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Regulation 42

Recommendations of working groups shall have no status within the Organization until they have been approved by the responsible constituent body. In the case of joint working groups the recommendations must be concurred with by the presidents of the constituent bodies concerned before being submitted to the designated constituent body.

Regulation 43

In the case of a recommendation made by a working group between sessions of the responsible constituent body, either in a session of a working group or by correspondence, the president of the body may, as an exceptional measure, approve the recommendation on behalf of the constituent body when the matter is, in his opinion, urgent, and does not appear to imply new obligations for Members. He may then submit this recommendation for adoption by the Executive Council or to the President of the Organization for action in accordance with Regulation 9(5).

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EXECUTIVE SUMMARY

The Fifth Session of the CBS OPAG on Integrated Observing Systems' Implementation and Coordination Team (ICT-IOS-5) was held at the WMO Headquarters in Geneva, Switzerland, from 15 to 18 September 2008, and was chaired by Dr James Purdom.

The ICT-IOS studied in detail the WIGOS Development and Implementation Plan (WDIP) and the WIGOS Concept of Operations (CONOPS), both adopted by EC-LX. The ICT-IOS discussed various issues regarding its role in the implementation of WIGOS, and identified many issues that need to be resolved. It also agreed that CBS should play the leading role in WIGOS development and implementation. The ICT-IOS noted satisfaction with the progress of the five Pilot Projects that have been initiated as part of WDIP.

The ICT-IOS reviewed both the surface-based and space-based components of the Global Observing System, and noted that there are still some issues regarding the implementation and operation of surface stations in some parts of the world.

The ICT-IOS was advised that the GCOS Reference Upper Air Network (GRUAN), a specialized network building on the GCOS Upper Air Network, is being developed. It was recommended that GRUAN be established as a WIGOS Pilot Project.

A Functional Specifications for Automatic Weather Stations and a list of the basic set of variables to be reported by a standard AWS for multiple users have been reviewed and updated based on comments received from the other technical commissions and are now ready for CBS endorsement.

The meeting reviewed the status of the Implementation Plan for the Evolution of the GOS (EGOS-IP) in conjunction with the Vision for the GOS in 2025. Many comments received from the ICT-IOS expert teams and other collaborators, have been incorporated into the current version of the Vision for the GOS in 2025, and the ICT-IOS requested that a new version of EGOS-IP be prepared that will incorporate the information included in the Vision. The ICT-IOS approved the Vision for the GOS in 2025 for submission to CBS for endorsement.

The new Virtual Laboratory (VL) Training Strategy for satellite data utilization for the next 5 years was adopted by ICT-IOS.

The ICT-IOS reviewed issues relating to the Manual on the GOS and Guide on the GOS and agreed that revisions to both may be needed following the approval of the WIGOS concept by Cg-XVI in 2011. Various scenarios for implementation of the redesigned Volume A were also discussed and it was suggested that a major RSMC may be prepared to host Volume A free of charge on behalf of WMO.

The main deliverables of the ICT-IOS were recast into a number of recommendations that will be submitted to CBS-XIV for considerations. These include revisions of the Terms of Reference of the ICT-IOS, its Expert Teams and Rapporteurs, and the future Work Plans for all the Expert Teams. Two new expert teams are proposed: ET-AIR which will deal with integration of AMDAR into WIGOS and ET-SBRSO which will deal with the area of surface-based remote sensing.
1. ORGANIZATION OF THE SESSION

1.1 Opening of the meeting

1.1.1 The Meeting of the CBS Implementation and Coordination Team on the Integrated Observing System (ICT-IOS) was opened at 09:00 hours on Monday, 15 September 2008, at the WMO Headquarters in Geneva, Switzerland.

1.1.2 Dr Wenjian Zhang, Director, WMO Observing and Information Systems Department (OBS), opened the meeting by recalling the strategic decision made by Congress on the WMO Integrated Global Observing Systems (WIGOS) and the WMO Information System (WIS) and the role CBS should play in their planning and implementation. He also brought to the attention of participants various recommendations from CBS Expert Teams that should be reviewed by ICT-IOS and forwarded to CBS-XIV for consideration. In closing, Dr Zhang wished the participants a successful and productive session and an agreeable stay in Geneva.

1.1.3 The ICT-IOS Chairperson, Dr James Purdom, warmly welcomed all participants, thanked them for their hard work during the intersessional period and expressed his confidence that the session would work hard to fulfill its goals.

1.1.4 The list of participants is given in Appendix I.

1.2 Adoption of the agenda

The ICT-IOS adopted the Agenda for the meeting, which is reproduced at the beginning of this report.

1.3 Working arrangements

The ICT-IOS agreed on its working hours and adopted a tentative work plan for consideration of the various agenda items.

2. REPORT OF THE CHAIRPERSON

2.1 The ICT-IOS Chairperson, Dr James Purdom, presented his report. He expressed pleasure and appreciation to the Chairs of the Expert Teams (ETs) and their members as well as the Rapporteurs that had resulted in a number of important accomplishments. He advised that the two satellite expert teams, namely ET-SAT and ET-SUP, have new acting Chairpersons, Mr James Gurka and Mr Wolfgang Benesch, respectively, following the resignation of Mr Jeff Wilson and Dr. Wenjian Zhang who had undertaken other positions. He welcomed Mr Gurka and Mr Benesch, and thanked them for stepping into these important roles and thanked the outgoing Chairs for their leadership and diligence in helping further the goals of WMO.

2.2 The Chairperson also informed the ICT-IOS that Mr Rainer Dombrowsky was elected as the Vice-president of CIMO and has resigned from the position as Chairperson of ET-AWS; Dr Igor Zahumensky has taken over as acting Chairperson. There has also been a change in the AMDAR Rapporteur, with Mr Jochen Dibbern resigning to take over as Director of the EUCOS Program. Mr Dibbern was thanked for his hard work as AMDAR Rapporteur. Dr Purdom welcomed Ms Magali Stoll to this position and Dr Zahumensky to Chair of ET-AWS and thanked the outgoing Rapporteur and Chair for their dedication and contributions to WMO.

2.3 Dr Purdom informed the ICT-IOS of the important decisions of WMO Constituent body sessions, such as CBS-Ext.(06), Cg-XV, EX-LIX and EC-LX and their subsidiary bodies, such as EC Task Team on WIGOS, EC Working Group on WIGOS-WIS, CBS Management Group (June 2007 and June 2008) as well as other relevant WMO meetings, namely Virtual Laboratory Management
Group (June 2007 and September 2008), WMO Global Satellite Optimization Workshop (July 2007), WIGOS GOS/GAW Pilot Project Meeting (March 2008) and other programmes, such as THORPEX.

2.4 The ICT-IOS was informed on the status of Recommendations to the OPAG-IOS adopted by CBS-Ext.(06) followed by a summary of achievements by OPAG-IOS Expert Teams, involvement of OPAG-IOS in WIGOS initiative and Strategic Planning Guidance for OPAG-IOS.

3. **WMO INTEGRATED GLOBAL OBSERVING SYSTEM (WIGOS)**

3.1 **Concept of Operations**

3.1.1 Dr Zahumensky introduced a WIGOS concept of Cg-XV and follow-up activities by the EC Working Group (WG) on WIGOS-WIS and EC-LX. The ICT-IOS was informed that EC-LX adopted the draft of the WIGOS Development and Implementation Plan (WDIP) and urged Members, Regional Associations and Technical Commissions to actively collaborate in the implementation of WDIP. The EC-LX also agreed with the WIGOS Concept of Operations (CONOPS), developed by the EC WG on WIGOS-WIS, which contains goals, objectives, major characteristics, operational framework, data policy and benefits of WIGOS.

3.1.2 The ICT-IOS was also informed that EC-LX emphasized the leading role that CBS has to play in the implementation of WIGOS concept and stressed the importance of CBS Technical Conference on WIGOS (TECO-WIGOS) that will be held in Dubrovnik, Croatia, from 23 to 24 March 2009, immediately prior to CBS-XIV.

3.1.3 The ICT-IOS studied CONOPS in details and raised a number of questions and recommendations:

(a) ICT-IOS sought clarity on the reporting mechanism, responsibilities and representation of different WMO bodies and was concerned with potential duplication of work;

(b) ICT-IOS was also concerned with both the financial and expert resources needed to address WIGOS issues and the risk that it would drain resources currently available to CBS and ICT-IOS. This is further exacerbated by the fact that the WIGOS Planning Office (PO WIGOS) is yet to be fully staffed;

(c) ICT-IOS supported the concept of WIGOS Pilot Projects (WPPs), however, it sought clarity on whether the WPPs should be comprehensive or should be limited in scope;

(d) ICT-IOS had little information to understand the nature of WIGOS Demonstration Projects (WDPs) as regards their substance and involvement of other Members from Region. It noted the value of the Regional Rapporteurs on the GOS being involved in their respective WDP. The rapporteurs would then be able to keep OPAG-IOS informed of progress with the regional WDP;

(e) ICT-IOS recognized that WIGOS concept should foster more effective integration of satellite and in-situ observations, however, little involvement of IOS satellite expert groups is seen so far. In the case that PPs would not be limited in scope, the ICT-IOS proposed that satellite components be incorporated into relevant WPPs;

(f) The ICT-IOS noted that the current Manual and Guide on the GOS already recognized many of the systems proposed to be part of WIGOS, but the challenge is effective integration of those data into WIGOS/WIS.

3.2 **Pilot Projects**

3.2.1 Following the guidance given by Cg-XV and the EC-LX, five WIGOS Pilot Projects (WPPs) have been initiated as part of WDIP. The status of each of the five WPPs and their planning was
3.2.2 In the case that WPPs would not be limited in scope, the ICT-IOS requested that the level of involvement of the Satellite Programme in the WPP be increased. This involvement is particularly needed in the WPP for Hydrology and for Marine. This should be reflected in the Future Plans of the relevant ETs.

3.2.3 The ICT-IOS felt that a GRUAN WPP could make a significant contribution to the development of WIGOS, and suggested that a new WPP might be appropriate.

3.3 WMO Secretariat Structure and Organizational Change

3.3.1 The Secretariat informed ICT-IOS that a new framework for the Result-based Management of the WMO was approved by Cg-XV. As a consequence the WMO Secretariat structure was reviewed and a new Secretariat structure was developed in accordance with established objectives and criteria, to align the structure to the WMO strategic direction, improve integration of plans and programmes, optimize use of resources, and streamline management and decision-making. The new Secretariat structure became effective on 1 January 2008.

3.3.2 As a result of the new structure the Observing and Information Systems Department (OBS) has overall responsibility for supporting the CBS, CIMO, JCOMM’s Observations Programme Area (OPA) and Data Management Programme Area (DMPA), CCI’s Open Programme Area Groups on Climate Data and Data Management and on Monitoring and Analysis of Climate Variability and Change, the WMO AMDAR panel, the EC Working Group on WIGOS and WIS (EC WG WIGOS-WIS), and the GCOS Joint Scientific and Technical Committee.

3.4 Potential Impact of WIGOS on the OPAG-IOS Working Structure

3.4.1 The ICT-IOS Chairman advised that WIGOS is a new major activity that may require major changes within the OPAG-IOS, depending on decisions of Cg-XVI. A major concern expressed by the ICT-IOS was how the lines of communication and reporting would be implemented between the OPAG-IOS and WIGOS.

3.4.2 The ICT-IOS discussed various issues regarding its role in the implementation of WIGOS, and identified many issues that need to be resolved (see agenda item 3.1).

3.4.3 ICT-IOS agreed that the Terms of Reference (TOR) of its Expert Teams and Rapporteurs should reflect, in due course, their potential involvement in WIGOS. However, the concern was raised that the involvement of the Expert Teams in WIGOS would take considerable resources, and that the work of the Expert Teams could be compromised. Furthermore, ICT-IOS recognized that some of the ETs’ present activities were already related to WIGOS.

3.4.4 ICT-IOS agreed that CBS should play the leading role in WIGOS development and implementation, however, CBS-MG should respond with a proposal of the CBS working structure that would allow an optimal involvement and representation of CBS in WIGOS.

4. REVIEW OF THE STATUS OF THE SURFACE BASED COMPONENT OF THE GOS

4.1 RBSN/ABSN

4.1.1 The level of implementation of the surface stations in 2008 that make 8 observations per day (complete observational programme) varied from 38% in Region IV to 97% in Region VI, with a global average of 74%. In Region I and the Antarctic there has been a significant increase in the number of
stations resulting from the Regional Association and Antarctic Meteorology sessions being held during the period 2006-2008. In Regions II, III, IV and V the number of stations have decreased with a small increase in RA VI recorded during the same period. Overall there has been an increase of over 2% in the number of stations in the RBSNs/ABSN during the intersessional period. The percentage of non-implemented stations (no observational programme) in each Region has decreased appreciably to 3% (115 stations) globally from 5% (182 stations) during the same period.

4.1.2 More than 90% of all established upper-air stations are included in the RBSNs/ABSN. During theintersessional period the number of fully operational stations (making 2 observations per day) has decreased, continuing the trend from the previous two-year period. Radiowind stations dropped from 571 to 554 and radiosonde stations dropped from 548 to 537. However, the implementation as a percentage of the RBSNs/ABSN has remained consistent at around 65% (radiowind) and 67% (radiosonde) during the same period. The geographical distribution remains a concern, with the southern hemisphere having consistently lower percentages of stations proposed for making two observations a day than the northern hemisphere. There is also a persistence of data-sparse areas over some parts of Africa and South America.

4.1.3 The ICT-IOS noted that the quality of land-surface reporting varies considerably from year to year, and also varies considerably between Regions. It was recognized that the comparison between Regions is difficult due to the differences in NWP models at the responsible RSMCs. The ICT-IOS requested that this issue be further investigated, possibly through quality control of all RBSNs/RBCNs by a single RSMC.

4.1.4 The ICT-IOS noted the marked improvement in the quality of the global radiosonde network in recent years in many parts of the world, in particular Russia, China, the Tropics and also the Southern Hemisphere.

4.2 RBCN/ABCN

4.2.1 As of July 2008 all regions including the Antarctic comprise a total of 3424 (2891 CLIMAT + 533 CLIMAT TEMP) reporting stations in the RBCNs/ABCN. A few stations have been deleted or added from the approved list of RBCN stations during the intersessional period, with only a significant increase in the number of stations in RA I and the Antarctic which revised their list of stations with the conclusion of the respective Regional Association and Antarctic Meteorology sessions. As in the case of most Regions, overall implementation globally has been over 80% with the only exception being RA I, which records a low of 63% for CLIMAT.

4.2.2 A series of training seminars conducted with the cooperation of GCOS have been a contributing factor towards a more effective performance in compiling and transmitting CLIMAT and CLIMAT TEMP messages over the GTS. Following the previous three training seminars conducted respectively in RA I, II and III, the fourth such sub-regional seminar for RA V is tentatively planned for early 2009.

4.2.3 The ICT-IOS expressed satisfaction with the improved level of implementation of the RBCNs/ABCN.

4.3 GSN/GUAN

4.3.1 Report of Mr Matthew Menne was presented by the Secretariat. The GCOS Surface Network consists of a subset of 1023 RBCN stations that, in general, have long periods of record. After remaining at about the 60% level through 2005, the overall availability of CLIMAT reports from GSN stations has increased to about 80%, which reflects, in part, the efforts by the CBS Lead Centres for GCOS and on-going training seminars in the Regions to improve reporting practices. However reporting levels across Regions remain quite uneven, ranging from 95% in RA IV to about 50% in RA I. Reporting by the GCOS Upper Air Network (GUAN) stations also continues to slowly improve, largely due to continued renovation efforts.
4.4 Marine and Oceanographic Observations

4.4.1 Mr Etienne Charpentier informed that the open-ocean component of the Global Ocean Observing System (GOOS) is now 60% completed and the Argo profiling float component became the second component to reach completion in November 2007 with 3000 operational units reporting in real-time from the world oceans. Argo is now playing a key role in improving the seasonal climate forecasts, and its data are routinely being used in coupled ocean-atmosphere models together with satellite products and other data from in-situ observing systems. The ICT-IOS recognized that sustainability of the Argo network over decadal timescales remained a matter of concern since most of the national Argo programmes are still supported through research funding.

4.4.2 There were 4336 ships recruited by WMO Members at the end of 2007; about 2000 of them are equipped with electronic logbook. However less than 1000 of the VOS report observations at least daily. Despite the reduced number of recruited vessels, the number of Automatic Weather Stations installed onboard ships and providing hourly observations has increased (now over 200 units) leading to a continued increase in the total number of SHIP reports available on the GTS. The VOS fleet has reached its initial target of 200 ships, but not all of the required additional elements (metadata, QC flags) are always recorded and distributed through the Global Collecting Centres (GCCs). The collection of these additional elements is essential to meet the requirements for climate studies (instrument siting, data of appropriate and known quality).

4.4.3 The ICT-IOS recognized that upper-air profiles made through the Automated Shipboard Aerological Programme (ASAP) complemented AMDAR data over data sparse ocean areas. In 2007, 6425 ASAP reports were received globally from the GTS. There are now 16 units operated by EUMETNET under E-ASAP, which produced 5235 TEMP SHIP reports in 2007 from the North Atlantic and the Mediterranean Sea, with 4029 of those being received from the GTS, including 3574 soundings achieving the 100 hPa level, 3264 the 50 hPa level, and 8 the 10 hPa level. EUMETNET is planning to extend the E-ASAP fleet to 19 ships in 2009. Other Members substantially contributing to ASAP are Japan and South Africa.

4.4.4 The Ship Of Opportunity Programme (SOOP) also provides for valuable upper-ocean thermal data through 41 high-resolution and frequently repeated XBT lines now fully occupied (target 51 lines). These data complement the Argo network.

4.4.5 The ICT-IOS recalled that CBS-Ext.(06), the Second Session of the JCOMM Observations Coordination Group, and the Twenty-third Session of the DBCP have recommended to equip the complete network of drifting buoys with barometers (1250 units). The ICT-IOS noted that good progress was made by JCOMM in this regard, noting that in June 2008, 554 units were actively reporting Sea Level Pressure. It invited ET-EGOS to consider impact studies regarding such data in order to ascertain their effectiveness on NWP.

