunami. It noted that there were many possibilities for CM space agencies to provide valuable services in support of a global tsunami alert system including data collection and dissemination. The session agreed that there was a strong connection with GEOSS and that further discussions within a GEO context were scheduled for the forthcoming GEO-6 to be held in Brussels, 14-15 February 2005.

7.2 The session was informed of results from the recent World Conference on Natural Disasters (WCDR) in which discussions on a tsunami alert system were prominent. The session noted that WMO strongly supported the leadership of UNESCO and its Intergovernmental Oceanographic Commission (IOC) in coordinating this critical undertaking. The session noted that fifty-three NMHSs were also responsible for seismology and tsunami early warnings, fourteen of them being in the Indian Ocean. WMO was committed to working together with UNESCO-IOC, ISDR and other key partners on international, regional, and national level to combine relevant capabilities and build on them to ensure that a multi-hazard approach for early warning systems would be available not only to all countries in the Indian Ocean, but also in other regions at-risk globally. To this end, WMO would help coordinate a multi-discipline team to identify actions for the new early warning system with the expectation that this would lead to a single coordinated plan. The session also anticipated that GEOSS would augment activities in the implementation of the single coordinated plan.

7.3 The session was informed of WMO's activities to achieve short-term and long-term goals. In the short-term, WMO will ensure that its GTS is sufficient to assist in exchange of all warnings and related information in the Indian Ocean within the next 6 months. In parallel, WMO has prepared a technical proposal for funding of necessary upgrades to the GTS within this target time. Beyond the first six months, WMO proposed to expand its GTS for tsunami early warning applications to other at-risk regions. Through the WMO Space Programme, coordination would be undertaken with the satellite operators to utilize satellite capabilities for date collection and dissemination to further expand on the capabilities of the GTS. JMA informed the session of its active involvement through the provision of knowledge and technologies regarding satellites. For example, collection of tidal data through satellites was highly effective for the operation of a tsunami early warning system. JMA was currently collecting tidal data using the Data Collection System (DCS) from the Data Collection Platforms (DCP) onboard GMS-5.

7.4 Similarly, CMA indicated its willingness to make available the DCS onboard the FY-2 series satellites as part of a tsunami alert system. Finally, India described its efforts towards the goal to establish a national integrated warning system.

7.5 In working closely with UNESCO-IOC and other potential partners, work towards the implementation of multi-hazard early warning system and related national alert and response mechanisms can be achieved. For example, with the initiative of IOC, WMO and the International Hydrological Programme (IHP) through a group of international experts a project proposal on Storm Surge Disaster reduction has been prepared. WMO suggested that this proposal be integrated and implemented as part of the multi hazard approach to reducing disaster risk in the Indian Ocean. Through its educational and promotional materials and regional training workshops, WMO would work jointly with its key partners and targeted at NMHS and the risk management community to raise the level of awareness on the benefits of multi hazards alert and response mechanisms.

7.6 In summary, the session agreed that WMO had been actively engaged in increasing the awareness of the World community as to WMO Members capabilities for global alert systems. It also recognized that with the recognition came the responsibility to make rapid progress. It was confident that once a consolidated plan of action was developed that the CM space agencies and the WMO Space Programme would be well positioned to respond to the emerging and demanding requirements.

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

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

In closing the Chairman noted the constructive discussions of the Meeting and further progress made in the implementation of the WMO Space Programme, as well as preparing for participation in GEOSS. He thanked the participants for their efforts in this regard. He then closed the session at 16h23.

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-4

3. REVIEW EXPANSION OF THE SPACE-BASED COMPONENT OF THE GLOBAL OBSERVING SYSTEM
   3.1 Changes in GOS since CM-4
   3.2 Changes in Space Agency Plans since CM-4

4. SUMMARY OF THE WMO SPACE PROGRAMME
   4.1 The first year
   4.2 Trust Fund status
   4.3 Staffing
   4.4 Formation of the ET-SAT

5. DISCUSSION OF IGEOLAB AND PLANNING THE WAY FORWARD

6. REVIEW OF ACTIVITIES RELATED TO THE AD HOC GROUP ON EARTH OBSERVATIONS
   6.1 GEOSS Implementation Plan

7. TSUNAMI ALERT SYSTEM

8. ANY OTHER BUSINESS

9. CLOSURE OF THE SESSION

ANNEX II

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ANNEX III

TERMS OF REFERENCE FOR THE FOCUS GROUPS
(FOR GIFTS AND GEO MW)

(a) To evaluate the technical aspects of the test proposal;

(b) To identify components of a space qualified system including associated ground systems that can be accomplished through international partnerships;

(c) To identify opportunities and prospective partners;

(d) To draft a proposal to the group of prospective partners including the identification of a lead agency to implement the proposal;

(e) To outline a time-table for accomplishing the mission plan.