4.5 Aircraft Observations

4.5.1 The Rapporteur on AMDAR Matters informed that the WMO AMDAR Panel has identified that the need for a reliable aircraft based water vapour sensor to provide humidity data is one of the highest priority for the AMDAR community. The USA AMDAR Programme has scheduled a one week field assessment in the last quarter of 2008 on the re-engineered Spectra Sensor WVSS-II and a second one week field assessment in the first Quarter of 2009. These field assessments will involve a direct comparison against high quality radiosondes. The E-AMDAR Programme has also agreed to continue with its field assessment of the WVSS-II in Europe. Following the successful USA and European-based evaluation trials, the sensor will be installed on aircraft in the USA, Europe, Australia, New Zealand and South Africa as part of a collaborative programme. The ICT-IOS recommended to AMDAR Panel that validation of AMDAR humidity data be performed not only with operational radiosondes and NWP models but also with the dedicated sensors on research aircraft (Recommendation 4.5.1)
4.5.2 The TAMDAR system gathers upper-air soundings from regional airports and cruise level data at 25,000 ft and below and from the more remote airports. Results in the USA have shown that improvements to NWP 3-hour forecast accuracy within the data domain of TAMDAR. Although, TAMDAR does not use the aircraft existing infrastructure, a major advantage of the AMDAR system, thus, the cost to operate TAMAR can be much higher than traditional AMDAR technology. The ICT-IOS recognized the importance for these types of observations and requested WMO AMDAR Panel to work on “a global solution” in sustaining these types of aircraft observations.

4.5.3 The AMDAR Panel Science Sub-Group is continuing to investigate a number of data quality issues relating to aircraft measurement parameters including, temperature, wind, icing, turbulence and the inclusion of atmospheric chemical measurement into the AMDAR programme.

4.6 Performance Monitoring Results

4.6.1 The percentage of SYNOP reports available at MTN centres in comparison with the number of reports required from the RBSN stations was about 76 per cent during the period 2004-2008, with small oscillations of a few percent over the period. There were significant deficiencies in the availability of SYNOP reports from some Regions; in Region I (51 per cent in April 2008), in Region III (58 per cent) and in Region V (70 per cent).

4.6.2 The percentage of TEMP reports available at MTN centres in comparison with the number of reports required from the RBSN stations increased from 62 per cent in 2004 to 68 per cent in 2008. The availability of TEMP reports was relatively satisfactory for the northern and eastern parts of Region II, the northern part of Region IV, and many countries in Regions V and VI. However the availability of TEMP reports was generally insufficient for most of the other parts of the world, particularly in Region I where the percentage of TEMP reports available has decreased from 31% in 2004 down to 25% in 2008. This is a definite concern that needs to be investigated.

4.6.3 The percentage of CLIMAT reports available at MTN centres in comparison with the numbers of reports required from the RBCN stations increased from 65 per cent in 2004 to 74 per cent in 2008. There were major deficiencies in the availability of CLIMAT reports from Region I (33 per cent).

4.6.4 The percentage of CLIMAT TEMP reports available at MTN centres in comparison with the numbers of reports required from the RBCN stations increased from 68 per cent in 2004 to 78 per cent in 2008. There were major deficiencies in the availability of CLIMAT TEMP reports from Region I (58 per cent) and from Region III (56 per cent).

4.6.5 The session was advised that Cg-XV has requested CBS to develop new ways of measuring the effectiveness of the GOS. The ICT-IOS took note of various actions proposed by the Secretariat and concluded that it is not practical to define an ideal (target) network as a baseline. It suggested that:

a) The baseline list of stations for monitoring not include planned or non-implemented stations;

b) The monitoring of implemented stations be based on procedures (techniques and applications) similar to those used by GCOS to measure the effectiveness and implementation of GSN and GUAN;

4.6.6 The ICT-IOS also suggested that the effectiveness of the GOS may be assessed on the basis of national monitoring reports and through national reports regarding the Implementation Plan for the Evolution of the GOS. The Regional Associations should encourage the National Focal Points in their reporting role and utilise the information compiled by them to access the effectiveness of the GOS within the region. Rapporteurs on the Regional Aspects of the GOS should be involved in this process.

4.6.7 The Rapporteurs should be able to assist with determination of individual station deficiencies found during monitoring exercises. The ICT-IOS requested the WMO Secretariat to prepare lists of
never implemented surface and upper-air stations and provide these to the Rapporteurs for further action.

5. REVIEW OF THE STATUS OF THE SPACE-BASED COMPONENT OF THE GOS

5.1 Operational Components

5.1.1. The latest status of current and planned satellites contributing to the GOS is summarized on the CGMS web pages that are maintained by WMO (http://cgms.wmo.int/), with hyperlinks to the websites of the relevant satellite operator. Detailed information on instruments characteristics is available on the WMO Space Programme web pages.

5.1.2. The present geostationary constellation meets the baseline configuration with GOES-11, GOES-12, Meteosat-9, FY-2C and MTSAT-1R, complemented by Meteosat-7 filling a gap over the Indian Ocean. Enhanced coverage is available over South-America thanks to the operation of GOES-10 at 60 deg W, over Europe with the Meteosat-8 rapid-scan, and over Asia thanks to the simultaneous operation of FY-2C and -2D.

5.1.3 The present low-earth orbit configuration meets the current baseline configuration. On the morning orbit, advanced instruments are available on the Metop-A satellite; however, near-real-time access to sounding data is hampered by the current interruption of the Direct Broadcast HRPT and LRPT service on METOP-A and by limited availability of some instruments on the 6-year old NOAA-17 spacecraft.

5.1.4 Two LEO satellites have been launched in 2008, and are currently in on-orbit testing: the new generation FY-3A (China) in May and the ocean surface topography satellite Jason-2 (EUMETSAT, France, USA) in June. Jason-2 is viewed as an important achievement in the transition from R&D missions (Topex-Poseidon and Jason-1) to a fully operational follow-on. The next operational satellites expected to be launched in 2008-2009 are Meteor-M1 and Elektro-L1 (Russian Federation), GOES-O and NOAA-N' (USA), FY-2E (China).

5.1.5 The ICT-IOS stressed that satellite operators should make instrument data available to NWP Centres and key users during a satellite’s on-orbit commissioning phase in order to aid in defining instrument characteristics which will facilitate early operational use, thus maximising this valuable investment. In particular, it expressed interest for early availability of FY-3A data.

5.1.6 The ICT-IOS also recommended that information on the status of operational satellites include an indication of how data may be acquired by WMO Members.

5.1.7 The ICT-IOS noted the concern of WIGOS PP on Hydrology regarding the sustainability of satellite observations for hydrological applications.

5.2 Research Components

5.2.1 Thirty R&D satellites with potential contribution to the GOS are currently on orbit, and another 22 are planned for launch over the next six years. The most recent launches were HY-1B (China) and CBERS-2B (Brazil and China) in 2007. The next R&D is GOCE (ESA) which is planned to be launched by the end of 2008.

5.2.2 The ICT-IOS expressed its appreciation that there was a range of R&D satellites of potentially high interest to the GOS. It recommended seeking confirmation from the relevant space agencies, whenever necessary, that these satellites can be considered as contributions to the GOS. It recommended that the WMO Secretariat discuss with the relevant Members and space agencies to clarify whether and how the data can be available to WMO Members. It furthermore recommended that future information on the status of R&D satellites potentially contributing to the GOS include an indication of how data are available to WMO Members.
5.2.3 The ICT-IOS also stressed the need for a conceptual framework and a mechanism to address the transition from relevant R&D missions and instruments to operational status, and it welcomed the progress made by ET-SAT and ET-SUP in this respect.

5.3 Global Planning

5.3.1 The ICT-IOS recalled the nominal constellation of six operational geostationary satellites that should be near-equally spaced around the equator, with on-orbit spare satellites. The locations and operational responsibilities agreed within the Coordination Group for Meteorological Satellites (CGMS) are the following:

- 135° W & 75° W (USA)
- 0° (EUMETSAT)
- 76° E (Russian Federation)
- 105° E (China)
- 140° E (Japan)

5.3.2 The current baseline for the operational satellites in Low-Earth Orbit (LEO) comprises four sun-synchronous satellites optimally spaced in time, two in morning orbits (a.m.), two in afternoon orbits (p.m.), and two other spacecrafts as in-orbit back-up.

5.3.3 Because of the long lead time for planning and implementation of satellite programmes, current planning activities are now mainly focused on the 2015-2025 time-frame, which is the target period of the proposed new Vision for the GOS in 2025 (addressed under ICT-IOS-5 Item 10). The baseline configuration is expected to be updated once the new Vision is adopted by CBS. In particular, it is anticipated that, in future, the baseline operational LEO component may include:

- Core imagery and sounding missions distributed over three sun-synchronous orbits (early-morning, mid-morning and afternoon orbits) instead of two orbits,
- A number of other missions operated on appropriate orbits, not necessarily polar sun-synchronous, providing an operational follow-on to some current R&D missions.

5.3.4 The ICT-IOS was informed that ET-SAT had performed extensive review of satellite plans for the next two decades and of their adequacy to meet the requirements of WMO and co-sponsored programmes, in preparation for the implementation of the new Vision.

5.4 Global Satellite Intercalibration

5.4.1 The Global Space-based Inter-calibration System (GSICS) project was launched in 2005 by WMO and the Coordination Group for Meteorological Satellites (CGMS) to ensure comparability of satellite measurements provided by different instruments and programmes, to tie these measurements to absolute references and SI standards, and also enable recalibration of archived data. It includes globally coordinated activities for pre-launch instrument characterization, on-board routine calibration, sensor intercomparison by collocation of individual scenes or overlap between time series, use of Earth-based or celestial references, as well as field campaigns. The following organizations are currently contributing to GSICS under the umbrella of WMO: CMA (China), CNES (France), EUMETSAT, JMA (Japan), KMA (Korea), NASA, NIST and NOAA (USA). Informal coordination is established with the Working Group on Calibration and Validation (WGCV) of the Committee on Earth Observation Satellites (CEOS) through overlapping membership.

5.4.2 The first objectives in the GSICS work plan were to perform systematic inter-calibration of all available Low-Earth Orbit (LEO) and geostationary IR and MW radiometers to reference LEO hyperspectral sensors. LEO-LEO intercalibration is performed on a routine basis by NOAA/NESDIS among pairs of sun-synchronous satellites instruments upon quasi-simultaneous overpass at the intersection of their orbital planes. This is referred to as the Simultaneous Nadir Overpass (SNO) technique. Statistical parameters such as bias, slope, etc are calculated from the intercomparison time series.
5.4.3 The GEO-LEO intercalibration is performed by each geostationary satellite operator, using a common algorithm baseline. The geostationary radiances are compared with radiances measured by a hyperspectral LEO imager serving as a common reference to all geostationary imagers. AIRS and IASI are currently used as reference LEO instruments. The objective for 2008 is to perform on an operational basis the intercalibration of Meteosat (MSG), GOES, MTSAT and FY-2 against AIRS and IASI.

5.4.4 The time series and statistical analysis of intercomparison results allow the detection of abnormal bias, contamination problems, improvement of sensor characterization, e.g. in detecting a shift of the spectral response function. Errors can then be corrected or reduced in order to achieve consistency of the radiances data provided by the different instruments. Available results are provided on the GSICS website in selecting “Products”.

5.4.5 GSICS is developing a “GSICS Products and Services Roster” providing a description of its various outputs and intends to engage in a dialogue on this basis with the target user communities (climate and NWP) in order to adapt its activity as far as possible to the users needs.

5.4.6 The ICT-IOS welcomed the development of a GSICS Product and Services Roster and looked forward to having it used as a basis for future dialogue with user communities towards ensuring that GSICS deliverables are best suited to user needs.

6. STATUS OF SURFACE-BASED AND SPACE-BASED SUB-SYSTEMS OF THE GOS IN THE REGIONS

6.1 Status of the Surface-based Sub-System of the GOS in the Regions

6.1.1 Region I Status

6.1.1.1 Mr Mahaman Saloum, RA I Rapporteur on Regional Aspects of the Integrated Observing System, presented the status of the evolution of the GOS in RA I. He informed the session that the fourteen session of RA I held in Ouagadougou, Burkina-Faso, February 2007, adopted the CBS approaches and actions to evaluate the GOS in the Region, aiming to ensure adequate distribution of the RBSN and RBCN stations in order to fulfil the need of many meteorological applications, including the different ranges of weather forecasts, synoptic, aeronautical meteorology and climatology applications. In preparing its strategic Plan, RA I considered four relevant surface sub-systems (among the twenty-two indicated in the EGOS-IP) to support actions to evolve the GOS in Africa. The Association agreed on the revisions of the RBSN and RBCN proposed by the Working Group on Planning and Implementation of WWW in RA I (WG-PIW-RA-I).

6.1.1.2 RA I recognized the need and the necessity to distribute good SYNOP data from operational surface observing stations which are not currently exchanged internationally. To this end RA I identified 126 additional surface stations that carry out the full synoptic surface observing programme (eight daily SYNOP) and additional 92 CLIMAT stations.
6.1.1.3 With regard to the upper-air component of the RBSN, five new upper air stations were implemented through the African Monsoon and Multidisciplinary Analyses (AMMA). The AMMA project has been successful in implementing its upper-air programme with the re-activation of several stations through upgrading the radio sounding equipment at seventeen upper-air stations in West Africa. However, the Association has concerns about the sustainability of AMMA stations after the completion of the project.

6.1.1.4 AMDAR is considered to contribute significantly to the evolution of the GOS in Africa. The last session of RA I stressed the use of AMDAR ascent / descent data at major airports and endorsed that high priority be given to achieve implementation of a fully operational AMDAR programme in West and Central Africa. The E-AMDAR Programme is working in partnership with ASECNA for the development of a software solution for Air France’s long haul fleet to assist with the provision of AMDAR observations in the ASECNA group of countries.

6.1.1.5 Telecommunications are a concern in RA I. In some countries, particularly in northern Africa, South Africa and some Ocean Islands having good telecommunications, and the number of reports transmitted internationally is very good. However, many silent stations in the central part of Africa are a result of the lack of telecommunications facilities. Also the reduction of observing staff in many countries exacerbates the problem.

6.1.1.6 The ICT-IOS noted that:

a) The evolution of the GOS in Africa, and in developing countries in general, must take into account upgrading, restoring, substitution and capacity building, especially in the use of new technologies of observing systems that are less dependent on local infrastructure. In some circumstances those include satellite, AMDAR, dropsondes and AWSs. Nonetheless, a minimum set of reliable RAOBs is required as a backbone to the GUAN and RBCN; these are also used to validate satellite observations;

b) Migration toward the table driven codes (BUFR and CREX) as a reliable representation of the data is required;

c) The production of vertical profiles by AMDAR in many data sparse areas is worthy of testing.

6.1.2 Region II status

6.1.2.1 Mr Yongqing Chen, RA II Rapporteur on Regional Aspects of the GOS informed the ICT-IOS on the composition of the Regional networks and availability of their data.

6.1.2.2 The global AMDAR programme continues to make progress on implementing national and regional AMDAR programmes and to improve AMDAR coverage in data sparse areas. In RA II the AMDAR Program is operational in Saudi Arabia, China, Japan, Hong Kong China and Korea.

6.1.2.3 The ICT-IOS was advised that the marine VOS programme operated by a number of Members, including Hong Kong, China, India, Japan, Malaysia, and Singapore. Regarding ASAP the main concentration of operations continues to be over the Northern Atlantic (5153 launches in 2006). However, an important contribution is also made by Japanese research ships operating primarily in the North Western Pacific areas and seas adjacent to Japan (938 launches in 2006). In addition a number of RA II Members are participating in the Data Buoy Cooperation Panel (DBC), and operate drifting buoys in the Region.

6.1.2.4 The last RA-II-WG-PIW meeting reviewed the revision of the Volume II (Region II) of Manual on the GOS which was prepared by the Rapporteur. The revised version of the Volume II (Region II) of the Manual on the GOS will be submitted to the XIV-RA II session for consideration.
6.1.3 Region III status

6.1.3.1 Mr Gaston Torres, RA III Rapporteur on Regional Aspects of the GOS informed the ICT-IOS on the composition of the Regional networks and availability of their data.

6.1.3.2 The AMDAR program continues with little progress due to limited interest of the National Airlines and to technical limitations of data reception. At the moment there is interest in having a regional AMDAR Workshop, with the collaboration of the National Airlines.

6.1.3.3 The ICT-IOS noted that:

a) Continued efforts are needed to mobilize resources to maintain the surface-based networks in the Region;

b) Members should be encouraged to give more facilities to develop a regional AMDAR programme;

c) Specific actions should be identified by members for the evolution of the Regional GOS;

d) Members need to ensure that the highest priority goes to the maintenance and upgrading of the RBSN and RBCN;

e) Additional existing stations should be identified, that belong to National Meteorological Services or to other agencies of the respective countries, to improve the spatial resolution of the surface networks for monitoring and detecting meteorological changes on a local scale;

f) The evolution of the GOS in the Region must take into consideration the maintenance of weather stations in accordance with WMO recommendations. This may require local government assistance with finance for station maintenance and equipment acquisition.

6.1.4 Region IV status

6.1.4.1 Mr Werner Stolz, RA IV Rapporteur on Regional Aspects of the GOS, informed ICT-IOS on the composition of the Regional networks and availability of their data. The ICT-IOS noted the completeness of his report on matters related to the GOS.

6.1.4.2 The ICT-IOS noted that the Caribbean Meteorological Organization (CMO) radar project, funded by the European Union, was installing new radars to replace the old and obsolete radar network installed by the CMO in the late sixties and early seventies in the Caribbean. Four S-band Doppler radars will be phased into operations during 2008 in Barbados, Belize, Trinidad and Guyana. These new radars will provide a major contribution to the Early Warning System in RA IV.

6.1.4.3 The ICT-IOS noted that:

a) Investigation should be made why some generated reports are not properly transmitted to the monitoring centres;

b) More guidance should be provided on the BUFR migration, particularly to Central American and Caribbean countries, where information and capacity relating to BUFR migration is insufficient;

c) Members are encouraged to participate in GEONetCast activities;

d) Members need to be informed about the update of the METLAB software;
e) Many countries need assistance with the provision of radiosondes, due to their lack of funds for the purchase of radiosondes. This is particularly true in Central America, where only one country (Costa Rica) has a radiosonde station providing routine observations;

f) In Central America only Belize and Panama have radars and that a project to implement a radar network should be considered as a priority.

6.1.5 Region V status

6.1.5.1 Mr Sunarjo, RA V Rapporteur on Regional Aspects of the IOS informed ICT-IOS on the composition of the Regional networks and availability of their data.

6.1.5.2 In Region V, there is a potential for future expansion of the AMDAR programme on some flight routes, especially in New Caledonia and French Polynesia. Access to, and easy display of AMDAR data, especially in the smaller NMHSs, is critical elements to demonstrate the value of AMDAR data for operational use.

6.1.5.3 Of growing importance is the role and responsibility of the World Weather Watch and NMHSs to support Early Warning Systems (EWS), and, in particular, Tsunami Warning Systems (TWS) in the Pacific and Indian Ocean, and, more generally, to the WMO Disaster Risk Reduction Programme. Observations are an important part of Early Warning Systems and there are opportunities for improving both the observing systems themselves, and the communications systems for the distribution of information. It is important to note that in many countries the National Meteorological and Hydrological Services also act as National Tsunami Warning Centres.

6.1.5.4 ICT-IOS recognized a need for a low cost lightning detection system for the Region and requested Dr Barrell to bring this matter to the attention of the UK Met Office regarding the possibility of expanding its long-range lightning detection system to better cover RA V.

6.1.5.5 The ICT-IOS noted that:

a) Continued efforts to mobilize resources are needed to maintain the surface-based networks in the Region;

b) More specific actions are required by Members for the evolution of the GOS and commence monitoring of the Regional implementation of the plan;

c) Continued assistance is needed from the AMDAR Panel and Technical Coordinator to develop a regional AMDAR development plan.

6.1.6 Region VI status

6.1.6.1 In the absence of the report of the Coordinator of the RA VI Sub-Group on Regional Aspects of the IOS, Mr Dibbern, the chairperson of the WG-PIW-RA-VI, prepared a report of the status and plans of EUCOS covering major part of the Region. This report was presented by the Secretariat. The ICT-IOS was informed on the composition of the EUCOS networks and their performance monitoring.

6.1.6.2 The current period of the Programme has five year duration (2007-2011) and a two stage approach was proposed in the programme definition. During the Transition Phase (2007-2008) no new programmatic objectives had been set because amongst others the Space-Terrestrial Study which investigated the relative contributions of selected space-based and surface-based observing systems to the forecast skill of global and regional NWP models had to be finalised first in 2007. Throughout the second phase of the Programme (2009-2011) the revised EUCOS design will be implemented and the EUCOS operational system will be steadily improved.

6.1.6.3 The EUCOS network design proposed in 1999 has broadly been fully implemented during the
2002-2006 operational phase. In summary the 2007 EUCOS Network consisted of 2 ocean platforms, 16 ASAP units, 89 drifting buoys, 4 moored buoys, 408 VOS ships, AMDAR reports, 52 radiosonde stations and 209 surface synoptic stations.

6.2 Status of the Space-based Sub-System of the GOS in the Regions

6.2.1 With respect to the status of the space-based GOS in the Regions, it was considered that regional aspects were mainly related to data access and use by WMO Members.

6.2.2 In spite of the still limited response rate (84 Members have replied), the biennial questionnaire on satellite data availability and use by WMO Members provides a useful basis to identify the most relevant “limiting factors” and “expectations” in each Region, which should be responded by actions at the regional level.

6.2.3 Specific actions at the regional level are also needed more specifically to refine data access requirements and support the operational implementation of adequate DVB-S regional broadcast services responding to these data requirements. User information is also required, with emphasis on the data and products that are available in each region and guidance for their use.

6.2.4 The ICT-IOS considered that such regional issues were important, in particular for developing countries, and could be addressed with the active involvement of Regional Rapporteurs for the Space Programme and of the Centres of Excellence of the Virtual Laboratory; however, it expressed concern that the Secretariat would not be in a position to efficiently support and coordinate these important activities unless more staff resources were allocated to the Space Programme Office.

7. REVIEW OF OTHER IN-SITU SYSTEMS

7.1 The JCOMM Strategic Work Plan for Ocean Observations

7.1.1 The ICT-IOS was informed of the status of the JCOMM strategic work plan for building a sustained Global Ocean Observing System in support of the Global Earth Observation System of Systems. The plan is largely contributing to the ocean chapter of the GCOS Implementation Plan for the Global Observing System for Climate in support of the UNFCCC (GCOS-92) but other requirements such as for NWP, and marine services are also being considered. The ICT-IOS noted that the plan was being routinely reviewed and that some adjustments were under consideration to reflect its consistency with the WMO and IOC strategic plans, and that it fully addresses WIGOS issues.

7.1.2 The ICT-IOS noted with appreciation that JCOMM engaged in an effort to develop a catalogue on standards and best practices which should be presented to the third Session of JCOMM, to be held in Morocco in November 2009.

7.1.3 The ICT-IOS noted JCOMM’s efforts to develop global wave observing capabilities to address the requirements for Maritime Safety Services (MSS), calibration / validation of satellite wave sensors, the description of the ocean wave climate and its variability on seasonal to decadal time scales, and the role of waves in the coupled ocean-atmosphere system, and their inclusion in weather and climate models. The ICT-IOS invited JCOMM to develop links with the ET-SAT and ET-SUP in assessing satellite capabilities for obtaining this information.

7.2 Update on AMDAR Activities

7.2.1 The number of AMDAR profiles available in data sparse regions of Southern Africa, Eastern Europe, parts of the Russian Federation, South and East Asia and South America has increased significantly. The Global AMDAR Programme now exchanges approximately 240,000 to 260,000 observations per day on the GTS.
7.2.2. Mature operational programmes, such as the USA, Australia and European E-AMDAR are providing on-route AMDAR observations and profiles into identified data sparse regions as part of their contribution to the WMO WWW Programme. The E-AMDAR Programme is assisting with the provision of AMDAR profiles into Southern Africa, India, Singapore and the ASECNA group of countries. The WMO AMDAR Panel, in collaboration with Australia, New Zealand and the French Pacific Territories are in the early stages of establishing a pilot regional AMDAR Programme for the South West Pacific.

7.2.3 Following the implementation of the WMO Secretariat structure and organization change, a new Aircraft Observation Unit (AIR) was created, within the Observing and Information Systems Department (OBS) and its Observing Systems Division (OSD). The unit now has the responsibilities for aeronautical observations. Within the WMO Integrated Global Observing Systems (WIGOS), a WIGOS Pilot Project (PP) for AMDAR has been initiated with participation from the EUCOS and USA AMDAR Programmes. The PP will focus on the practices impacting AMDAR data collection, processing, archiving and dissemination.

7.2.4 The ICT-IOS agreed that for the integration of AMDAR into WWW programme and CBS working structure, there is a need for dedicated Expert Team on Airborne Observations (ET-AIR). The 11th WMO AMDAR Panel will review the ET-AIR Terms of Reference (TOR) and will inform the ICT-IOS on their conclusion regarding the establishment of the ET and/or wish to continue with the Rapporteur on AMDAR Issues. See Recommendation 7.2.4 of a possible new ET and Appendix XII for draft TOR of Rapporteur on AMDAR Issues, as appropriate.

7.2.5 Technical training workshops are forming an important part of the work of the AMDAR Panel. A South-East Asian Regional training programme will take place as part of the 11th AMDAR Panel meeting and the 5th Science and Technology Workshop will be hosted by the Malaysia Meteorological Department. A two and half day regional technical training workshop was held in Bucharest, Romania in November 2007 with 8 participating countries from Central and Eastern Europe. Additional workshops have been formally requested by the Russian Federation, Brazil and India.

7.2.6 NMHSs that have expressed an interest, or are actively working towards implementing their own AMDAR Programme include:

- **RA I.** Kenya, Mauritius, Morocco, the ASECNA Group of Countries
- **RA II.** India, Iran, Pakistan, Thailand, Russian Federation, United Arab Emirates
- **RA III.** Argentina, Brazil, Chile
- **RA IV.** Mexico
- **RA V.** Malaysia, Singapore, South-West Pacific counties (including French Polynesia and New Caledonia)
- **RA VI.** Austria, Bulgaria, Croatia, Czech Republic, Hungary, Iceland, Ireland, Italy, Poland, Portugal, Romania, Spain, Ukraine

7.2.7 The ICT-IOS noted that the current AMDAR coverage and number of AMDAR observations being reported could be reduced as airlines replace aging AMDAR equipped aircraft with more modern aircraft that are at present not able to support the existing suite of AMDAR software. The ICT-IOS made the recommendation that CBS support a proposal for the AMDAR Panel and WMO to request funds from WMO Members to develop a generic AMDAR software solution for all aircraft makes and models (see Recommendation 7.2.7).

7.2.8 It was noted that one of the best opportunities to provide upper-air observations in those areas that have been identified as being data sparse is the provision of AMDAR data from operational AMDAR Programmes. A recommendation to encourage all operational AMDAR Programmes to collect and distribute AMDAR data outside their national territories as part of their contribution to WWW was approved by ICT-IOS (see Recommendation 7.2.8).

7.2.9 ICT-IOS recognized a need for increased horizontal density of radiosondes and/or AMDAR observations, particularly over Africa and generally across the tropics (see Recommendation 7.2.9a). It also supported the AMDAR Panel with its data sharing negotiations with third party data providers,
such as TAMDAR, for the provision of upper-air data to the global meteorological community via the GTS (see Recommendation 7.2.9b).

7.3 Update on the GCOS Networks (GRUAN, CBS Lead Centers for GCOS)

7.3.1 The report prepared by Mr Matthew Menne was presented by the Secretariat. The ICT-IOS was informed that GCOS will issue a report on progress with the GCOS Implementation Plan by June 2009. This report is being developed at the request of UNFCCC SBSTA. Additionally an update of the 2004 GCOS Implementation Plan - conceived to cover a 5-10 year period - is also planned, possibly associated with a review of GCOS observation requirements.

7.3.2 The ICT-IOS was advised that the GCOS Reference Upper Air Network (GRUAN), a specialized network building on the GCOS Upper Air Network, is being developed. This small network of 30-40 reference sites will provide long-term high quality climate records to constrain and calibrate data from more spatially-comprehensive global observing systems. The Richard Aßmann Observatory in Lindenberg has been designated by WMO as the lead centre for the GRUAN network.

7.3.3 The first Coordination Meeting of the CBS Lead Centres for GCOS was held in Teheran, Iran in November 2007. Revised Terms of Reference of the CBS Lead Centres for GCOS have been developed. The ICT-IOS approved the revised terms of reference for submission to CBS-XIV for consideration (see Recommendation 7.3.3a). The coordination Meeting also updated the list of CBS Lead Centres for GCOS and their areas of responsibility. This list was reviewed by ICT-IOS, and adopted for submission the CBS-XIV (see Recommendation 7.3.3b).

7.3.4 ICT-IOS was informed of the current status of the investigation into the discontinuation of CLIMAT TEMP reports. The ICT-IOS requested that it be kept informed of progress with this activity.

8. IMPACT STUDIES

8.1 Impact of New Instrumentation

8.1.1 Mr William Nyakwada, Co-Rapporteur on the impact of new instrumentation on the GOS, presented the report on the Impact of New Instrumentation. He advised ICT-IOS that following a decision taken at CBS-Ext.(06), a questionnaire on the Impact of New Instrumentation on the GOS was prepared and issued in 2007. Fifty Members responded to the questionnaire.

8.1.2 Despite the relative low response (only 30% of the potential number of returns were received), overall expenditure on observational systems was higher than in 2006, both in terms of new equipment and upgrades; though more particularly with new systems. A high proportion of the funding came directly from the Members (though not always the NMHS), a welcome trend.

8.1.3 The questionnaire summary highlights that a global priority appeared to be in investment in AWS systems, since some 72% of all respondents had introduced new/additional AWS systems and some 22% had upgraded AWS systems during the period in question. Satellite reception equipment and upper air systems were the next highest categories for investment though there were some
individually high investments in equipment such as next generation Radar by a few Members.

8.1.4 The ICT-IOS requested Secretariat to provide detailed responses to the Questionnaire to the Rapporteurs on regional Aspects of the GOS.

8.2 Observing System Experiments and Observing System Simulation Experiments

8.2.1 Dr Jean Pailleux, Co-Rapporteur on Scientific Evaluation of OSEs/OSSEs, reported to the ICT-IOS that the 4th Workshop on the Impact of Various Observing Systems on NWP was held in Geneva in May 2008. The results, conclusions and recommendations were compiled and discussed during ET-EGOS-4, Geneva in July 2008. The Workshop proceedings (24 scientific papers, plus a summary report) are ready for publication as a CD-ROM and will be available from the WMO WWW web site.

8.2.2 Compared to the previous workshop (Alpbach, 2004), the main conclusion is about the emergence of new satellite systems (hyperspectral infra-red sounders, GPS radio-occultation systems) whose global impact has now the same magnitude as (e.g.) AMSU-A.

8.2.3 A set of recommendations were produced from the Workshop results. They fall into three categories:

- Recommendations about the interaction between NWP centres, data providers and data users;
- Recommendations about observational data requirements;
- Recommendations about future studies.

8.2.4 The Workshop found that an important tendency of the period 2004-2008 has been the appearance of new observing systems (especially from satellites), the individual impact of most individual observing systems has decreased compared to 2004, but the total impact of the combined observing systems has improved, and the GOS is now more robust because of the variety and quality of instruments available.

8.2.5 The ICT-IOS agreed with the Workshop’s conclusions including a proposal to hold the 5th Workshop in 2012 and adopted Recommendation: Rec. 8.2.5 “4th Workshop on the Impact of various Observing Systems on NWP”.

9. REPORTS OF THE ICT-IOS EXPERT TEAMS

9.1 Report of ET-AWS

9.1.1 The ICT-IOS was advised of outcomes from the Fifth session of ET-AWS, held at WMO Headquarters, Geneva, Switzerland, from 5 to 9 May 2008. The expert team considered issues requested by CBS-Ext.(06), including the agreed work plan for the team, and formulated five recommendations for submission to CBS-XIV.

Achievements

9.1.2 The following major achievements were recorded:

a) The Functional Specifications for Automatic Weather Stations were reviewed and updated based on the proposals of other technical commission

b) The ET-AWS agreed on the principal conclusions regarding the Requirements for a robust AWS suitable particularly to remote location.

c) Preliminary draft of the Requirements for AWS sensors to contribute to the calibration and ground truth of space-based observations was developed and submitted to ET-SAT and ET-
SUP for consideration. Further development on this issue should be subject to their recommendations.

d) The ET-AWS discussed generic and sensor specific requirements for existing as well as new sensors which would improve the capability of AWS to report meteorological parameters addressing user requirements. The ET-AWS recognized that the work should continue to finalize the requirements.

e) A method was discussed that has a potential for use in the selection of observing stations for RBSN/RBCN and for the continuous optimization of these networks. The ET-AWS agreed on the need to further investigate the suitability of this technique by its testing on the existing RBSNs/RBCNs.

f) Guidelines concerning the transition to specific automated observations were considered and a preliminary draft of the Guidelines and procedures to assist in the transition from manual to automatic surface observing stations was elaborated.

g) The ET-AWS considered the development of four AWS metadata catalogues and agreed to continue further in their development.

h) The need for the Guidelines for the Siting classification of Surface Observing Stations (not only of AWS) was considered. The ET-AWS recommended that further work be done on the Siting Classification in close collaboration with CIMO, with the objective to be validated by CBS and then included in the Manual of the Global Observing System (WMO-No. 544) and Guide to Meteorological Instruments and Methods of Observation (WMO-No. 8). Following approval by CBS, a joint ISO/WMO standardization should be explored.

i) The list of the Basic set of variables to be reported by a standard AWS for multiple users was finalized based on the proposals received from other technical commissions.

j) A preliminary review of BUFR descriptors was done. The ET-AWS expressed its opinion that the meaning of BUFR descriptors should be clear to data users and should be transparent to standard terminology of the WMO Technical Regulations. Regarding a type of measurement/observation, there should be clear reference to the Guide to Meteorological Instruments and Methods of Observation (WMO-No. 8). The ET-AWS reviewed the BUFR descriptors related to AWS metadata transmission and identified those metadata for which BUFR descriptors do not exist.

k) The ET-AWS considered the “merged” BUFR template for surface observations from one-hour period and for reporting SYNOP data in BUFR including proposed national station identification and recommended that its validation should be done as a matter of urgency.

l) The ET-AWS discussed in details the Vision for the GOS in 2025 (surface component) and proposed additions to the draft Vision, which was submitted to ET-EGOS for consideration and finalization.

m) As requested by ET-EGOS (Action G21 (a) of the EGOS-IP), a list of advances in AWS technology (as well as limitations) was elaborated, however it requires continuous monitoring.

n) As requested by ET-EGOS (Action G21 (b) of the EGOS-IP), the ET-AWS addressed the evolution of the AWS network (see items 2, 4, 5, 6, 8 above).

**Issues**

9.1.3 ET-AWS reported that within the CBS working structure there is no dedicated expert team dealing with the operational issues related to surface observing networks. The ET-AWS identified this
as a potential problem and decided to address network issues related to AWS implementation and operation.

**Recommendations**

9.1.4 The ICT-IOS discussed recommendations proposed by ET-AWS and agreed to provide Recommendations: Rec. 9.1.4 a) “BUFR descriptors for Functional Specifications for AWS”, Rec. 9.1.4 b) “AWS metadata catalogue” and Rec. 9.1.4 c) “Siting classification” to CBS-XIV for endorsement and Recommendations: Rec. 9.1.4 d) “Function Specification for AWS” and Rec. 9.1.4 e) “Basic set of variables for standard AWS” for considerations by CBS-XIV. The ET-AWS also proposed a Work Plan for its work for the period 2009 to 2011 (see agenda item 13.3).

9.2 Report of ET-EGOS

9.2.1 During the last two years, the Expert Team on Evolution of the Global Observing System (ET-EGOS) held two meetings, both in Geneva: ET-EGOS-3, 9-13 July 2007, and ET-EGOS-4, 7-11 July 2008. During this period the work of the ET has focussed on:

- reviewing progress on several activities related to Integrated Observing System, such as WIGOS, GEO/GEOSS, WWRP-THORPEX, International Polar Year (IPY), AMMA, AMDAR, GCOS, EUCOS, and ET-AWS;

- as part of the Rolling Review of Requirements process; reviewing and updating the WMO/CEOS databases of user requirements for observations and of observing system capabilities, and reviewing and updating the Statements of Guidance (SoGs) in several application areas;

- reviewing progress on studies through which real and hypothetical changes to the GOS are assessed for their impact on NWP performance, mainly through organization of and consideration of outcomes from the 4th WMO Workshop on “The impact of various observing systems on numerical weather prediction”, Geneva, 19-21 May 2008;

- reviewing and updating the Implementation Plan for the Evolution of the GOS (EGOS-IP), including consideration of input from relevant bodies, such as other IOS ETs, WMO Regional representatives, and WMO Members via the newly-created National Focal Points (NFPs);

- preparing, in consultation with other IOS ETs and interested parties, a “Vision for the GOS in 2025”.