ANNEX IV

HOW THE WMO SPACE PROGRAMME CAN BE A CORE CONTRIBUTOR TO THE SPACE COMPONENT OF GEOSS

THE SCOPE AND OBJECTIVES OF GEOSS ARE IN LINE WITH THE WMO 6TH LONG-TERM PLAN

1. GEOSS, as established by the Washington Summit Declaration intends: "to monitor continuously the state of the Earth, to increase understanding of dynamic Earth processes, to enhance prediction of the Earth system, and to further implement our international environmental treaty obligations". To meet this objective GEOSS should provide "timely, quality, long-term, global information as a basis for sound decision making".

2. The overarching 10-year vision in the societal benefit of GEOSS is to further enhance coordination among operational observing systems with global coverage. These need to be capable of supporting effective forecasts and of generating information products that enable planning, in support of sustainable development. Disparate, multidisciplinary, basic, and applied research must be integrated into operational systems. Gaps must be filled in observations, in knowledge, in technology, in capacity, but above all, in organization. Providing this collaborative framework to permit free exchange of and efficient use of data, together with support for continuity of operations for all essential systems, is precisely the purpose of GEOSS.

3. The Framework Document of GEOSS sets out nine objectives, referred to as societal benefit areas, on which there is agreement that clear benefits could be derived from a coordinated global observation system. These nine areas are:

(1) Improving weather information, forecasting, and warning;
(2) Understanding, assessing, predicting, mitigating, and adapting to climate variability and change;
(3) Improving water resource management through better understanding of the water cycle;
(4) Reducing loss of life and property from natural and human-induced disasters;
(5) Supporting sustainable agriculture and combating desertification;
(6) Understanding environmental factors affecting human health and well being;
(7) Improving management of energy resources;
(8) Improving the management and protection of terrestrial, coastal, and marine ecosystems;
(9) Understanding, monitoring, and conserving biodiversity.

4. Whereas the first 4 items are clearly dominant within WMO's current missions and responsibilities, all of them correspond to areas where WMO can play a significant role and wishes to achieve results and impact, as stated in chapter 4 of the WMO 6th Long-Term Plan. The nine strategies and associated goals adopted by WMO and its Members and described in this Long-term Plan make repeated reference to societal benefits which significantly overlap with those of the GEOSS 10-year Implementation Plan and listed above. This similarity between the long-term objectives of WMO and those of GEO is indeed fully in line with the new **vision of WMO**:

> To provide world leadership in expertise and international cooperation in weather, climate, hydrology and water resources, and related environmental issues, and thereby to contribute to the safety and well-being of people throughout the world and to the economic benefit of all nations.

5. This vision is more explicitly described in the five **desired outcomes** stated in this plan which are:

(1) Improved protection of life and property;
(2) Increased safety on land, at sea and in the air;
(3) Enhanced quality of life;
(4) Sustainable economic growth;
(5) Protection of the environment.

6. It appears clearly that WMO and GEOSS are pursuing parallel efforts towards the same objectives. It seems both logical and necessary, then, that these efforts be conducted with the largest possible coordination. Any other route might results in significant inefficiencies, wasting of resources and, possibly, conflicts of interest.

Recommendation: With regard to the GEOSS space component, the similarities of objectives of GEOSS and WMO fully justify the willingness of WMO, through its recently established WMO Space Programme, to play a significant driving role in the GEOSS process.

THE NEED FOR A COORDINATED AND COOPERATIVE EFFORT

7. It is recognized in the 10-year Implementation Plan of GEOSS that many of the targets set in the nine societal benefit areas are already pursued by existing entities (organizations, committees and programmes) and that these entities are likely to continue to do so. The added value that GEOSS wants to bring is: 1) the identification, in consultation with all the actors of the system, in particular providers and users, of new measures still needed to achieve the above targets, and, 2) the fostering of cooperation among these entities. The report is particularly careful in emphasizing the need to build on current efforts and to maintain the integrity of programmes managed by participating organizations:

> “GEOSS will provide the overall conceptual and organizational framework to build towards integrated global Earth observations to meet user needs. GEOSS does not mean an attempt to incorporate all Earth Observing systems into a single, monolithic, centrally controlled system. It is intended to improve the data supply to users and not as a justification for annexing existing observation and data distribution systems into a new international organization. GEOSS systems are themselves often ‘systems of systems’. It is desirable to organize in this way in order to remain closely in touch with dynamic observational requirements within particular societal benefit areas and geographical domains”.
>
> “GEOSS will be a “system of systems” with components consisting of existing and future Earth observation systems across the processing cycle from primary observation to information production. The Earth observing systems that participate in GEOSS retain their existing mandates and governance arrangements, supplemented by their involvement in GEOSS. Through GEOSS, they will share observations and products with the system as a whole and take such steps as are necessary to ensure that the shared observations and products are accessible, comparable, and understandable, by supporting common standards and adaptation to user needs”.
>
> “GEOSS builds upon current cooperation efforts amongst existing observing and processing systems, while encouraging and accommodating new components. Across the processing cycle from data collection to information production, participating systems maintain their mandates, their national, regional and/or intergovernmental responsibilities, including technical operations and ownership”.

8. This issue of the independence of observing systems, which would be maintained through the GEOSS, is particularly sensitive for the space components. For technological, industrial as well as political sovereignty reasons, most space-faring countries, or groups of countries, will wish to remain in complete control of their space assets. However, it should be noted that, although the approach proposed by GEOSS is welcome from the political point of view, it may not be the most efficient one and may lead to significant duplications between different systems. In particular, it may not be consistent with the current strategy of WMO which aims at moving away from the existing series of independent observing systems, either dedicated (e.g., WWW GOS, WHYCOS, GAW) or co-sponsored (e.g., GCOS, GOOS, GTOS) to an integrated WMO global observing system. Indeed, a more integrated strategy, such as the one advocated by the Integrated Global Observing Strategy Partnership (IGOS-P), is likely to be both more efficient and more cost-effective than stand-alone strategies. WMO should, therefore, play an active role within GEOSS in ensuring that a more integrated approach is preferred whenever possible.

9. CEOS, the Committee on Earth Observation Satellites, was meant to provide a forum for space agencies to coordinate their activities taking into consideration space agencies' requirements to maintain independence of space systems. As evidenced by recommendations made on the calibration and validation of space data, CEOS remains a means for participants to remain mutually informed of each other's plans. The creation of the Consultative Meetings on High-level Policy on Satellite Matters was a WMO initiative to provide effective coordination of space observations of the Earth, at least in the area of weather, climate and hydrology. These Consultative Meetings were initiated to provide guidance to the WMO Space Programme in order "to make an increasing contribution to the development of the WWW GOS,..., 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". It seems that the greater focus of the Consultative Meetings on the objectives of the WWW and WMO Programmes and their close links with the user communities within WMO Members have been two significant elements of its success so far.

Recommendation: With the creation of GEOSS, there is a significant risk of duplication with pre-existing similar (although less ambitious) initiatives and, eventually, of superposition of systems capabilities. Due, in particular, to its strong links with a user community and its focused approach, WMO, through its Space Programme, should play a significant role in order to establish and maintain a strong coordination with the various stakeholders and users of GEOSS and to strengthen the coordination needed to warrant the interoperability of existing systems and the progressive integration of future ones.

A NEED TO MAXIMIZE THE USE OF EXISTING SPACE-BASED OBSERVATION CAPABILITIES

10. The purpose of GEOSS is to coordinate the build-up of the necessary infrastructures and thus provide for the delivery of services. Services, whether commercial or public, are about the provision of the right information at the right moment to the proper person. To achieve the nine objectives set forth in the Framework Document of GEOSS, high-level operational information services are needed, and not simply space data or satellite images. Scenarios, estimates of socio-economic impacts, quantitative statistics, reliable previsions and trends as well as accurate forecasts are demanded at various geographical and temporal scales in support of public policies and to enhance quality of life. Quantitative assessment and control are required in support of industrial and commercial activities such as energy, agriculture, insurance, construction and tourism, to sustain economic growth.

11. However, the 10-Year Implementation Plan of GEOSS recognizes that "despite laudable efforts in some domains, the current situation with respect to the availability of Earth observations fails, particularly with respect to coordination and data sharing between countries, organizations and disciplines, to meet the needs of sustainable development. There is therefore a need, as agreed at the World Summit on Sustainable Development, in the Framework Document, and in

many other fora, for targeted, collective action to bring observing systems in line with the requirements for addressing a range of issues of concern to society".

12. Amongst the inadequacies of existing Earth Observation systems that are often cited, one of the most important is the lack of timeliness and the insufficient frequency of observations. For example, in order to provide useful information to support prevention, assessment and support in the case of natural disasters, frequent coverage and near real time access is a crucial requirement. Today, after thirty years of development, Earth Observation still remains largely a tool for R&D and defence. Operational meteorology is the only area where the transition from R&D to operational activities has been successfully conducted.