**Achievements**

9.2.2 The following major achievements were recorded:

a) Updating and reporting on observational data requirements:
   - Sections of the CEOS/WMO database of user requirements relating to the observational needs of WMO Programmes have been reviewed and updated as necessary.
   - For each user requirement, a “breakthrough” value has been added, in addition to the “threshold” (minimum) and “optimum” (maximum) values.

b) Reviewing and reporting on the capabilities of both surface-based and space-based systems that are candidate components of the evolving composite GOS:
   - Sections of the CEOS/WMO database of observing system capabilities have been reviewed. Some updates have been made for surface-based observing systems. (ET-SAT has taken the lead in the review of the space-based systems.)
c) Carrying out the Rolling Review of Requirements (RRR):
   • As outputs of the RRR process, Statements of Guidance (SoGs) have been maintained and updated for 10 application areas: global NWP, regional NWP, synoptic meteorology, nowcasting and very short-range forecasting, seasonal and inter-annual forecasting, aeronautical meteorology, climate monitoring, ocean applications, and agrometeorology, hydrology and water resources, atmospheric chemistry.
   • For climate monitoring, it was agreed to adopt the GCOS Adequacy Reports as the SoG, and then to respond to relevant items in the GCOS Implementation Plan.
   • The RRR process for other climate applications is currently under consideration by CCI but has not yet resulted in a draft of SoG.

d) Reviewing out studies of hypothetical changes to the GOS:
   • Results of impact studies conducted by NWP centres and by participants in THORPEX have been kept under review.
   • The 4th WMO Workshop on “The impact of various observing systems on numerical weather prediction” was organised and held in Geneva, 19-21 May 2008.
   • Outcomes of the Workshop have been analysed in terms of their implications for the evolution of the GOS.

e) Maintaining and updating the Implementation Plan for Evolution of the GOS (EGOS-IP):
   • At each ET-EGOS meeting, EGOS-IP has been reviewed and updated, as a record of progress against the original Plan distributed to Members. Updates have taken account of feedback from many sources including: AMDAR Panel, JCOMM, GCOS, other IOS ETs, WMO Regional representatives, and WMO Members via the newly-created National Focal Points (NFPs).
   • The latest version of the EGOS-IP, updated at ET-EGOS-4, is at Appendix II.

f) Preparing documents to assist Members, summarizing the results from the above activities:
   • The results of these activities are available to Members via the web in the form of:
     o an online databases of user requirements and observing systems capabilities,
     o the latest approved versions of the Statements of Guidance,
     o the report of the 4th WMO Workshop on “The impact of various observing systems on numerical weather prediction”,
     o the latest version of the Implementation Plan for the Evolution of the GOS.

g) Revised Vision for the GOS.
   • The ET led the preparation of a new “Vision for the GOS in 2025”. The version proposed for adoption by CBS is at Appendix III.

h) Contributing to WIGOS planning.
   • The ET has responded to requests to contribute to WIGOS activities. In particular ET-EGOS-3 developed proposals for WIGOS Pilot Projects.

i) Interacting with GCOS.
   • The ET reviewed the proposal for a GCOS Reference Upper-Air Network (GRUAN).

j) GOS performance statistics
   • The ET reviewed available GOS performance statistics and proposed some improvements to procedures.

k) Long-range surface-based remote sensing lightning detection systems.
   • The ET considered the potential of these systems as a cost-effective component of the evolving GOS and made appropriate reference to them within EGOS-IP and within the new “Vision”.

l) AMMA, IPY and THORPEX.
   • The ET has started to consider plans to sustain key components of AMMA, IPY and THORPEX observational networks beyond the end of their respective experiments. Concerning AMMA, the ET recommended that the leadership of the current AMMA management group be progressively taken over by ASECNA on behalf of the West African NMHSs involved in AMMA, and that ASECNA should work with two or three NWP centres to carry out detailed monitoring of AMMA radiosondes.

m) Maintaining a web page
   • A web page “Redesign of the GOS” has been maintained, containing links to: ET-EGOS Terms of Reference, Work Plan and Actions List; Statements of Guidance; the Implementation Plan for GOS Evolution; the Vision for the GOS; final reports from meetings and other material.

Issues

9.2.3 The ET-EGOS reported the following issues:

a) The ET would expect to interact with forthcoming WIGOS activities, but the nature and scope of this interaction is not yet clear.

b) The RRR process conducted by the ET is concerned primarily with initiating action to improve the observing system. It is not concerned with improving the availability and use of existing observations (although a few aspects of EGOS-IP are concerned with these issues). Consideration should be given to a parallel RRR process to improve the availability and use of observations.

c) In support of a previous recommendation, the ET encourages the establishment of a long-term management group for the AMMA radiosonde.

d) The ET encourages the establishment of a global solution for optimization of AMDAR.

e) The ET expressed concerns regarding the resources available to the Secretariat for maintaining and updating the CEOS/WMO databases, recalling that these databases are important for the work of the NMHS and are expected to play even a greater role in the context of WIGOS.

f) The ET noted that only 37 Members had nominated National Focal Points for reporting on EGOS-IP actions and that, of these, only 13 had submitted reports. Whilst analysis of these reports has provided useful information, ways of improving the engagement of Members with this process should be considered.

g) The ET noted recent developments in Space Weather, including a paper for EC-LX on this topic. The ET considered it premature to initiate the RRR process for this area, but invited ET-SAT and ET-SUP to consider the topic.

h) Assuming that the new “Vision for the GOS in 2025” is adopted by CBS, a new version of the EGOS-IP will be required in response to the new “Vision”. The ET seeks the endorsement for a restructuring of EGOS-IP for consistency with the new “Vision”.

Recommendations

9.2.4 The ICT-IOS discussed recommendations proposed by ET-EGOS and agreed to provide Recommendations: Rec. 9.2.4 a) “China’s new polar satellite FY-3A”, Rec. 9.2.4 b) “Statements of Guidance for Climate Monitoring”, Rec. 9.2.4 c) “WIGOS Pilot Project for GRUAN”, Rec. 9.2.4 d) “Addressing aspects of the EGOS-IP”, Rec. 9.2.4 e) “IPY”, Rec. 9.2.4 f) “Collocation of wind and wave sensors”, Rec. 9.2.4 g) “Barometers on drifting buoys”, Rec. 9.2.4 h) “Distribution of hourly
9.3 Report of ET-SAT

9.3.1 The fourth session of the Expert Team on Satellite Systems (ET-SAT) and of the Expert Team on Satellite Utilization and Products (ET-SUP) met in Langen, Germany, 2-5 September 2008. The session was held partly in a joint meeting and partly in parallel meetings of the two Expert Teams. In addition, the meeting was attended on 2 September by members of the Virtual Laboratory Management Group.

9.3.2 Primary objectives for the session were to provide guidance on the main activities of the WMO Space Programme from a satellite system point of view. For this purpose, the session reviewed the status of operational and R&D satellite programmes and the gap analysis with respect to WMO requirements; discussed on information on satellite products availability; refined the new Vision for 2025 for the space-based component of the GOS; discussed the strategy for transition of R&D instruments to operational missions; reviewed user information activities; considered Space Weather issues and discussed the status and plans for the database on observational requirements and observing system capabilities.

Achievements

9.3.3 The following major achievements were recorded:

a) In September, 2007, a review of satellite capabilities and plans was performed, as well as a Gap Analysis evaluating the planned capabilities for the next two decades against user requirements. This was provided as input to ET-EGOS as a reference material to initiate the new Vision for the GOS in 2025.

b) CM recommendations were systematically recorded and taken into account. In particular, in response to CM requests, ET-SAT has: a) addressed the strategy for transition of R&D missions to Operational status and developed a set of guidelines in this matter; b) reviewed and supported proposed test cases for cooperative projects on Highly Elliptical Orbit missions for high-latitude monitoring, in the framework of IGEOLAB; and c) advised on the potential involvement of WMO in Space Weather issues.

c) ET-SAT designated points of contacts who volunteered to assist in the development and update of SoGs through providing advice on satellite-related aspect.

d) ET-SAT has developed the rationale for an expansion of the space-based component of the GOS. In order to assess the response to these requirements, it has reviewed current plans for the coming decades, monitored a detailed Gap Analysis and has identified continuity issues. It has suggested a re-design of the GOS and thoroughly reviewed the space-based part of the new Vision for the GOS in 2025.

e) ET-SAT performed a thorough review of the GCOS Implementation Plan and its Satellite Supplement and subsequently developed a response that triggered a number of actions: a) new Vision for the GOS; b) development of R/SSC-CM; and c) new emphasis on calibration activities.
9.3.4 The ET-SAT reported the following issues:

a) Reviewed the space-based component of the Vision for the GOS in 2025 and considered that this Vision represented a major step towards the sustainable availability of satellite data for weather and climate applications and other WMO needs, reinforcing the role of the GOS within the Global Earth Observation System of Systems; it recommended that the Vision, with some proposed clarifications, be submitted to the fourteenth session of CBS in March 2009 for adoption.

b) Considered a set of four documents describing respectively the status of the space-based component of the GOS, the instruments characteristics, the Gap Analysis and the expected product accuracy; the meeting was convinced that this outstanding technical documentation would be a useful reference for planning purpose and recommended that it is maintained in the coming years.

c) Emphasized that the transition from R&D missions and instruments to operational status was a critical process to ensure long-term sustainability of the GOS, highlighted a number of pre-requisites for a smooth transition related to three different aspects of this transition: (i) Instrument technology readiness to support operations; (ii) Maturity level of the applications and user preparedness; (iii) Programmatic status and associated commitment on continuity. Subsequently, in response to the Consultative Meetings on High-level Policy on Satellite Matters, the session has derived guidelines for WMO action to facilitate the transition from R&D to operational status (see Appendix IV):

d) Expressed concern that the CEOS-WMO Database on User Requirements and Observing Capabilities cannot be updated because of lack of staff resources within the Space Programme Office; confirmed that the database should be further maintained as it was the basis for the Rolling Review of Requirements and should play an even greater role with WIGOS; recommended to redesign the current database and to secure resources for its further maintenance.

e) Was informed on preliminary WMO activities regarding Space Weather, including the report on the potential role of WMO in Space Weather. In response to the Executive Council’s request that CBS and the Commission on Aeronautical Meteorology (CAeM) develop work plans for supporting Space Weather activities, with extra-budgetary resources, the session suggested that an Inter-Commission Team be established among CBS and CAeM to look after Space Weather matters; the team would include satellite and aeronautical meteorology experts and representatives of the Space Weather Community.

f) Reviewed the status of the three candidate IGeoLab initiatives; acknowledged the strong interest expressed for an IR Hyperspectral demonstration mission; was informed of the forthcoming Focus Group meeting for the geostationary microwave initiative (Beijing, 15-16 October 2008); and encouraged agencies to participate in the Focus Group meeting of the Highly Elliptical Orbit candidate initiative tentatively planned in November 2008.

g) Welcomed the initiative of the Expert Team on Automatic Weather Stations (ET-AWS) to consider the potential of AWS networks to support calibration of space-based observations and product validation; confirmed the importance of ground-truth data considering that such measurements could support validation or quality monitoring of geophysical products level 2 data or above; expressed interest in investigating further this opportunity which seemed particularly timely in the context of WIGOS and took action to provide consolidated comments after circulation to ET-SUP and ET-SAT Members.
Recommendations

9.3.5 The ICT-IOS discussed recommendations proposed by ET-SAT and agreed to provide Recommendations: Rec. 9.3.5 a) “Guidelines to WMO for facilitating the transition of relevant R&D missions” to CBS-XIV for endorsement. In addition the ET prepared a draft Work Plan for its work during the period 2009 to 2011 (see agenda item 13.3).

9.4 Report of ET-SUP

9.4.1 Mr Wolfgang Benesch, Acting Chairperson of ET-SUP, advised the ICT-IOS that the fourth session of ET-SUP took place, partially jointly with ET-SAT, from 2 to 5 September 2008 at the Training and Conference Centre of the Deutscher Wetterdienst (DWD) in Langen, Germany. Major topics discussed were: a new Virtual Laboratory (VL) Training Strategy for the next 5 years; preparations for new Centres of Excellence in Pretoria (South Africa) and Russia; the progress of the Regional ATOVS Retransmission Services (RARS) and Integrated Global Data Dissemination Service (IGDDS) projects; the analysis of the 2008 edition of the biennial questionnaire on the status of availability and use of satellite data and products by WMO Members in the period 2006-2007; input to ET-SAT regarding the New Vision of the Space-based Component of the GOS; and improved user information on satellite product availability with focus on data of R&D satellite missions and related education and training in their use.

Achievements

9.4.2 The following major achievements were recorded:

a) In following the Rolling Review for the Strategy to Improve Satellite System Utilization, a TD on status of the availability and use of satellite data and products by WMO Members for the period 2004-2005 was published (WMO-TD No. 1423; WMP Space Programme SP-4); a preliminary analysis of the 2008 edition of the biennial questionnaire on availability and use of satellite data and products by WMO Members covering the period 2006-2007 was completed with the aim to publish the final analysis as a WMO TD by January 2009.

b) Interacting with the IGDDS Implementation Group, ET-SUP-3 (2007) reviewed plans and progress of both the IGDDS and RARS projects through the outcomes of the respective Implementation Groups. Regarding IGDDS, it expressed a strong view that there was a primary requirement for “GEO imagery over the region” that should be provided in every region on all components of the IGDDS, including through DVB-S satellite broadcast service. ET-SUP-4 (2008) raised an action to bring to the attention of CGMS the threat to DVB-S coverage for S. America posed by the foreseen withdrawal of the EUMETCast-Americas component of the IGDDS and the limitations of the GEONETCast-Americas component.

c) In reviewing present and future R&D satellite data and products including their availability and application towards better utilization by WMO Members, ET-SUP-4 discussed ways to enhance user information on data and products availability, with particular emphasis on R&D data and products.

d) As regards the representation of WMO Member needs to the CGMS/WMO Virtual Laboratory for Satellite Data Utilization (VL) in relevant areas, ET-SUP-3 (2007) considered the outcome of the recent Virtual Laboratory Management Group meeting (VLMG-3), including a review of lessons learnt from the HPTE along with other recommendations and actions raised by the VLMG. In particular, the ET-SUP considered the importance of the role of Regional Focus Groups and reviewed progress towards their establishment involving all VL partners. The status of other training activities, both past and planned, was reviewed taking account of the progress towards routine involvement of VL materials, tools and techniques. ET-SUP-4 (2008) took note of further progress with the implementation of the VL, in particular the establishment of Regional Focus Groups (RFG) African Centers of Excellence (CoEs) (Niamey, Nairobi) and Oman (Muscat) and regular RFG Activities in Americas and Caribbean.
It further noted the expansion of the network of CoEs to include Russia and South Africa. An expression of interest in becoming a CoE was also received from India (ISRO). The fourth meeting of the VL Management Group (VLMG-4), collocated with ET-SUP-4, generated the draft of a new 5-year Training Plan for review by ET-SUP. ET-SUP revised the strategy that should allow the VL to better address the needs of WMO in meteorology and other related application areas. The expansion of the VL will allow better addressing the needs of WMO Members in all Regions and all WMO languages.

e) As concerns further clarification of Information Needs of WMO Members regarding access to and utilization of satellite data and products and the associated capacity building, and best way to meet these requirements, ET-SUP-4 (2008) initiated, in conjunction with the WMO Space Programme Office, several actions to address the provision of information for WMO Members both via the WMO Space Programme web pages and also through enhancements to the proposed web pages comprising the Virtual Resource Library (VRL).

f) In order to further the concept of Regional/Specialized Centres on Satellite Products, ET-SUP-3 (2007) reviewed the evolution of the concept of Regional/Specialized Satellite Centres for Climate Monitoring (R/SSC-CM) and the draft Implementation Plan. It proposed that the outcomes and benefits of R/SSC-CM be reviewed after two years prior to extending the concept to other areas such as air quality. ET-SUP-4 (2008) conducted a further review of the progress made towards the implementation of the R/SSC-CM noting the outcome of the Planning Meeting held in Darmstadt, Germany, in April 2008. The extant action to consider extending the concept based on the experiences of the R/SSC-CM – treating that as a pilot project – was confirmed and given a due date of 2009.

g) Regarding further expansion of the space-based component of the GOS baseline to include sustained observations of additional variables as required for climate monitoring work jointly with ET-SAT and ET-EGOS, ET-SUP-3 and ET-SAT-3 (2007) carried out a joint discussion of the re-design of the space-based GOS, which led to the development of a new Vision for the GOS. This action has been actively pursued with ET-SAT lead, and input provided by ET-SUP.

h) In further developing the “R&D to operations transition” concept and the identification in more detail the role WMO could assume, ET-SUP-3 and ET-SAT-3 (2007) acknowledged that in the new Vision for the GOS many capabilities currently relying on R & D missions without any long-term commitment would then be required on an operational basis. The Session highlighted several aspects of the transition: technology evolution from demonstration to pre-operational and operational stage, programmatic implications of the change from a research objective to an operational objective, user involvement and preparedness. The role of WMO in this process was emphasized. In a similar way, the collocation of ET-SUP-4 and ET-SAT-4 (2008) allowed this joint discussion to be pursued. The session agreed on guidelines for the role of WMO to facilitate this transition.

i) As regards the preparation of documents to assist Members, summarizing the results from the above activities, ET-SUP noted, in reviewing the WMO Space Programme web pages, the recent developments in which a large number of documents, covering the full range of WMO Space Programme activities, are now presented for public consumption in a user-friendly layout. The ET-SUP members reviewed the status of the draft technical document on the Status of WMO Members Use of Satellite Data and Products for the years 2004 and 2005. The ET-SUP prepared and published the Technical Document containing the analysis of the 2007 edition of the user questionnaire.

Issues

9.4.3 The ET-SUP reported the following issues:
a) The WMO Space Programme is currently not adequately resourced to properly support the planned training and education activities as elaborated through the VL strategy and ET-SUP work plan.

b) In their responses to the biennial questionnaire on availability and use of satellite data a relatively high number of WMO Members reporting lacks or deficiencies, for example financial difficulties as a limiting factor influencing education and training in satellite meteorology. Follow-on actions should be initiated vis-à-vis those Members reporting problems.

c) The biennial assessment of the status of availability and use of satellite data and products by WMO Members could be more representative if the return rate were increased. Involvement of the Regional Rapporteurs to the WMO Space Programme could help to achieve a higher return rate.

d) Users from South America have a requirement for level 1 satellite data which are currently available via EUMETCast-Americas, but not from GEONETCast-Americas; however the availability of EUMETCast-Americas is limited.

Recommendations

9.4.4 The ICT-IOS discussed recommendations proposed by ET-SUP and agreed to provide Recommendations: Rec. 9.4.4 a) “Virtual Laboratory”, Rec. 9.4.4 b) “Satellite data deficiencies” and Rec. 9.4.4 c) “Satellite data and utilisation questionnaire”, Rec. 9.4.4 d) “EUMETCast-Americas” to CBS-XIV for endorsement and Recommendation and Rec. 9.4.4 e) “VL Training Strategy” for considerations by CBS-XIV. In addition the ET prepared a draft Work Plan for its work during the period 2009 to 2011 (see agenda item 13.3).

10. EVOLUTION OF THE GOS AND VISION FOR THE GOS IN 2025

10.1 The ICT-IOS reviewed the report on progress on the “Implementation Plan for the Evolution of the Surface-based and Space-based Sub-systems of the GOS” (EGOS-IP) and the “Vision for the GOS in 2025”. Revised versions of these, with changes agreed at the meeting, are at Appendix II) and Appendix III respectively.

10.2 Several new actions have been identified for addition to the Plan, such as the development of in-situ wave observations, increase in time resolution of SST data, consolidation of the VOSClim fleet, involvement of GRUAN, expanded BSRN and improved accuracy of remotely sensed precipitation.

10.3 Recent ET-SAT and ET-SUP sessions have endorsed the report on progress on the EGOS-IP.

10.4 Some actions implied by the report on progress on the EGOS-IP have resulted in several recommendations (see Rec. 9.2.4 h), Rec. 9.2.4 i), Rec. 9.2.4 j), Rec. 9.2.4 k) and Rec. 9.2.4 l).

10.5 The ICT-IOS was briefed on the development of the “Vision for the GOS in 2025” being led by ET-EGOS. Many comments have been received from the ICT-IOS expert teams and other collaborators, and have been incorporated into the current version of the Vision which will be submitted to CBS-XIV for consideration (see Recommendation 9.2.4 o)).

10.6 ICT-IOS approved the report on progress on the revised EGOS-IP, and requests that it be submitted to CBS-XIV for endorsement (See Recommendation 9.2.4 p).
10.7 Assuming that the Vision for the GOS in 2025 is endorsed by CBS-XIV, the ICT-IOS requests that CBS-XIV additionally request a new version of EGOS-IP be prepared that will incorporate the information included in the Vision (see Recommendation 9.2.4 p).

11. FUTURE COMPOSITE GOS AND ITS IMPACT ON DEVELOPING COUNTRIES

Issues related to composite GOS and impact on developing countries were discussed while addressing Status of the GOS in Regions, Implementation Plan for the Evolution of the GOS and the Vision for the GOS in 2025 (see relevant agenda items for details).

12. UPDATES OF THE GOS-RELATED REGULATORY MATERIAL

12.1 The Rapporteur on GOS-Related Regulatory Material informed that, as requested by CBS-Ext.(06), the revised Guide of the GOS (WMO No. 488) was published in 2007. In addition Volume II of the Manual on the GOS (Regional Aspects) is currently in the process of adoption by the Regional Associations, and that RA I, V and VI already approved their parts of the Volume II of the manual on the GOS.

12.2 The ICT-IOS agreed that revisions of the Manual and the Guide on the GOS may be needed following the approval of WIGOS concept by Cg-XVI in 2011.

12.3 The ICT-IOS considered inclusion of relevant information gained through WMO observing experiments, such as THORPEX and IPY in the GOS regulatory material. The possible placeholder would be the Preamble to the Manual on the GOS.

12.4 The ICT-IOS noted that there are differences in certain elements among the Regions in the Manual on the GOS, Volume II, where a certain level of consistency may be needed. For instance, better harmonization of criteria for inclusion of stations in the RBSN/RBCN, classification of stations, procedures for updating and amending the RBSN/RBCN and basic definitions may benefit from regional harmonization. While fully acknowledging the need for Regional differences, the ICT-IOS requested the Rapporteur on Regulatory Material to coordinate with all the Rapporteurs/Coordinators on the Regional Aspects of the GOS regarding possible harmonization of Regional differences and provide a report to the next ICT-IOS (see Recommendation 12.4 “Harmonization of Regional sections of Volume II of the Manual on the GOS”).

12.5 To assist Rapporteurs with the design and optimization of RBSNs/RBCNs, the ICT-IOS suggested that one or two simple tools be developed. These tools would also allow for harmonizing the criteria for inclusion of new stations in the regional networks, classification of existing stations according to their information weights (meteorological and economical impacts) and estimating the degradation of networks in the case of removal of existing operational stations from regional networks. ICT-IOS requested Dr Eyre and Dr Pailleux to propose a technical specification for this task. A report on progress will be prepared by 5 November 2008 and based on this the WMO Secretariat may request the services of a contractor to address this issue (see Recommendation 12.5 “Tools for design and optimization of RBSNs/RBCNs”).

12.7 The ICT-IOS was informed on the current status of the revised WMO-No. 9, Volume A application. A revised version of Volume A was developed as a standalone Oracle application. It was implemented in late 2007 on a dedicated PC within the Observing Systems Division (OSD) in the Secretariat. Preliminary tests conducted by Secretariat staff were satisfactory with the application not showing any obvious deficiencies. It was concluded that the Application in its current mode has great potential and could completely replace the present operational version of Volume A.

12.8 As a standalone Oracle application on a dedicated computer, used only for test purposes, the application does not require an Oracle DBMS license or an Oracle APP server license. However, for operational use, it requires an Oracle Database administrator, appropriate licensing, a stable environment that would guarantee regular maintenance, development and administrator support with backups and disaster recovery services. With the Oracle servers within the Secretariat now
outsourced to the United Nations International Computing Centre (UNICC), the implementation of the redesigned Volume A within the Secretariat is not possible.

12.9 The ICT-IOS discussed various scenarios for implementation of the redesigned Volume A and concluded that the most reasonable solution is to continue for now with the old Access-based version of Volume A currently ported on WMO computer platforms. It requested the Secretariat to try to find a major RSMC that would be prepared to host Volume A free of charge on behalf of WMO. However, the ownership should remain with WMO (see Recommendation 12.6 “WMO-No. 9, Vol. A”).

13. PREPARATION OF OPAG-IOS INPUT FOR CBS-XIV

13.1 Review of the Terms of Reference of the ICT-IOS and its Expert Teams

13.1.1 The ICT-IOS reviewed its own Terms of Reference for itself and those of its Expert Teams. The draft Terms of Reference were adopted for submission to CBS for consideration (see Appendix XI).

13.2 Review of the Terms of Reference of Rapporteurs

13.2.1 The ICT-IOS reviewed the Terms of Reference for the OPAG-IOS Rapporteurs. The draft Terms of Reference were adopted for submission to CBS for consideration (see Appendix XII).

13.3 Finalization of Work Plans

13.3.1 The Work Plans for all the Expert Teams were adopted for submission to CBS (see Appendix XIII).

13.4 Input for CBS-XIV

13.4.1 ICT-IOS discussed the preparation of documentation for CBS-XIV. It was decided that the Secretariat would prepare the draft documents based on ICT-IOS-5 Final Report. The draft documents for CBS-XIV would be passed to the ICT-IOS Chairperson and Co-Chairperson for finalization. The ICT-IOS Chairperson and Co-Chairperson would also coordinate with the Regional Rapporteurs, if necessary.

13.4.2 ICT-IOS requested that a new agenda item on the “Vision for the GOS in 2025” be added to the CBS-XIV agenda. The CBS-MG meeting in November was tasked with this action.

14. ANY OTHER BUSINESS

14.1 An ad-hoc meeting was organized during the ICT-IOS with Rapporteurs on Regional Aspects of GOS with a view to bridging the gap between CBS guidance on the evolution of GOS and implementation in Regions.

14.2 The ICT-IOS recognized the important role of Rapporteurs on Regional Aspects of the GOS in facilitating the implementation of GOS in Regions, in development of the Regional Practices for approval by RAs and for inclusion in the Manual on the GOS, Volume II. Rapporteurs should also review and advise on the design and implementation of RBSN/RBCN, keep abreast of matters related to the development and introduction of new observing systems in their respective Regions and provide links to various CBS ETs as well as to ICT-IOS. To accomplish these tasks it is important that a group of experts is involved in the process rather than a single Rapporteur. In this regard, the ICT-IOS wish to encourage (through CBS-XIV) Regional Associations to establish Sub-groups on the GOS within their Working Groups on Planning and Implementation of WWW, similar to the practice of RA-VI (see Recommendation 14.2 “PIW Sub-groups on the GOS in Regions”).

14.3 ICT-IOS welcomed the contributions from the Rapporteurs on Regional Aspects of the GOS to the effective implementation of the GOS within the WMO Regional Associations and noted that their
roles and responsibilities are defined by terms of reference designated by the respective Regional Association. Rapporteurs’ participation in the work of ICT-IOS is of significant value and ICT-IOS highlights the particular areas in which the Rapporteurs can assist the ICT most effectively:

(i) Monitor, report and make recommendations on the capability and utilization of an integrated system of different observing networks to meet regional requirements for weather analysis, forecasts and warnings;

(ii) Review and make proposals on the observational data requirements of Members in the context of the WWW Programme in the Sixth WMO Long-term Plan, particularly in relation to the full implementation of the Global Observing System;

(iii) Monitor, and work with Members to improve shortfalls in the performance of Members in delivering the RBSN; identify gaps in the RBSN; work with Members to ensure the list of existing RBSN stations, including relevant metadata, remains valid and propose revisions to the RBSN list; and to identify automatic stations on land and fixed positions at sea to be included in the RBSN;

(iv) Keep abreast of developments within the Region in observing systems, including automatic weather stations, wind and temperature profilers, radars, thunderstorm detection techniques, AMDAR, ASAP and data buoys, and advise on coordinated assessment and implementation developments within the Region;

(v) Lead for the Regional Association, working with Members, to maintain regulatory material related to observations (including Volume A and the Manual on the GOS) related to the Region;

(vi) Liaise with other appointed Regional Rapporteurs to ensure that global observing system aspects are addressed in a coordinated way;

(vii) Represent the Region at sessions of the CBS Implementation Coordination Teams on IOS.

14.3 ICT-IOS considered that the Regional Rapporteurs would be well assisted in these functions through liaison and collaboration with the Chair of the Working Group on Planning and Implementation of the WWW and other appointed Regional Rapporteurs and through coordination with and support from the Secretariat, especially the Regional and Sub-regional Offices that should be in a position to assist Rapporteurs in conducting their tasks.

13. CLOSURE OF SESSION

The session closed at 18:05 hours on Thursday, 18 September 2008.
# LIST OF PARTICIPANTS

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REPORT ON PROGRESS ON THE IMPLEMENTATION PLAN FOR THE EVOLUTION OF THE SURFACE- AND SPACE-BASED SUB-SYSTEMS OF THE GOS

(Version 1.6, 17 September 2008)

CONTENTS

1. Introduction
2. Evolution of surface-based sub-system of the GOS
3. Evolution of space-based sub-system of the GOS
4. Considerations for evolution of the GOS in developing countries

Annex A Acronyms
Annex B Vision for the GOS in 2015
IMPLEMENTATION PLAN FOR THE EVOLUTION OF
THE SURFACE- AND SPACE-BASED SUB-SYSTEMS OF THE GOS

1. Introduction

1.1 This Implementation Plan has been prepared by the WMO/CBS/OPAG-IOS Expert Team on
the Evolution of the Global Observing System (ET-EGOS, formerly the Expert Team on Observational
Data Requirements and Redesign of the Global Observing System, ET-ODRRGOS).

1.2 The Plan is prepared and updated in the following way:

1.2.1 Using the CBS Rolling Review of Requirements (RRR) process, user requirements for
observations are compared with the capabilities of present and planned observing systems to provide
them. Both user requirements and observing system capabilities are collated in a comprehensive,
systematic and quantitative way in the WMO/CEOS database, which attempts to capture observational
requirements to meet the needs of all WMO programmes. The comparison of user requirements with
observing system capabilities for a given “application area” is called a “Critical Review”. The output of
the Critical Review process is reviewed by experts in the relevant application and used to prepare a
Statement of Guidance (SOG), the main aim of which is to draw attention to the most important gaps
between user requirements and observing system capabilities, in the context of the application. This
has been done systematically for (currently) 11 “application areas”: global NWP, regional NWP,
synoptic meteorology, nowcasting and very short range forecasting, seasonal and inter-annual
forecasting, aeronautical meteorology, climate monitoring, ocean applications, agrometeorology,
hydrology and water resources, and atmospheric chemistry. Thus a wide range of applications within
WMO programmes have already been addressed. The latest versions of SOGs are available through
the WMO web site.

1.2.2 The “gap-analysis” provided by these SOGs is then reviewed by ET-EGOS. The key issues
emerging from them are used to formulate recommendations for action and, following endorsement by
CBS, these recommendations form the basis of an Implementation Plan (IP), through which progress
to meet the recommendation is recorded and appropriate actions are proposed. The IP is a living
document and is reviewed regularly to take account of progress in implementation, and of changes in
user requirements and observing system networks and technologies.

1.2.3 In drafting the IP, ET-EGOS has been guided by the vision for the GOS in 2015, as adopted by
CBS (CBS-Ext.(06), Cairns, 1-12 December 2002).

1.3 The IP is also informed from a number of other sources:

1.3.1 ET-EGOS works closely with the CBS Rapporteurs on Global and Regional Observing System
Experiments (OSEs) to take note of conclusions emerging from impact studies, through which real and
hypothetical changes to the GOS are assessed for their impact on NWP performance. In particular ET-
EGOS takes note of the conclusions of the WMO-sponsored Workshops on “the Impact of Various
are recorded in WMO/TDs 1034 and 1228 respectively. The conclusions of the workshops in Geneva
(2008) will be available on CD ROM from WMO. In addition, ET-EGOS commissions impact studies to
answer specific questions when necessary.

1.3.2 ET-EGOS takes note of developments in observing system technology. Candidate observing
systems (space-based and surface-based) for the coming decade were studied and reported in
WMO/TD 1040.

1.3.3 The IP is informed by advice from a number of other bodies including: other CBS Expert
Teams, the World Weather Watch Programme, the WMO Space Programme, JCOMM, the WMO
AMDAAR Panel, GCOS and representatives of the WMO Regions.

1.3.4 The scope and assumptions of the IP are as follows:
• It addresses both surface-based and space-based sub-systems of the GOS.
• It responds to observational requirements of all WMO programmes to which the GOS might reasonably be expected to contribute.
• It responds to a vision of the GOS in 2015 and beyond as set out in section 5.
• It envisages that the future GOS will build upon existing sub-systems, both surface- and space-based, and will capitalize on existing and new observing technologies not presently incorporated or fully exploited; each incremental addition to the GOS will be reflected in better data, products and services from the National Meteorological and Hydrological Services (NMHSs).
• It responds to those elements of the GCOS Implementation Plan which call for action by WMO Members (through CBS) or by the WMO Space Programme. (A cross-check between the GCOS Implementation Plan and this IP has been performed.)
• It takes note of the GAW Strategic Implementation Plan but does not attempt to duplicate its actions.
• It does not explicitly express the need for aspects of continuity of current observing systems – it is concerned primarily with evolution rather than continuity. However it is recognized that aspects of continuity of observing systems are of key importance for many applications, including operational weather forecasting and climate monitoring.
• It recognises the special challenges and issues concerning developing countries (see section 4).

1.5 In preparing this IP it has become clear the scope of changes required to the GOS in the next decade are massive and will need new approaches for science, data handling, product development, training and utilization.

1.6 The IP currently contains a set of about 50 recommendations, each with corresponding comments on progress and accompanying actions. There is a set of recommendations for the surface-based sub-system of the GOS (see section 2) and a set for the space-based sub-system of the GOS (see section 3).
2. Evolution of surface-based sub-system of GOS

Data coverage, distribution and coding

G1. Distribution - Some observations made routinely are not distributed in near real-time but are of interest for use in meteorological applications. In addition, hydrology applications, and also GCOS, will benefit from in-situ observation of parameters such as snow cover, snowfall, snow water content, soil moisture and run-off to be used in combination with satellite data.

(a) Observations made with high temporal frequency should be distributed globally at least hourly.

Comment: Studies have shown that modern, four-dimensional data assimilation systems can make excellent use of hourly data, e.g. from SYNOPs, buoys, profilers, and more frequent data from other automated systems, in particular AWS. The CBS has urged WMO Members to implement this recommendation at the earliest possible date. Availability to hourly surface pressure data is important for NWP and should be improved. Drifting buoy hourly pressure data are now exchanged routinely. Over land, more frequent observations are available from AWS but are not necessarily being shared amongst Members in real-time.

Update July 2008: Recommendation relayed to the Ship Observations Team for transmission of data with higher temporal resolution at least from shipboard AWS. After the 2004 design study of EUCOS, E-SURFMAR made efforts to get hourly air-pressure data from VOS equipped with AWS. However, at this time, most of the AWS operators are facing high satellite data telecommunication costs (Inmarsat Code41). Inmarsat-C data reporting using compressed binary transmission and Iridium SBD transmissions looks promising. E-SURFMAR is expected to issue new recommendations by the end of 2008. In 2009, we should see European NMSs purchasing new AWS with agreed upon specifications. For its own objectives, E-SURFMAR should fund about 12-15 simple AWS each year to be installed on ships sailing in the Mediterranean Sea and in the North Atlantic, during the 2008-2011 period.

New actions July 2008: CBS to reiterate the recommendation to distribute hourly data in real-time, globally. SOT to continue to address the issue about hourly ship data as an ongoing activity. More frequent data than 1 hour from AWS are encouraged to be shared between Members in real-time.