13. This has already been recognized by the WMO Space Programme which recommends that space agencies continue to be encouraged to make their observations available to the Global Observing System (GOS) without restriction. "The objective is to bring about a very significant increase in the availability and utilization of data, products and services, not only in terms of volume and variety, but also in the geographical spread of the users. The increases which are already promised by the upcoming satellite systems in terms, for example, of higher spatial resolution, more frequent observations and the availability of more spectral bands, are not simply minor improvements, but represent in many cases step changes".

14. The implementation plan of the WMO Space Programme 2004-2007 defines a series of concrete actions to facilitate the transition from research to operational systems, namely:

- to promote awareness of the availability and potential uses of R&D satellite data and products;
- to facilitate access to R&D satellite data and products to potential users;
- to provide consolidated user feedback on the usefulness of R&D satellite data and products.

15. These actions will be essential to reach the objectives jointly stated by GEOSS, WMO and a number of other initiatives to increase the use of space for the benefit of mankind and in the everyday life of the citizens of the world, and they should be actively conducted.

16. Two other elements of this Implementation Plan should have a critical influence on the early definition and provision of information and services relevant to the societal benefit areas of GEOSS. They are:

- the Integrated Global Data Dissemination Service and its associated concept of Alternative Dissemination Methods (ADM), and
- Contingency Planning.

17. Both elements are needed to produce timely information on a regular basis and to effectively deliver this information to the users, where they need it and when they need it. "Making these significantly improved data, products and services available and at the same time aiming to increase the number and geographical spread of the users, will represent the major challenge for the WMO Space Programme in the next decade." This will include data from R&D satellites which are deemed to be relevant to the GOS, but should eventually also include high resolution optical and radar space imagery for which access to data remains an issue.

18. Indeed, the situation is far less satisfactory for imagery satellites. Despite the many Earth Observation satellites in orbit, it is not yet possible to get the right information at the right time. When used separately, few if any of the current in-orbit systems can provide operational information to a wide community of users, whereas used in a cooperative way, as a single interoperable system, they would. Therefore, without waiting for large dedicated satellite constellations, the situation can be improved significantly by better integrating existing satellite sources even of different resolution, quality, etc. Currently, there are 15 to 20 civilian imagery

satellites available, which provide imaging data in the 1-30 metre resolution range using optical, infrared or radar sensors. Each of these instruments has its own specific purpose, but there is a clear lack of an integrated and synergistic approach to fully exploit the very large volume of available measurements.

19. GEOSS provides a major opportunity to overcome the individual shortcomings of each mission by jointly exploiting the multitude and variety of instruments and thus easing the task of building and providing operational services. This is already in progress through various initiatives, and noticeably so within the WMO Space Programme.

20. Indeed, it should be recognized that the Global Observing System of WMO could contribute to most of the GEOSS societal benefit areas. As already stated, most of these areas correspond to the current priorities of WMO. The careful reading of Section 4 of the 10-Year Implementation Plan, entitled “Societal Benefits and Requirements”, provides multiple evidence of the potential role of WMO and the WMO Global Observing System and, in particular, of its space component. Paragraphs 4.x.3 of the report, which describe the “Existing situation and gaps”, make repeated and explicit reference to WMO and WMO observing systems.

21. In this respect, the foreseen development of the space-based component of the integrated WMO Global Observing System on the basis of observation components for 3 earth-system domains and 2 cross-cutting domains (atmosphere, ocean, land-surface and fresh water, climate, disasters) will allow the GOS to contribute to almost all nine areas of GEOSS. This integrated approach rightly recognizes that a given satellite can contribute to several different types of applications in all domains.

22. For instance, geostationary meteorological satellites, which have been designed primarily for weather forecasting, have demonstrated that they can contribute to reducing loss of life and property not only from meteorological disasters like tropical hurricanes but also from weather-induced disasters such as floods, droughts as well as forest fires. Data from the same satellites are also being used in the current efforts towards understanding the environmental factors affecting human health and the re-emergence of new diseases such as meningitis and cholera which are related to the abundance of aerosols, respectively desert and coastal, and their transport by winds.

23. The mapping of wind fields, which is a direct contribution to weather modelling, is used more and more to optimize the setting and operations of windmill farms inshore and offshore as well as their integration into the distribution grid. For the latter, the wind pattern measured from geostationary satellites is supplemented by the use of polar orbiting scatterometers. Polar orbiting satellites, operational as well as R&D are, in turn, used for a variety of other applications. Wide-field multispectral imagers, such as the instrument MERIS on Envisat for instance, are used for resources and ecosystems management both inland and at sea, but also for supporting sustainable agriculture or combating desertification.

24. The experience gained in Europe, from the ongoing demonstration projects of GMES, provides dozens of examples of new services which can be provided from space observations and which require several different satellite data sources which belong today to different components of the GOS (GOOS, GTOS, WHyCOS, WWW, GAW,...). This demonstrates the value of a more integrated approach for the future evolution of the GOS as well as for the implementation of GEOSS.