(b) Observational data that are useful for meteorological applications at other NMHSs should be exchanged internationally. Examples include high resolution radar measurements (i.e. products, both reflectivity and radial winds, where available), surface observations, including those from local or regional mesonets, such as high spatial resolution precipitation networks, but also other observations, such as soil temperature and soil moisture, and observations from wave rider buoys. WMO Members in regions where these data are collected should make them available via WMO in real-time or near-real-time information systems, whenever feasible.

Comment: CBS agreed that the Commission working through Regional Rapporteurs, would urge all Members with existing operational observing capabilities and networks to distribute their full information content as quickly as possible. CBS further agreed that the OPAG-IOS Chairman, in consultation with the Chairs of the regional Working Group on Planning and Implementation of the WWW, should ensure that operators and managers of regional observing systems were made aware of GOS requirements (CBS-XIII Report).

The global exchange of radar wind and reflectivity data will require substantial development work concerning data specification and formatting. Also the SYNOP code, and its BUFR implementation, are inadequate for the transmission of a variety of surface observations currently not exchanged on the GTS, but are of interest to application areas.
**Update July 2008:** The most current version (July 2007) of GCOS observation requirements for in-situ parameters, such as snow cover, snow water equivalent, soil moisture and river discharge, are given in the WMO/CEOS database of observation requirements. An update of these observation requirements is planned for June 2009, in order to ensure consistency with the planned update of the GCOS Implementation Plan in 2009.

Centres or groups (e.g. the EUMETNET OPERA radar group) have developed local BUFR Tables, by definition not published in the Manual on Codes. WWW Centres or groups such as the EUMETNET radar group should be invited to consolidate proposals for the extension to the BUFR Tables, including BUFR templates, required for the global exchange of radar data, and submit their proposals to the CBS/ET-DRC for their inclusion in the Manual on Codes. A meeting of the ET-DRC is scheduled from 1 to 5 September 2008 in Geneva.

**New action July 2008:** (i) The development of expanded BUFR templates for the exchange of these observations should be considered, to be addressed via ET-DRC; (ii) Encourage that existing regional composite radar data/maps be extended to continental scale and include neighbouring countries. Encourage international exchange of data on a free basis, including Radar reflectivity data, winds and other derived variables.

**G2. Documentation** - All observational data sources should be accompanied by good documentation including metadata, careful QC, and monitoring. The need for good metadata exchange in support of observational data, sometimes in real-time, is essential.

**Comment:** OPAGs IOS and ISS and JCOMM DMPA were encouraged to progress the development of an integrated metadata distribution system to support the needs of the GOS.

**New action July 2007:** Ongoing action of ET-EGOS, to be reviewed in the light of the evolving WIS and WIGOS.

**Update July 2008:** The Inter-programme Expert Team on Metadata Implementation (IPET-MI) is tasked to pursue the development of the WMO core profile of the ISO metadata standard and to develop guidance for the implementation and use of operational information catalogues. The WMO Core profile of the ISO metadata standards concerns metadata required for the discovery of data in a first stage to be followed by further stages concerning the access and the usage of the data. Other metadata should be either exchanged together with the data or included in operational catalogues to be defined. Proposals to include metadata in the code forms for their exchange with the data, e.g. proposals for new entries in the BUFR tables, should be submitted to the CBS/ET-DRC.

**New action July 2008:** IPET-MI to provide a status report on the implementation to the next ET-EGOS. Ongoing action of ET-EGOS, to be reviewed in the light of the evolving WIS and WIGOS

**G3. Timeliness and Completeness**

(a) There should be a timely distribution of radiosonde observations with ideally all observation points included in the message (together with the time and the position of each data point; information on instrument calibration prior to launch, and information on sensor type and sub-sensor type). Appropriate coding standards should be used to assure that the content (e.g. vertical resolution) of the original measurements, sufficient to meet the user requirements, is retained during transmission.

**Comment:** NWP OSEs have demonstrated the usefulness of full resolution data for NWP. The NWP OSE Workshop (Alpbach, 2004) reiterated the need for near real-time distribution of full resolution RAOB data. CBS has asked all Members to generate, as soon as possible, sounding data in Table Driven Code Forms (BUFR or CREX), following the technical specifications defined by CBS in the Guidance for Migration (see [http://www.wmo.ch/web/www/documents.html#CodeTables](http://www.wmo.ch/web/www/documents.html#CodeTables)).

Guidelines regarding the required vertical resolution: transmit as high resolution data as possible and end users will apply appropriate filtering or algorithms to meet their specific requirements, if necessary.

New action July 2008: CBS to encourage Members to migrate to internationally agreed BUFR templates, especially regarding upper air radiosonde profiles for the distribution of high resolution data.

(b) The timely availability of ocean observations for meteorological use is very important.

Comment: The DBCP noted that the drifting buoy data timeliness was poor in a number of ocean areas as less than 50% of the data collected by Argos through its global system were received in real-time. Whereas elsewhere more than 80% was received in real-time.

Update July 2008: Limited improvements noted despite some efforts to connect new Argos receiving stations to the global system.

Action July 2008: DBCP to continue efforts to improve the situation in the ocean regions where more real-time data are needed, including the South Atlantic Ocean, the South-East Pacific Ocean, and the North of the Indian Ocean. Promote use of Iridium satellite data telecommunication to improve data timeliness.

G4. Baseline system - Provide comprehensive and uniform coverage with at least 12-hour frequency of temperature, wind, and moisture profiles over mid-latitude continental areas and coastal regions. In tropical regions the wind profile information is particularly important.

Comment: Regional and global forecasting systems continue to show benefit from a comprehensive and uniform coverage with at least 12-hour frequency of temperature, wind, and moisture profiles over mid-latitude continental areas and coastal regions. In tropical regions the wind profile information is considered to be of particular importance. At this stage the radiosonde and PILOT network still plays an important role in meeting these requirements (NWP OSE Workshop, Geneva 2008). Profile data are now and will in future, to an increasing extent, be provided from a mix of observing system components and will be complemented by the utilization of radar winds and satellite data over land.

Members have been suitably informed of these requirements through CBS (CBS-XIII Report). This is more easily achievable where sub-regional programmes, such as EUCOS, or large national programmes exist. It is acknowledged that this is more of a challenge with a collection of small national programmes.

The EUCOS plans for the redesign of the upper air network in Europe will address the issue of best mix of radiosonde and AMDAR profile data. Although EUCOS is focused on regional aspects for NWP in Europe, their findings may be applicable elsewhere.

(i) WWW monitoring activities should reflect the baseline systems requirements and provide suitable feedback to Members concerning their baseline systems commitments.

Update July 2008: The statistics of the monitoring exercises coordinated by the Secretariat (see http://www.wmo.int/pages/prog/www/ois/monitor/monitor-home.htm ) include information
on the availability of TEMP, PILOT and wind profiler reports; the monitoring information do not
detail the availability of the data types such as wind, temperature or humidity. WWW centres
have developed and implemented schemes for the monitoring of the availability of reports and
are invited to contribute to the monitoring of data types such as wind, temperature or
humidity; requirements on the presentation of the monitoring statistics should be specified by
the ET-EGOS.

**New action July 2008:** Ongoing activity

(ii) Impact studies to address the question of best mix of vertical atmospheric profiles to be
obtained from different observing systems.

Results at the Geneva 2008 Workshop on observation impacts emphasized the importance
of the existing radiosondes at high latitudes. In particular, significant impact was shown for
the Canadian Arctic. The complementarity, at regional and global scales of radiosondes and
aircraft profiling data was clearly demonstrated. The results indicate that the two observing
systems provide equivalent wind and temperature profiling capabilities for the purposes of
regional and global NWP, within the troposphere. It should be noted that the radiosondes
additionally provide valuable humidity profiles and extend into the stratosphere. Other studies
quantified a degree of redundancy between these two profiling observing systems. This is
thought to originate from locations where aircraft and radiosondes are both present within a
short period of time. Wind-profilers are currently available in Japan and in parts of America
and Europe, where radiosondes and aircraft are also available. Their additive contribution is
therefore relatively modest at present.

**New action July 2008:** AMDAR Panel to promote AMDAR in data sparse areas; and to
complement other upper-air observing systems in other areas. CBS to encourage NMHS to
ascertain what is the appropriate mix of upper air observing systems to serve the needs of
NWP.

**G5. Stratospheric observations** - Requirements for a stratospheric global observing system
should be refined. Document the respective needs for radiosondes, radiances, wind data, humidity
data, noting the availability and required density of existing data sources, including GPS sounders,
MODIS winds and other satellite data.

**Comment:** The GPS-RO missions (e.g., COSMIC) have provided a substantial
enhancement to the stratospheric observing system. Impact studies have shown the benefit
of high reaching radiosonde data. For humidity, AOPC has noted that current in-situ
measurement capabilities for upper troposphere and lower stratosphere water vapour are not
meeting climate requirements and stressed the need for further development. It is therefore
important to address the question of the best mix of observations required from radiosondes
and satellites in the stratosphere for NWP, but also for GCOS purposes.

**Update July 2008:** The Geneva Workshop (May 2008) noted that the description of the
stratospheric temperature has been dramatically improved by new observing systems which
are now assimilated in NWP, especially radio-occultation measurements. No OSE presented
at the Workshop can answer directly the question: “how many radiosondes need to go up far
into the stratosphere?” with reference to the additional challenges and cost of achieving
balloon ascents to such heights. However, the question can be addressed again through new
emerging tools which allow the evaluation of the observation impact (adjoint technique).

**New action July 2008:** CBS to recommend to EC that major NWP centres assess the
impacts of the stratospheric observing systems and report to ET-EGOS-5.
Broader use of ground-based and in-situ observations

G6. Ozone Sondes - Near real-time distribution of ozone sonde data is required for calibration and validation of newly launched instruments, for environmental monitoring and for potential use in NWP.

Comment: This requires close inter-commission co-ordination between CAS and CBS to be facilitated by the WMO Secretariat. The GAW meeting in Payerne October 2005 stressed the importance of real-time distribution of ozone data and total column ozone data on the GTS. BUFR formats have been developed and Members are encouraged to make use of them for data exchange.

Update July 2008: WIGOS Pilot Project for GOS-GAW will address ozone measurements and accessibility to the data in near real-time through WIS. A number of European ozone sonde stations submit data in NRT to the Norwegian Institute for Air Research (NILU), that pass the data on to ECMWF in CREX format. This service has been on-going for many years and NILU is willing to expand this to encompass all ozone sonde stations worldwide, if necessary/desired. This should be seen as an important component of the WIS-WIGOS pilot project. In the future, NILU could play a role of the WIS DCPC.

New Action July 2008: Ongoing within the WIGOS pilot project for GOS-GAW. WMO Secretariat to remind Members that all available ozone soundings be made available in near-real time on the GTS.

Moving towards operational use of targeted observations

G7. Targeted Observations - Observation targeting to improve the observation coverage in data sensitive areas for NWP should be transferred into operations once the methodology has matured. The operational framework for providing information on the sensitive areas and responding to such information needs to be developed. Negative targeting, to release resources for use elsewhere in the GOS are also of value (excluding climate stations).

Comment: The proof of concept of observation targeting was demonstrated by the US Weather Service in the north-eastern Pacific for winter storms. THORPEX has declared observation targeting a core research activity in its implementation plan, has successfully carried out jointly with EUCOS the NA-TreC campaign, and has benefited from the lessons learned from FASTEX.

CBS-XIII requested the OPAG-IOS to maintain liaison and to ensure that targeting methodologies developed by programmes such as EUMETNET and targeting strategies developed by programmes such as THORPEX were carried through to operational implementation. A Data Targeting System (DTS) has been developed by EUCOS/PREVIEW and is under test in Europe (Met Office & ECMWF) until the end of 2008.

Update July 2008: At the Geneva workshop it was shown that observation-targeting experiments have demonstrated the benefits of additional profile information in otherwise data sparse areas. The measures of impact computed by the adjoint technique will probably be very useful to assess data targeting strategies like the ones which are currently tested within the EUCOS/PREVIEW Data Targeting System. It will take time before an optimal targeting strategy can be worked out. Whether it is better to add extra targeted observations every now and then, or to target intensively some particular weather episodes for several days in a row, is still an open question. To answer such a question, studies like the current DTS project are needed, but also studies using existing data, especially satellite data.

The discussion on the verification and validation of targeting strategies led also to the following points: (i) The verification and validation must not be limited to the averaged scores measuring the overall impact of targeted data. (ii) Some tests must be made to check if
targeted data are more valuable than non-targeted data. (iii) Targeting of special meteorological events (cases of high impact) must continue to be supported.

National reports: Comments about observations targeting and optimisation of the rawinsonde network provided many positive examples of the willingness of Members to conduct flexible and adaptable programmes. The criteria for data targeting relate to the requirements of forecasters, the occurrence of specified severe weather conditions and the proximity of typhoons / hurricanes. Investigations are being pursued for NWP-based data targeting systems.

The THORPEX Pacific Regional Campaign (T-PARC) is addressing improvement of Typhoon forecasts through targeted observations.

New action July 2008: To encourage EUCOS to evaluate the EUCOS/PREVIEW DTS trial period and report to ET-EGOS-5.

Optimization of vertical profile distribution

G8. RAOBs - Optimize the distribution and the launch times of the radiosonde sub-system allowing flexible operation while preserving the GUAN network (taking into consideration regional climate requirements). Examples include avoiding duplication of Automated Ship-borne Aerological Programme (ASAP) soundings whenever ships are near a fixed rawinsonde site (freeing resources for observations at critical times) and optimizing rawinsonde launches to meet the local forecasting requirements. [recommendation is supported by information from the EUCOS Studies]

Comment: Observation targeting requires a flexible observing practice. THORPEX has included this concept in their considerations. ET-EGOS will follow the THORPEX Implementation Plan and to learn from the THORPEX experience whilst remembering the importance of safe-guarding the integrity of the baseline observing system.

Update July 2008: Several studies presented at the Geneva Workshop (May 2008) showed a very large impact (negative) obtained by removing a small number of radiosondes from data sparse areas (North Atlantic ASAPs, West Africa). Over an area like Europe (data dense) a reduction by a factor of 3 or 4 of the number of radiosondes also showed a large degradation. These studies give clues about the “optimum”.

A study in support of network optimisation for Australia identified potential redundancy in the most populated areas in mid-latitudes, relative to the sparsely populated tropical and subtropical regions. The optimisation activities within EUCOS were presented, and these received the support of the workshop. For regional high-resolution NWP applications, the benefit of high density of radiosondes was underlined. Studies performed by MGO (Russian Federation) showed that it was possible to plan improvements to the upper-air network (e.g. in Siberia and Africa) through simple network studies based on the estimation theory.

Optimization strategies for the network are required in an increasingly adaptive context. A range of aspects are to be considered for the best mix of observing systems (e.g. impact, cost).

New action July 2008: Encourage development of a simple, portable mathematic software tool based on the optimal estimation theory for a design of RBSN/RBCN. The priority should be given to the upper-air network.

G9. AMDAR - AMDAR technology should provide more ascent/descent profiles, with improved vertical resolution, where vertical profile data from radiosondes and pilot balloons are sparse as well as into times that are currently not well observed, such as 2300 to 0500 local times.
Comment: This recommendation is supported by impact results from the Toulouse, Alpbach and Geneva Workshop reports. The AMDAR Panel objective is to coordinate more homogeneous coverage of AMDAR data over 24 hours over as many regions as possible and to improve the value of upper-air data through a combination of:

a) Expanding the number of operational national and regional programmes;

Update June 2008: Existing AMDAR Programmes in Australia, Asia, Southern Africa, the USA and Europe continue to expand AMDAR coverage both domestically and internationally. The Republic of Korea and China have now full operational AMDAR Programmes.

b) Development and use of new onboard software and alternative AMDAR technologies;

Update June 2008: The AMDAR Panel is in the early stages of planning to develop and implement a generic version of onboard AMDAR software. This new standardized AMDAR software would be suitable for installation on all aircraft types and models and would enable those aircraft equipped with the appropriate water vapour sensing technology, to report humidity data. An instrument package developed for small regional aircraft (TAMDAR Tropospheric AMDAR) is still undergoing operational trials in the Great Lakes area of the USA. The AMDAR Panel is currently addressing problems associated with the free exchange of TAMDAR data on the GTS. The Australian AMDAR Programme recently developed a new version of AMDAR software. This particular version of software is suitable for some Boeing aircraft models (B737) and will support water vapour measurement and reporting. The ICAO Automatic Dependant Surveillance-Broadcast (ADS-B) system is under development and this system is providing limited coverage of AMDAR Type reports over the North Atlantic and SW Pacific Ocean.

New Action July 2007: The AMDAR Panel to prepare a work plan to develop a standardized software solution for larger aircraft makes and models. This will be a longer term perspective.

c) Selective deployment of humidity/water vapour sensors;

Update July 2008: The AMDAR Panel together with the E-AMDAR Programme are currently working closely with the manufacture of the WVSSII water vapour sensor to resolve several issues with the sensing technology. The newly updated version of the WVSSII water vapour sensor will undergo a further series of operational tests on a number of UPS B757 freighter aircraft and South West Airlines B737 aircraft in the USA before the release of the Final Report on the operational performance of the sensor. The European AMDAR Programme (E-AMDAR) is continuing with a European based WVSSII evaluation test on 3 Lufthansa A319 aircraft with the results of the test expected early 2009.

New action July 2007: (i) The AMDAR Panel will make available and ET-EGOS to consider the evaluation reports of both the USA and European based trials. (ii) The AMDAR Panel to prepare a work plan to develop a standardized humidity sensor solution for larger aircraft makes and models. This again will be a longer term perspective.

d) Provision of additional observations into data sparse areas and special weather situations;

Update June 2008: The E-AMDAR Programme continues to provide AMDAR data into the Southern Africa region and Singapore as part of a data agreement with those NMHSs. The E-AMDAR Programme has also been assisting the Indian Meteorological Service with a trial of AMDAR profiles and on-route data into the India area. Work coordinated by the AMDAR Panel continues on the establishment of a substantial AMDAR programme for the ASECNA group of countries, the North African and Western Asian region, and the South West Pacific area.
New action July 2007: AMDAR Panel to continue exploring opportunities for providing additional observations into data sparse areas.

e) Use of optimization systems to improve cost effectiveness;

Update June 2008: E-AMDAR continues to develop and refine its AMDAR Optimization System to management data on-route and AMDAR profiles in the EUCOS area. Australia is currently undertaking a development of an appropriate AMDAR Optimisation System for the Australian AMDAR Programme. The USA has conducted an investigation into the impact of an optimization system on the USA AMDAR Programme and is now considering a development of an optimization system for the USA Programme. There is a need to specify, based on the advice from the various application areas, the GOS requirements for the optimization of data collection. This task will greatly benefit from the experience from some of the operational AMDAR Programmes where optimization is in operation, e.g. the E-AMDAR Programme.

New action July 2007: (i) The AMDAR Panel to continue with the development and the implementation of the optimization schemes for operational AMDAR Programmes. (ii) AMDAR Panel to request input via the WMO Secretariat from the various application areas on the optimization requirements for AMDAR data collection.

f) Improvements in the monitoring, quality control;

Update June 2008: All AMDAR monitoring centres have made substantial improvements to their AMDAR data quality monitoring systems. A series of studies have shown that temperature data quality is very clearly linked to individual aircraft type and model and that there are clear differences in the bias seen between ascent and descent profiles on many aircraft types. The AMDAR Panel Science Sub Group (SSG) is planning to conduct a study to investigate and develop a solution for these problems. The AMDAR Panel SSG is also planning to investigate and develop a solution for the poor wind quality derived from aircraft at high latitudes that results from the use of aircraft magnetic heading systems, which is unreliable at these latitudes.

New action July 2007: Continuing activity of the AMDAR Panel.

g) Efforts to encourage and pursue the free exchange of data;

Update July 2007: Discussions continue with the provider of the TAMDAR system to allow for the provision of data free of charge to NMHSs allowing for the free exchange of TAMDAR data on the GTS.

New action July 2007: (i) The AMDAR Panel to develop a standard text on data ownership and usage which can serve as the basis of agreements between NMHSs and data providers. (ii) CBS to encourage the USA AMDAR Programme to make available AMDAR data outside the USA as part of an AMDAR optimisation system.

h) Improvements in user awareness & training plus operational forecasting tools and systems;

Update July 2007: The AMDAR Panel webpage is now operational but requires updating. The AMDAR Panel held a regional Technical Workshop in Romania in November 2007 where a number of neighbouring member NMHS attended. Further AMDAR Technical Workshops have been requested by Malaysia, and interest has been expressed by Brazil, Chile, India, and the Russian Federation.
Comment Sept 2008: The integration of AMDAR into the GOS is being progressed through a WIGOS Pilot Project, with the AMDAR Technical Co-ordinator now part of the WMO Secretariat.

Atmospheric moisture measurements

G13. Ground-based GPS measurements for total water vapour. Develop further the capability of ground-based GPS systems for the inference of vertically integrated moisture towards operational implementation. Ground-based GPS processing (of Zenith Total Delay and Precipitable Water, priority for ZTD) should be standardized to provide more consistent data sets. Data should be exchanged globally. [Recommendation is supported by information from the NWP OSE Workshop in Alpbach.]

Comment: Such real-time networks currently exist in Europe, North America and Asia. It is expected that the coverage will expand globally over the coming years.

CBS has urged Members to collect and exchange the ground-based GPS data. Members were to take the appropriate action to ensure that the data-processing be standardized by November 2005. However, this is challenging as it is evident that Members generally depend on collaboration with relevant mapping and / or seismic agencies for access to data from their GPS ground stations.

A GPS BUFR template has been developed and approved. Ground-based GPS data are inserted on the GTS from Europe, by the Met Office in Exeter, UK.


New action July 2008: Ongoing action. WMO Secretariat to remind Members that all available ground-based GPS data be made available in near-real time on the GTS.

Improved observations in ocean areas

G14. More profiles over oceans - Increase the availability of high vertical resolution temperature, humidity, and wind profiles over the oceans. Consider as options ASAP and dropsondes by designated aircraft.

Comment: The main concentration of the ASAP operations continues to be over the Northern Atlantic (5153 launches in 2006). An important contribution is also made by Japanese research ships operating primarily in the North Western Pacific areas and seas adjacent to Japan (938 launches in 2006). Fewer manual soundings are made by South Africa from ships sailing in the South Atlantic. Radio sondes data are also needed for the calibration of satellite products, and are especially sparse in the North Pacific and the Southern Hemisphere. The transition of high vertical resolution data will be achieved by the migration from TEMP-SHIP to BUFR (G3). Useful ASAP observations should be continued.

Update July 2008: It was noted by the Geneva Workshop that radiance bias corrections for NWP models has improved with availability of GPS radio occultation temperature profiles.

There are cost issues when using BUFR to transmit high vertical resolution data through Inmarsat. Investigations/tests show promising cost-effective results when using Iridium satellite data telecommunication. Need to investigate whether complete reports (without gaps) can be transmitted operationally via Iridium.

New actions July 2008: (i) SOT (and E-ASAP) to continue efforts and test Iridium data telecommunication. (ii) ET-EGOS to solicit, e.g. through impact studies, further guidance on the desirable coverage of ASAP soundings over the oceans.
G15. **Improvements in marine observation telecommunications** Considering the expected increase in spatial and temporal resolution of in-situ marine observing platforms (from include drifting buoys, profiling floats, XBTs for example) and the need for network management, the bandwidth of existing telecommunication systems should be increased (in both directions) or new relevant satellite telecommunications facilities should be established for timely collection and distribution.

**Comment:** The JCOMM Operations Plan provides background for actions in this area. Iridium provides for high resolution data transmission and is global. Experiments still being conducted with small number of Argo profiling floats. Argos 3 generation is onboard METOP and provides higher bandwidth and downlink capability. High resolution XBT data collected via Inmarsat are made available through Global Temperature and Salinity Profile Programme (GTSPP). BUFR distribution of high resolution XBT data is under development in the USA. Iridium and other providers also offer substantially reduced telecoms tariffs, with no reduction in performance.

**Update July 2007:** The DBCP has established a DBCP drifter Iridium Pilot Project to evaluate the Iridium satellite data telecommunication system for use with drifting buoys. The Pilot Project is targeting the deployment of about 50 units in the world oceans in the period 2007/2008. Similarly, the SOT has also engaged in the evaluation of the Iridium system for use from VOS ships. Iridium, which is a global system, provides potentially the cost-effectiveness, telecommunication bandwidth and the timeliness needed for applications of ocean data. Iridium could also potentially solve the problem of transmitting in real-time high vertical resolution ASAP soundings to shore.

**Update July 2008:** About 40 Iridium drifters are now operating and showing good and cost-effective results. JCOMM will continue to address these telecommunication activities. Some data management issues for automatic quality control and GTS distribution are being addressed.

**New action July 2008:** JCOMM to continue the DBCP and SOT Iridium pilot projects.

G16. **Tropical moorings** - For both NWP (wind) and climate variability/climate change (sub-surface temperature profiles), the tropical mooring array should be extended into the tropical Indian Ocean at resolution consistent with that presently achieved in the tropical Pacific and Atlantic Oceans. [The JCOMM Operations Plan provides background for actions in this area].

**Comment:** The overall target for the tropical moorings under the JCOMM/OPA strategic work plan is for 76 moorings in the Tropical Pacific Ocean, 18 in the Tropical Atlantic Ocean, and 47 moorings in the Tropical Indian Ocean. The Tropical Pacific Ocean array is complete. Operations and maintenance of most of the Tropical Pacific Ocean array has been transferred to an operational agency in USA. However, sustainability is still an issue for the rest of the network. Vandalism remains a concern.

**Update July 2008:** Salinity is now available nearly on every TAO mooring site. There are now 18 sites occupied in the PIRATA array. Progress continues towards the development of a 47-element Indian Ocean Observing System (IndOOS), a multi-national, multi-platform network designed to support climate forecasting and research. The array has been named the Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction (RAMA). In 2007, the number of ATLAS moorings in RAMA is now 32% complete. 2008 scheduled deployments will increase this to 43%. Progress has been made towards multinational sustained support for RAMA via Memoranda of Understanding and Implementing Arrangements between the US and India, between the US and Indonesia, and between the Peoples Republic of China and Indonesia. An existing MOU between the US and Japan is being updated to include RAMA.
**New action, July 2008:** JCOMM to continue working towards developing RAMA in the Indian Ocean and sustaining both RAMA and the Atlantic Ocean arrays.

**G17. Drifting buoys** - Adequate coverage of wind and surface pressure observations from drifting buoys in the Southern Ocean in areas between 40S and the Antarctic Circle should be assured using an adequate mix of SVPB (surface pressure) and WOTAN technology (surface wind). The pressure observations are a valuable complement to the high-density surface winds provided by satellite. [Recommendation is supported by information in the Toulouse NWP OSE Workshop Report and the ET-EGOS OSE studies.]

**Comment:** DBCP maintains an array of about 1250 drifting buoys globally. About 450 of them report air pressure. It maintains an array of about 80 barometer drifters south of 40S. The JCOMM strategic work plan is targeting to install barometers on all operational 1250 drifters globally by 2010. This involves maintaining a network of about 300 drifters with barometers in the Southern Ocean. Hourly air pressure data are recorded by the instruments and distributed on GTS. Efforts are being made in Southeast Pacific and the South Atlantic to improve data timeliness by installing and/or connecting of Argos receiving stations to the Argos System.

The number of drifting buoys making wind is insignificant. Global coverage of near surface wind observations is achieved through satellites. Wind drifters with WOTAN technology are deployed in small quantities and in conjunction with hurricanes.

ET-EGOS has endorsed the JCOMM/OPA strategic work plan for the DBCP.

**Update July 2008:** The number of drifters with barometers has increased substantially (585 in April 2008). These are vitally important for NWP. Given that the scatterometers and Windsat provide ample coverage of wind information for the global oceans (with the exception of ice-covered areas), the Geneva Workshop concluded that the need for wind information from buoys is primarily for calibration of scatterometers.

**New action July 2008:** CBS to encourage major NWP centres to conduct a new study on requirements for in-situ surface pressure in terms of optimal horizontal resolution required in presence of satellite wind data (study was promoted by the Geneva 2008 Workshop). Results to be reported at the next ET-EGOS meeting and/or impact workshop.

**G18. XBT and Argo** - For Ocean Weather Forecasting purposes, improve timely delivery and distribution of high vertical resolution data for sub-surface temperature/salinity profile data from XBTs and Argo floats. Note: The JCOMM Operations Plan provides background for actions in this area.

**Comments:** All operational Argo floats report their data in real time. Most Argo national programmes are supported by research funding, which poses difficulties for sustaining the observations over decadal time-scales. Mechanisms for long-term support are required. Support from operational agencies and users are needed to justify the long term funding.
Regarding the XBT network managed by the SOOPIP under the JCOMM SOT, between 2004 and 2006 there has been a gradual decrease in the annual number of XBT observations transmitted in real-time to the national data centres, from just over 25,000 in 2004 to about 18,000 in 2006. The target for 2010 is to sample 26 high density ship lines (4 transects per year a high horizontal res.) and 25 frequently repeated ship lines (18 transects per year at low horizontal res.). Significant progress has been made in improving the quality of the XBT observations (automated systems, improved real time QC), and in enhancing the real-time transmission of XBT observations in high vertical resolution. USA is now developing software to permit the distribution of the XBT data in BUFR format. OOPC is now planning to organize a conference focused on global ocean observations, in about 2009, ten years after the OceanObs99 conference that defined the implementation strategy for the SOOPIP, Argo, and the Tropical moored buoy array in support of upper ocean thermal applications.

**Update July 2008:** The Argo network achieved completion and is being maintained at the 3000 operational float level but the Argo Steering Team is still striving to achieve sustainability. XBT network remained at a similar level in 2007 as in 2006, i.e. about 18000 probes deployed. 15 out of the 45 recommended UOT SOOP Frequently Repeated and High Density lines were under sampled; 10 were not sampled. Progress is being made regarding the definition of an acceptable BUFR template for XBT data. USA is planning to implement the new template once accepted by CBS.

**New action July 2008:** JCOMM to continue efforts on sustainability. An upper ocean thermal review is being planned in conjunction with the OceanObs’09 conference, Venice, 21-24 Sept 2009, to address complementarity of observing networks providing thermal profiles (i.e. Argo, XBTs, and tropical moorings). The third Argo Science Workshop in early 2009 in Hangzhou, China, and the OceanObs’09 conference will also address the value of Argo and XBT networks. Results to be reported to ET-EGOS.

**G19. Ice buoys** - For NWP purposes, coverage of ice buoys should be increased (500 km horizontal resolution recommended) to provide surface air pressure and surface wind data. Note: The JCOMM Operations Plan provides background for actions in this area.

**Comments:** After reviewing the requirements established by the WMO and NOAA for meteorological and oceanographic observations, it was determined that the IABP will strive for a spatial resolution of 250 km for the IABP buoy network. About 190 buoys are needed to achieve this resolution. On the other hand, the WCRP-SCAR International Programme for Antarctic Buoys (IPAB) is still targeting 500km*500km horizontal resolution in the sea-ice zone while actual resolution is actually substantially lower.

The Eurasian side of the Arctic Ocean appears to be data sparse. With the reduction of the sea ice extend due to global warming, development of seasonal ice buoys is becoming essential.

**Update July 2008:** 200 buoys were deployed for IPY in 2007, many with a short life-time; a sub-set, e.g. the DAMOCLES buoys did not report on the GTS. In September 2007, the buoys probably covered 2/3 of the Arctic, but by March, the array was compressed to about 1/3 of the Arctic by high-AO conditions against the Canadian Archipelago. About 80 buoys reported on GTS from the Arctic basin in April 2008. According to a EUCOS study, there are several indications that the current (2008) buoy observing network is close to optimality in terms of surface pressure in Northern Atlantic and near the Northern pole. However the Eurasian part of the polar cap (North of 75N, from East Greenland to the East up to 180E) is still a data-void area. Even if no case of obvious synoptic forecast error was found during the winter 2007-08, coming from this area and affecting Europe, it is clear that the first obvious recommendation would be to deploy a buoy network in this polar area (North of Europe and Siberia) comparable to what it is to the North of Canada. Another (smaller) improvement action could be the refinement of the buoy data density in the less dense areas of North Atlantic. No scenario corresponding to a drastic change in buoy coverage can be envisaged. No specific
OSE or OSSE seem to be needed to drive these changes.

Because of the lack of in-situ observations in the polar latitudes, every effort should be made to maintain the existing sites, and/or find new systems to observe the vertical structure of the atmosphere (wind, temperature, humidity) in the polar areas. The IPY year has provided the opportunity to deploy new systems. An exhaustive list of these IPY-specific observations should be made available to all NWP users to enable dedicated impact assessment. The extension of some of these systems beyond the IPY should be considered.

**New action July 2008:** DBCP/IABP to deploy a buoy network in this polar area (North of Europe and Siberia) comparable to what it is to the North of Canada. Collaboration from the Russian Federation is required in terms of logistics.

**Improved observations over tropical land areas**

**G20. More profiles in Tropics** - Temperature, wind and if possible the humidity profile measurements (from radiosondes, PILOTs, and aircraft) should be enhanced in the tropical belt, in particular over Africa and tropical America.

**Comment:** There is evidence from recent impact studies with the radiosonde / PILOT balloon network over the Indonesian / Australian region that such data give a better depiction of winds in the tropics and occasionally strongly influence the adjacent mid-latitude regions. Information on the collection of additional profile data from aircraft and ASAP is provided under G9 and G14. In addition, the AMMA (African Monsoon Multidisciplinary Analysis) project in West Africa is operating at various stages and during field phases a number of additional TEMP and PILOT stations. The AMMA Programme provides an opportunity for impact studies and subsequent network design. Sustaining an operational network in the region will be a challenging task.

**Update July 2008:** Impact studies on the radiosondes and/or AMDAR have been performed (Southern Africa; AMMA studies) over Africa. Results were reported at the Geneva Workshop. They confirmed that the availability of more profiles (temperature, wind) over Africa should receive the highest priority. The results can certainly be extrapolated to the whole tropical band.

A clear benefit of the existing aircraft data over Africa was demonstrated. Continued expansion of the collection AMDAR data in the tropics and in Africa in particular was recommended. The AMMA radiosondes contribute to the predictive skill of rainfall in the area, provided observation bias issues are addressed in the humidity profiles.

**New action July 2008:** Recommendation to CBS and EC that Members increase spatial resolution of radiosonde and/or AMDAR over Africa, and generally across the tropics.

**New Observing Technologies**

**G21. AWS** - Noting the widespread adoption of AWS and their importance in the measurement of Essential Climate Variables,

(a) there should be coordinated planning that includes:

- appropriate codes and reporting standards;
- global standard for quality management and the collection / sharing of metadata; and
- expanded range of measured parameters;
- ensuring recommended practices are complied with.

**Update July 2008:** Addressed at ET-AWS-5. A new action “Advances in AWS technology” was addressed by Item 15.
New action July 2008: ET-AWS to follow up on action proposed by ET-AWS5. Ongoing action, ET-AWS to be asked to summarize advances in AWS technology for ET-EGOS, and to formulate how the operational implementation of this technology might be formulated and promoted within the EGOS-IP.

(b) exact time of observation, as distinct from a notional time or time period, should be reported.

The evolution of the AWS network needs to be addressed. National reports stress the importance of enhanced AWS operations, including wider range of measured parameters; more frequent data, network expansion and further automation across the network. OPAG/IOS needs to consider how best to carry this forward. ET-EGOS chair to liaise with ET-AWS chair on future co-operation.

Update July 2008: The meeting agreed that a new action “The evolution of the AWS network” had been addressed also under individual Agenda Items. Developing corresponding requirements and relevant guidelines, ET-AWS formulated how this technology can be implemented in operational practices of in Member countries. When considering the role of ET-AWS, the ET-EGOS adopted the Recommendation 10.

New action July 2008: Ongoing action to further address evolution and improving capability of AWS network in cooperation with ET-AWS.

G22. New systems - The feasibility of new systems should be demonstrated as much as possible. These possible operational sub-systems include but are not limited to:

- ground based interferometers and radiometers (e.g. microwave) that could provide continuous vertical profiles of temperature and humidity in selected areas;
- Unmanned Aeronautical Vehicles (UAVs);
- high altitude balloons;
- TAMDAR (see G8);
- Ocean Gliders;
- Deep ocean time series reference stations (oceanSITES).

The OceanSITES is a worldwide system of long-term, deepwater reference stations measuring dozens of variables and monitoring the full depth of the ocean from air-sea interactions down to 5,000 meters. OceanSITES is installing meteorological instruments on most of its sites. While data are public for most of these southern ocean sites, the data are only being distributed in delayed mode.