Recommendation: GEOSS should benefit from WMO’s experience of the space-based component of the GOS as a model for integrating independent space observation capabilities into a single system. The following actions initiated through the WMO Space Programme should be further supported in order to be progressively migrated into GEOSS:

- Integration of the space-component of the various observing systems throughout WMO programmes and WMO-supported Programmes;
- Contingency planning;
- Integrated Global Data Dissemination Service.

AN URGENT NEED TO DEMONSTRATE THE CAPABILITIES OF GEOSS

25. The Tsunami that devastated the coastal regions of southern Asia, following the magnitude 9 earthquake off the coast of Sumatra provides a sad illustration of the urgent need to demonstrate the capabilities of GEOSS. Because we have failed so far to demonstrate the ability of a global system with a strong space-based component such as GEOSS to provide advance warning and efficient support to rescue operations and the early phase of reconstruction, this event may have adverse consequences on the implementation of a global system. Indeed, the Summit which took place in Jakarta on 6 and 7 January has initiated the deployment of a dedicated "tsunami warning system" in the Indian Ocean, similar to the existing system covering the Pacific Ocean. This decision follows similar ones taken in several countries which participate in GEO to implement independent forecasting and warning systems dedicated to floods, heat waves, forest fires, air quality, etc.

26. This policy of deploying dedicated local warning or monitoring systems ignores the benefits and economies of scale that can be provided by a global approach making maximal use of space-based technologies for information gathering and dissemination. Any attempt at emphasizing the role of space techniques in a system such as GEOSS is often seen as a lobbying effort by the space community. The responsibility of the WMO, which has been jointly benefiting of in situ and space-based observations for several decades, will therefore be critical in recalling and substantiating the following three essential virtues of space.

Satellites provide global observations

27. Satellites provide global observations of the Earth and of the natural and anthropogenic processes that take place at its surface and which spread across political boundaries. Earth observation from space has demonstrated its ability to observe and study, sometime to forecast, a large number of natural phenomena. Demonstrations have been provided for natural disasters prevention, mitigation and forecast, in the case of landslides, floods and forest fires, for the protection of terrestrial, marine and coastal ecosystems, in the fight against desertification, in the management of fishing, agriculture and forestry, as well as to insure security at sea. These are based mostly on imagery and altimetry satellites. Some of these applications are becoming rapidly operational in precision farming, daily sea ice and icebergs monitoring and forecasting of ocean circulation.

28. But none of these applications has reached yet the level of efficiency and the scale of the World Weather Watch (WWW) and the level of coordination of its Global Observing System (GOS).

Satellites observations are fair

29. Ground-based and other in situ measurements require costly infrastructures and maintenance. On the other hand, a satellite can make continuous, long-term observations over every part of the globe, every country, irrespective of its GNP. This is well appreciated by WMO and its Members. Indeed, observations from the space-based component of the GOS have played a key role in improving the weather forecasts in the southern hemisphere. The accuracy of weather forecasting in the Southern Hemisphere has long suffered from the scarce distribution of in situ meteorological observatories. This was due both to geographical and economical reasons. Indeed, the extent of oceanic areas in this hemisphere prevents from having a dense network of ground-based observatories. In addition, developing countries have often lacked the necessary resources to set up, operate and maintain observatories, to disseminate their data and/or to acquire the necessary processing and modelling capabilities. Over the past two decades, the

reliability of 3-days (resp. 5-days) forecasts obtained by the European Centre for Medium-term Weather Forecast (ECMWF) has increased from 85% to 95% (resp. 65% to 85%) in the Northern Hemisphere. In the same period, it has increased from only 70% to the same value of 95% (resp. 50% to 85%) in the Southern Hemisphere. Without satellites, we would lose today 3 precious days of forecast in the Southern Hemisphere. It is clear that the space component of the WWW has not only improved the reliability of weather forecasts throughout the globe, it has brought a fair balance of forecasting capabilities in developing countries. This is a very general rule which should apply to all the societal benefit areas of GEOSS: **any service based on global observations can be readily implemented all over the globe, in any country, irrespective of its economic condition!**

Satellites are cost-efficient

30. Today, the richer countries spend ten times more for in situ monitoring of the environment than for space-based observations. Of course, many in situ observations are absolutely needed in conjunction with space-based observations, but their number can be significantly reduced by developing the proper synergies with global satellite observations. Forecasts and warnings require the implementation of coordinated observing systems, data collection and data sharing mechanisms, advanced processing and modelling capabilities, the definition of standard products and services and distribution mechanisms to reach the users. A critical aspect, at this point, is the opportunity to gain synergies and cost savings by using one observational infrastructure for more than one purpose, i.e. to have a single infrastructure, and this holds for many of the objectives of GEOSS, and not just for natural hazards. For example, validation of land cover products requires a distributed network of ground locations. These can be co-located with existing stations currently set up for weather and climate observations and provide additional synergies between the WWW GOS and GEOSS.

31. Again, this is true for each of the nine societal benefit areas of GEOSS. They all have observational needs for many variables, with requirements for their accuracy, spatial and temporal resolution; they have their own modelling techniques, specific routes and speed of delivery to the users. Still, it is also clear that there is considerable commonality of observation needs, modelling capabilities and delivery techniques. This powerful argument for implementing GEOSS has already been recognized by WMO and its Members and further justifies the role that WMO should play in the definition and implementation of GEOSS.

32. The current trend is somewhat reminiscent of the competition that prevailed ten years ago in the mobile telephone industry. Set aside the technical difficulties inherent to mobile phone operations from a constellation of satellites, Globalstar and Iridium ventures could have been successful, had they managed to control a significant market share at the expense of cellular networks. The latter technology won the battle and now provides 99% of the capacity for mobile communications. But this was a competition between private enterprises to control a commercial market. Monitoring the Earth and its environment, managing natural resources and energy, and ensuring the safety and well being of people are the responsibility of national and regional governments, institutions and it will always be supported eventually by taxpayers money. Market rules do not strictly apply and sound advice by international organizations should prevail in public decision-making.

Recommendation: The multiple benefits gained from the integration of a space-based component in the Global Observing System of the World Weather Watch (global, fair, cost-effective) should be used to promote the potential benefits that GEOSS will bring to society.

PROPOSED ACTIONS

33. The previous paragraphs have demonstrated the tremendous contribution that the WMO Space Programme can make to GEOSS. It would, therefore, be beneficial to both programmes that the WMO Space Programme contributes to the achievement of the goals and targets of

GEOSS. However, in view of the potential conflicts of power and interests which are likely to emerge during the early implementation of GEOSS, it is recommended that WMO and, in particular, its Space Programme adopt a strategy of progressive migration of its implementation mechanisms and systems into GEOSS.

34. This "Trojan horse" approach may be facilitated by the strategy set out in the GEOSS 10-year Implementation Plan which recognizes the need to link with UN user agencies: "The established Earth observation systems, through which many countries cooperate as members of the United Nations Specialized Agencies and Programmes and as contributors to international scientific programmes, provide essential building blocks for GEOSS. GEO will seek to ensure effective consultation and coordination with the UN system and other international agencies sponsoring or cosponsoring the major component global observing systems on which GEOSS will be built".

35. The GEOSS Implementation Plan further emphasizes the value of building upon existing national systems and/or coordination of systems such as the space component of the GOS of WMO: "There are clear improvements that can be made to existing Earth observations through adopting a coherent global approach that will guide the expansion of observing systems to meet society's needs. The incremental cost of bringing the systems up to specification and linking them together is small relative to the existing expenditure, and very small relative to the potential benefits that can accrue".

36. Consistent with the structure of GEOSS as a 'system of systems', the GEOSS Implementation Plan states that the goals and targets will be achieved through and with the existing component systems. Based on these assumptions, the 10-year Implementation Plan proposes to build up the GEOSS through the following series of steps, which may well become seven working programmes of the future GEOSS Secretariat:

- Agreements to make systems interoperable and to share data;
- Collective optimization of the observation strategy;
- Cooperative gap filling;
- Commitments to observational adequacy and continuity;
- Data transfer and dissemination;
- Collaboration on capacity building;
- Harmonization of methods and application of observation standards.

Recommendation: The most straightforward mean of including the space component of the integrated WMO Global Observing System as a core contributor to the space component of GEOSS will be to assist the GEO Secretariat in the implementation of these seven programmes. The co-location of the GEO Secretariat on the premises of WMO in Geneva should greatly facilitate this effort.

37. The detailed role that the WMO Space Programme could play in each of these programmes will depend on the way they will be implemented by the future GEO Secretariat. At this stage, only a few preliminary and fairly general observations can be made, in particular regarding the assets and possible benefits that WMO will have in each of these programmes.

Agreements to Make Systems Interoperable and to Share Data

38. This is the basic principle of GEOSS: "GEOSS participating systems will agree to abide by interface specifications with respect to the portion of their data systems that they agree to share, which will provide meaningful links between systems, and will help to make their products more compatible with those of other systems and thus of use to a wide community".

39. With respect to this agreement, the space component of WMO has a major competitive advantage. It is the only existing space system based on contributions from different national agencies where interfaces and data exchange formats have already been specified. The WMO Space Programme can, therefore, support GEOSS in order to "provide a mechanism through which partial or full data sharing can be negotiated and a technical process by which it can be achieved".

40. This action is in line with the programme 1.4 of the WMO 6th Long-Term Plan, the WWW Data Management (WWWDM). The main objective of this programme is to implement modern standardized data handling and archiving procedures for the efficient exchange, archiving and retrieval of information in order to define the Framework WMO Information System (FWIS). It stems from the above, that this FWIS should not be limited to the sharing of data and information but also include the procedures to guarantee the interoperability of systems.

Collective Optimization of the Observation Strategy

41. In the absence of cooperation, each observing system would have to deploy a sufficient number of in situ observing sites together with a specified number of space-based systems to satisfy the requirements of each application, in terms of density and frequency of sampling. GEOSS intend to create a collaborative forum which will perform the technical analyses in order to define the most appropriate observation strategies by combining, for instance, the spatial coverage of satellites with the precision of in situ measurements.

42. Optimization of sampling, both in space and time, requires a complete understanding of the underlying natural or physical processes. It is, therefore, essential to maintain close and interactive relationships between organizations responsible with the definition and optimization of observation systems, research programs, and the user communities. WMO has a long history of building and maintaining a close relationship with the scientific community involved in atmospheric and, more recently, oceanic studies. In order to be able to take into account and to respond to all the objectives of GEOSS, WMO will have to strengthen its working relationship with the land community and to establish new links with the solid Earth community, which is not yet involved in the GOS.

Cooperative Gap Filling

43. The 10-year Implementation Plan states that "GEOSS will cooperate with participating systems and with the various user communities, to identify gaps and unnecessary duplication, redirect or initiate activities to optimize the system, and ensure the necessary continuity in observations. By cooperating on new missions, it will encourage a more effective overall fulfilment of user observational needs". The report puts the emphasis on in situ observations in these parts of the globe (specifically the open oceans and Antarctica) which are outside of the territory of individual countries. "It is to the benefit of all that these areas are adequately observed and that the burden of doing so is equitably shared to the best of each contributor's capacity" and, therefore, the logistics of deploying a system throughout the globe would be more feasible if undertaken as a cooperative action by many countries.

44. As we discussed above, the issue is quite different for space-based observing systems. There, any nation deploying a space system will benefit directly from it. But, because of laws of celestial mechanics, this resource will also be available to perform the same measurements above oceans and developing countries, thus providing a global resource for all. Cooperative gap filling will, therefore, allow different nations to contribute to the system by providing global measurements of a number of different parameters of the Earth system, while remaining the sole contributor to a given satellite. Although this may not seem, in principle, different from the collective deployment of a global in situ system, it is for political and industrial reasons much easier to achieve.

45. One of the roles that the WMO Space Programme could play is to look into the technical and industrial interests in space of the participating nations to GEOSS in order to propose the most adequate distribution of responsibilities in the development of future systems. One clear benefit for the space component of the GOS will be to further increase the number of polar orbiting satellites, which is limited today, and to provide access to high-resolution imagery satellites, which are out of reach for many developing countries.

Observational Adequacy and Continuity

46. None of the objectives of GEOSS will be achieved in the long term if we fail to secure a fundamental commitment to the continuation of observations at an acceptable level of accuracy and coverage. Participation in GEOSS should imply an acceptance of this need for adequacy and continuity. This is, of course, true for in situ as well as space-based observing systems.

47. The GEOSS Implementation Plan provides the example of “the network of hydrological gauging stations worldwide, which has been in decline since the 1960s, due largely to inadequate provision for maintenance. For many basins, the network is now below the minimum required for adequate engineering design of flood protection structures, bridges, dams, and water supply schemes. Ongoing investment is needed to keep the network functional and up to date with technical advances”.

48. The UNFCCC Report on the Adequacy of Global Climate Observations, the GMES Forum as well as the World Climate Research Programme (WCRP) among others, are all advocating the need for continuity of Earth Observation sensors for climate observations. Even short-term applications, such as disaster monitoring, require a long-term perspective of data provision to justify the adaptation of the institutional and technical infrastructure in favour of using space technology. For Earth observation to be a viable information source for policy implementation, continuity should be guaranteed. But continuity cannot be guaranteed until a community of users has expressed a sustainable demand and a mechanism to support the provision of information. This chicken and egg situation has only been solved in the cases of meteorology and defence. With a few exceptions, Earth observation missions are one-time R&D missions with lifetime periods of around 5 years. This is clearly not sufficient for GEOSS.

49. For the weather and climate community, the value of space missions comes mostly from the capability to produce globally integrated, high quality and reliable weather and climate data products requiring the merged analysis of measurements from the whole constellation of operational and research/demonstration satellites. The WMO Space Programme wishes to guarantee the availability of long-term, stable and high quality observations as currently provided by operational satellites (such as geostationary meteorological satellites) complemented with innovative, process-oriented observations provided by research satellites using new technologies. This approach should be advocated by the WMO Space Programme within GEOSS and extended to all the identified societal benefit areas.

50. An important example, also provided in the GEOSS Implementation Plan, is the need for continuity of moderate- to high-resolution, space-based imagery of the land and sea surface in the visible and near-infrared, as provided today by commercial programmes operated by public or private companies like Landsat, Spot, IRS, Quickbird and Ikonos. These data have been repeatedly demonstrated to be of benefit to several user communities of GEOSS. This will require designing a mechanism by which these data will be made available through GEOSS to GEOSS-users.

51. Similar transfers of research instruments and measurements to operational agencies are critical in many other domains, including among others atmospheric composition and dynamics, cryosphere evolution, ocean temperature and salinity. The WMO Space Programme has already tackled this latter problem. Indeed, its long-term strategy as contained in the WMO 6th Long-Term Plan, includes the “facilitation of the transition from research to operational systems”. This activity

should be reinforced and the WMO Space Programme should use its experience in these matters to support the GEO Secretariat.

Data Transfer and Dissemination

52. The 10-year Implementation Plan recognizes explicitly the existing activities of WMO towards this objective: "Enabling all users globally to receive the relevant data in a timely fashion is imperative for maximizing the successful exploitation of the data observations and products. This involves the collection of global data, particularly from in situ networks, the transfer of data and products between agencies responsible for observations and products, and the dissemination of data and products to users. In some domains, such as the World Weather Watch programme, much effort has already been invested in the achievement of this objective".

53. Programme 1.2 of the WMO 6th Long-Term Plan, Global Telecommunication System (GTS), is addressing this important aspect of GEOSS. The GTS is an integrated system of managed data communication networks, point-to-point circuits and satellite-based data collection and broadcast systems. The main goal of this programme is to further develop the structure and operational principles of the GTS to respond to the growing data communication needs of all WMO programmes.

54. Concerning the WMO Space Programme, the Integrated Global Data Dissemination Service has already been mentioned. With this approach, access to satellite data would be provided by a combination of direct broadcast from meteorological satellites and "Alternative Dissemination Methods" such as the Eumetcast system implemented by EUMETSAT using DVB technology. The main advantage for GEOSS is that the ADM concept will allow for the seamless inclusion of data and products from additional polar and geostationary satellites, whether operational or R&D. **The WMO Space Programme should strongly advocate the use of these methods throughout the whole GEOSS system**.

Collaboration on Capacity Building

55. "The GEO definition of capacity building includes three observation system elements: human resources, infrastructure, and institutional capacity". The 10-year Implementation Plan recognizes that a variety of organizations have made excellent efforts in capacity building".

56. One of the primary aims of WMO, as laid down in its convention, is to encourage training and capacity building. This is the purpose of the Education and Training Programmes and of the Technical Cooperation Programmes. This translates within the WMO Space Programme Long-term Strategy into "Additional and continuing emphasis on education and training". To date these efforts are concentrating on meteorological and hydrological applications. It is obvious that in order to influence these activities within the GEO Secretariat, the WMO Space Programme will have to coordinate with other agencies involved in training and capacity building on issues related to other societal benefit areas of GEOSS.

Harmonization of Methods and Application of Observation Standards

57. This last programme of GEOSS covers two important but fairly unrelated issues. At this stage of the process, this programme is far from mature. The 10-year Implementation Plan mentions that "The combination of data from different sources is essential to advance our knowledge of the Earth system, but is in many cases constrained due to incompatible observations, missing standards and insufficient operational data assimilation capacity". This issue of the absence of standards for the exchange of observations is a straightforward one, and has, indeed, already been addressed (see paragraphs 38-40 above). On the other hand, the definition of harmonized methods of modelling and analysis is a much more complicated issue and the 10-year Implementation Plan limits the role of GEOSS in this respect to the first issue: "GEOSS can provide a mechanism for achieving the convergence or harmonization of observation methods,

agreement on the use of standards and references and the promotion of intercalibration and operational data assimilation”.

58. Modelling and assimilation techniques are fundamentally related to the nature of the underlying physical, chemical and biological processes at work in the Earth system. Each of these processes can be modelled by a set of equations which can not be “harmonized”. There might be a benefit in trying to export assimilation techniques, which are well developed in fluid modelling, to other areas of Earth sciences. However, it should be left to the scientific community to demonstrate whether the mathematics involved can be submitted to such transfers and harmonization. Supporting these efforts should also be a responsibility of the GEO Secretariat.