- Lightning detection

Long-range ground-based remote sensing lightning detection systems have now an accepted role as a cost-effective component of the evolving GOS. Such systems should be considered complementary to existing lightning detection systems for improving coverage in data sparse regions, including the oceans and polar areas.

New actions July 2007: (i) ET-EGOS chair to ensure that any impact studies for new technologies carried out by THORPEX or other groups are made available. (ii) JCOMM to encourage OceanSITES to distribute their data in real-time. (iii) ET-EGOS to include remote sensing lightning detection systems in the revised “Vision for the GOS in 2025” and WMO Secretariat to encourage Members to collaborate on the realization of a truly global system for sharing real-time data with all Members.

Update July 2008: The WMO Workshop, Geneva, May 2008, discussed some studies on “vertical profiles of temperature and humidity in selected areas”, and on wind profilers, GPS
data, Doppler wind radars, and high altitude balloons. The ET-EGOS chair is not aware of any impact studies presented on any other "new systems" on the list. See also the report and proceedings of the second meeting of the THORPEX observing systems working group, Louisville, USA, 2-4 May 2007.

**New action July 2008:** ET-EGOS to keep informed about new developments and trials.

**G23. Quality Assurance** - All observational data should be subject to careful QC, and monitoring and corrective procedures.

**Update July 2008:** Activity promoted under the WIGOS Pilot Projects. Members are encouraged to follow the example of EUCOS and AMDAR quality management approach.

**Action July 2008:** Ongoing action of ET-EGOS, to be reviewed in the light of the evolving WIS and WIGOS.

**NEW ACTIONS TO BE ADDED BASED ON NEW REQUIREMENTS SPECIFIED IN SEVERAL APPLICATION AREAS:**

**GN1. Develop in-situ wave observation capability.** *In-situ* wave observations are needed to meet the requirements for maritime safety services, and in particular for (i) assimilation into offshore wave forecast models, (ii) validation of wave forecast models, (iii) calibration/validation of satellite wave sensors, (iv) description of the ocean wave climate and its variability on seasonal to decadal time scales. Some coastal buoys are presently making directional wave observations and some open ocean buoys are making significant wave height measurements. However, practically none are reporting directional or spectral wave data from the open ocean. Observations are needed at a minimum, significant wave height, peak period and 1-D spectra, hourly in real-time, for assimilation into coupled atmosphere-ocean wave models for real-time forecasting activities, and subsequent verification.

**Action July 2007:** JCOMM to set up a Pilot Project with a view towards integrating the in-situ wave observation capability into WIGOS.

**Update July 2008:** The idea of a sub pilot project under the WIGOS Pilot Project for JCOMM was abandoned. However, JCOMM is still pursuing the idea separately from the WIGOS, or at least not directly as part of it to address issues such as (1) assimilation into offshore wave forecast models; (2) validation of wave forecast models; (3) calibration and validation of satellite wave sensors; (4) ocean wave climate and variability; (5) role of waves in coupling. The DBCP and the JCOMM Expert Team on Storm Surges (ETWS) are jointly organizing a Technical Workshop on Wave Measurements from Buoys, tentatively in NE US in September 2008. The goal is (i) to provide a forum for the exchange of ideas and information related to wave measurement from moored and drifting buoys, taking into consideration the users requirements; (ii) to discuss priorities for the development of cost-effective wave observing technology; and (iii) to develop a technical work plan for implementation of enhanced global wave measurements, for consideration by the DBCP and its Action Groups.

**New action July 2008:** JCOMM to continue efforts in developing cost-effective *in-situ* wave observing technology.

**GN2. Increase time resolution of SST data (in-situ observations from drifters).** Increased time resolution SST data, at least hourly, are needed in order to better resolve the diurnal cycle of the SST. In-situ SST data are being used by the GHR SST together with satellite data. Relatively minor technological developments should eventually permit these requirements to be met for all global drifters.

**Update July 2008:** The PTT real-time clock on drifters can be used with sufficient accuracy to provide for the hourly SST. On the other hand, accurate real time clocks have been installed
on some prototypes.

**New action July 2008:** DBCP to continue efforts to distribute hourly SST data and report to ET-EGOS.

**GN3. Develop and consolidate the VOSClim fleet.** Climate variability and predictability applications require better quality data from the VOS fleet (better QC and flags, additional metadata). The fleet is currently comprised of about 220 ships but not all of them report the required additional parameters and could increase the frequency of observations by using more automated systems together with the recording of traditional variables that can only be observed manually. The SOT has recommended increasing the number of ships participating in the VOSClim fleet which is now targeting a total of 250 ships. At the same time, efforts should be made to increase the number of observations and the number of VOS ships recording the additional parameters required by the VOSClim.

**Update July 2008:** The VOSClim fleet is now close to the 250 ships target. However, the collection of the additional elements remains a matter of concern. On the other hand, some of the VOS ships not participating in the VOSClim fleet are actually collecting the additional elements and are encouraged to join the VOSClim fleet.

**New action July 2008:** SOT to consolidate the VOSClim fleet and make sure that the additional elements are being recorded and collected by participating vessels.

**GN4. Develop operational procedures for the GRUAN.** The proposal for the GCOS Reference Upper Air Network (GRUAN) has been endorsed by the AOPC. The Lead Centre for the GRUAN will develop operational procedures in consultation with appropriate CBS and CIMO expert team, GSICS and other relevant partners.

**Update July 2008:** The Richard Assmann Observatory in Lindenberg, Germany, was designated by WMO as the Lead centre for the GRUAN network for an initial pilot phase. The Implementation Meeting of the GRUAN, organized by the AOPC Working Group on Atmospheric Reference Observations (WG-ARO) (Lindenberg, Germany, 26-28 February 2008) decided on necessary actions required to refine the cooperation with all partners, resolve scientific and technical issues from the report of the AOPC WG-ARO and define a work plan for the implementation of the network. As part of the work plan:

- A set of twelve initial candidate sites shall be invited by WMO/GCOS to become GRUAN sites;

- Close linkages with the satellite community, mainly through GSICS, shall be sought and maintained, particularly in view of utilization of GRUAN data for satellite instrument calibration and validation, and of possible sponsoring of additional radiosondes launches at GRUAN sites;

- The GRUAN Lead Centre, in collaboration with initial GRUAN sites, CBS, CIMO and WG-ARO will develop a manual for operating practices at GRUAN sites; the manual will be included in the WMO regulatory material. At its 8th session in June 2008, the CBS Management Group agreed to recommend formal establishment of GRUAN to CBS-XIV in 2009.

**New actions July 2008:** (i) Radiosonde inter-comparison is planned for 2010 under the auspices of GCOS and CIMO, to determine the best set of instrumentation and practices for GRUAN sites; (ii) it is recommended that the working group on reference radiosonde observations be made aware of the WIGOS pilot projects, and the GRUAN development advance in the spirit of such projects.

**GN5. Maintain and expand the Baseline Surface Radiation Network to obtain global coverage.** Data are used for climate monitoring and to provide valuable observations for the validation
of earth radiation budget satellite data.

**Action July 2008:** WMO Secretariat to seek commitment from Members to provide continuity for these measurements.

**GN7. Improve the accuracy of precipitation estimates from remotely sensing systems.** This applies in particular to rain estimates from satellites and weather radar.

**Comment:** ET-EGOS chair to bring this to the attention of ET-SAT and the developers working on the algorithms to exploit radar measurements.

**Update July 2008:** The IPWG, which will meet in Beijing next October, is the appropriate forum to address this recommendation, but ET-EGOS may consider whether additional input from ET-SAT is needed. The Chair of ET-SAT sent an email to the Co-Chairs of the IPWG to request them to respond to this recommendation at the next IPWG meeting.

**New action July 2008:** Add an agenda item for ET-SAT-4 to discuss this issue (see http://www.wmo.int/pages/prog/sat/meetings/ET-SAT-SUP-4.html).

3. **Evolution of space-based sub-system of GOS**

**A balanced GOS - Concern 1 - LEO/GEO balance**

There has been commendable progress in planning for future operational geostationary satellites. In addition to the plans of China, EUMETSAT, India, Japan, Russian Federation and USA, WMO has been informed of the plans of the Republic of Korea to provide geostationary satellites. The Republic of Korea has made a formal declaration to WMO and is now considered part of the space-based component of the GOS. These developments increase the probability of good coverage of imagery and sounding data from this orbit, together with options for adequate back-up in case of failure. On the other hand, current plans for LEO missions are unlikely to fulfill all identified requirements. It would be timely for the WMO Space Programme and/or CGMS to study the balance between polar and geostationary systems and to advise if there is scope for optimizing this balance between the two systems in the long-term.

**Progress Jul 08:** The optimal use of the GEO-LEO complementarity is one aspect of the optimization and re-design of the space-based observing system initiated in 2006. The first optimization workshop has reviewed the planned locations of geostationary satellites and proposed to take advantage of additional satellite capabilities to increase robustness of the geostationary constellation.

**Next Actions Jul 08:** To bear in mind the desirable balance between GEO and LEO components in future global planning activities.

**A balanced GOS - Concern 2 - Achieving complementary polar satellite systems**

While no single satellite operator can provide all the LEO satellite missions needed to fulfill WMO requirements, this would be achievable through sharing of responsibility, investment and expertise among the various WMO Members contributing to the GOS, provided that the individual programmes of agencies can contribute to a globally planned system in a complementary fashion. Through this process, the goals of GEOSS could be greatly advanced. WMO Space Programme Office is encouraged to facilitate this process in fostering the development of an agreed vision of the future GOS, addressing any obstacles to progress, and identifying opportunities for international partnerships, an example of which is the NOAA-EUMETSAT Joint Polar System.

**Progress Jul 08:** Following the two optimization workshops held in 2006 and 2007 the development of a new vision for the GOS to 2025 is well underway.

**Next actions Jul 08:** To refine and adopt a new vision for the GOS in 2025 that would provide guidance on how individual agencies’ plans can best contribute to a globally optimized system in a complementary fashion.
**Calibration**

**S1. Calibration** - There should be more common spectral bands on GEO and LEO sensors to facilitate inter-comparison and calibration adjustments; globally distributed GEO sensors should be routinely inter-calibrated using a given LEO sensor and a succession of LEO sensors in a given orbit (even without the benefit of overlap) should be routinely inter-calibrated with a given GEO sensor.

**Comment:** A major issue for effective use of satellite data, especially for climate applications, is calibration. GCOS Implementation Plan (GIP) Action C10 calls for continuity and overlap of key satellite sensors. The advent of high spectral resolution infrared sensors (AIRS, IASI, to be followed by CrIS) enhances the possibilities for accurate intercalibration. As regards visible channels, MODIS offers very comprehensive onboard shortwave solar diffuser, solar diffuser stability monitor, spectral radiometric calibration facility, that can be considered for inter-comparison with geosynchronous satellite data at visible wavelengths. MERIS appears to have merit in this area due to its programmable spectral capability, if implemented. GOES-R selected ABI channels have been selected to be compatible with VIIRS on NPOESS. This only deals with optical sensors, and other sensor types (e.g., active, passive, MW) should be considered. The Global Space-based Inter-Calibration System (GSICS) has been established to ensure comparability of satellite measurements provided through different instruments and satellite programmes and to tie these measurements to absolute references. GSICS activities will ultimately include: regular processing of VIS-IR-MW radiances from co-located scenes of GEO and LEO satellites, with common software tools as well as: pre-launch instrument characterization; on-orbit calibration against on-board, space or earth-based references; calibration sites and field campaigns; radiative transfer modelling.

**Progress Jul 08:** CMA, CNES, EUMETSAT, JMA, KMA, NASA, NIST and NOAA are joining their efforts in GSICS. LEO to LEO intercalibration is performed on a routine basis by NOAA. A common procedure has been developed in order to perform GEO to LEO IR intercalibration in a similar way for each geostationary satellite. Hyperspectral sensors such as MODIS and IASI are taken as references in order to account for differences in Spectral Response Functions of the various broadband instrument channels. Results are available on a routine basis through the GSICS website (http://www.wmo.int/pages/prog/sat/Calibration.html).

**Next Action Jul 08:** To pursue the implementation of GSICS with the expectation that GEO to LEO IR intercalibration becomes fully operational at global scale in 2009, and then extended to visible channels.

**S2. GEO Imagers** - Imagers of future geostationary satellites should have improved spatial and temporal resolution (appropriate to the phenomena being observed), in particular for those spectral bands relevant for depiction of rapidly developing small-scale events and retrieval of wind information.

**Progress Jul 08:** The following geostationary satellite operators have reported at CGMS that they will have at least SEVIRI-like capability before 2015: EUMETSAT (present), Russian Federation (2008). By 2015, future generation satellites should provide further improved imaging capabilities: GOES-R (NOAA), MTSAT-FO (JMA), FY-4-O (CMA) and MTG (EUMETSAT).

**Next Actions Jul 08:** WMO Space Programme will continue discussions with space agencies, via CGMS; IMD plans need clarification.

**S3. GEO Sounders** - All meteorological geostationary satellites should be equipped with hyperspectral infrared sensors for frequent temperature/humidity sounding as well as tracer wind profiling with adequately high resolution (horizontal, vertical and time).

**Comment:** Infrared hyperspectral sensors should be required on all operational geostationary
satellites as a high priority for meeting existing user requirements in numerical weather prediction (NWP), nowcasting, hydrology and other applications areas. Based on the experience gained from classical IR sounding from GEO satellites and from hyper-spectral Infrared sounding from LEO satellites, hyper-spectral sensors on GEO satellites are expected to enable a breakthrough, in particular for regional and convective-scale NWP; it would help to overcome current limitations of rapidly evolving severe weather forecasting.

In addition, in order to ensure a timely and optimal preparation of the user community, to optimize the positive impact of this new instrument type, and as a risk reduction measure to refine the specifications of the relevant operational ground segments, it would be very useful to proceed with a preparatory mission in advance of the operational flights.

**Progress Jul 08:**

- CMA has plans for its FY-4/Optical series by 2014; EUMETSAT has included IRS in the Phase A baseline for the MTG sounder series planned for launch around 2017; NOAA is re-considering options for a hyperspectral sounding instrument on GOES-R series; JMA is exploring the possibility of such development for MTSAT-Follow-on.

- The CEOS Strategic Implementation Team has agreed an action to WMO to seek confirmation of plans for geostationary hyperspectral sounders on MTG and FY-4-O, by end 2008, and GOES-S and MTSAT-FO, later (Action WE-06-02_4).

- The US prototype instrument GIFTS is available and could be used for a preparatory mission if funding could be identified to upgrade the current engineering unit to the status of pre-operational space qualified instrument.

- Opportunities for international cooperation on such a demonstration mission are being explored by CGMS in the context of the International Geostationary Laboratory (IGeoLab), noting a flight opportunity for GIFTS on board of the geostationary satellite Elektro-L 2 planned for launch in 2010.

**Progress September 08:**

- JMA informed ET-SAT/SUP that an hyper-spectral sounder is no longer considered for MTSAT follow-on.

**Next Actions Jul 08:**

- WMO to encourage geostationary satellite operators to confirm and implement their plans for GEO hyperspectral instruments.

- WMO to pursue in the meantime the initiatives towards flying a preoperational hyperspectral sounder in geostationary orbit in advance of 2015, as a preparatory mission, in order to allow risk reduction and optimal benefit of the planned operational missions.

**S4. GEO System Orbital Spacing** - 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. This will provide global coverage without serious loss of spatial resolution (with the exception of Polar Regions). In addition, this provides for a more substantial backup capability should one satellite fail. In particular, continuity of coverage over the Indian Ocean region is of concern.

**Comment:** The nominal configuration of the operational geostationary constellation should guarantee both system reliability and product accuracy. The 5-satellite system that has been maintained through recent years is not sufficient to meet these needs in the long-term.
Progress Jul 08: WMO Space Programme office submitted a proposal to CGMS-35 in November 2007 for a geostationary locations scheme where inter-satellite separation would not exceed 60° longitude, and an action was agreed by satellite operators to review the constraints and flexibility of future geostationary locations.

Next Actions Jul 08: WMO and CGMS satellite operators to explore further the possibility to reduce the maximum longitude separation between future adjacent geostationary satellites.

LEO satellites

S5. LEO data timeliness - More timely data are needed to improve utilization, especially in NWP. Improved communication and processing systems should be explored to meet the timeliness requirements in some applications areas (e.g., Regional and Global NWP).

Comment: There are several avenues to improve timeliness of LEO satellite data. The use of both an Arctic and Antarctic data acquisition station allows the collection of global data with no blind orbit and with a limited on-board storage time. A network of ground stations distributed around the globe such as the NPOESS SafetyNet allows further reducing the latency of global data. A complementary approach is to collect and retransmit direct readout data following the concept of the Regional ATOVS Retransmission System (RARS). For the long-term, the use of Data Relay Satellites can also be considered.

Progress Jul 08: The current goal of the RARS project is to ensure that over 90% of the global ATOVS datasets can be acquired and retransmitted within 30 minutes. The RARS network includes the EUMETSAT EARS, the Asia-pacific RARS and the South-American RARS. Mid 2008, the coverage exceeds 75% of the globe and it is expected to reach 85% in 2009 thanks to planned extensions on Pacific islands, Africa and the Pacific coast of South-America. It is considered to extend the RARS approach to advanced sounders such as IASI, AIRS, and other time-critical data such as ASCAT.

The applicability to IASI data is subject to the reactivation of Metop HRPT, the capability of RARS receiving stations to receive Metop, and the reduction of data volume through eigenvector compression. The FY-3A satellite that was launched in May 2008 includes an IR and MW sounding capability (IRAS, MWTS, MWHS) and a direct readout capability in X-band and L-band (MPT, AHRPT) that could be considered for an extension of the RARS.

After complete implementation of the NPOESS SafetyNet, 80% of NPOESS global data should be acquired within 15 min, which would be consistent with the stated timeliness requirements for NWP, provided that provisions are made for the timely redistribution of these data towards international NWP centres. However the SafetyNet will not be available for NPP and, by the launch of NPOESS-C1, it would only be partly implemented with McMurdo and Svalbard but not all its 14 stations. Acquiring and distributing sounding data (CrIS, ATMS) from NPP and NPOESS-C1 through a RARS-type arrangement would be a useful gap-filler until data timeliness can be ensured through the SafetyNet. It would enhance the benefit of the NPP and NPOESS missions and minimize the negative impact of phasing out the last ATOVS instruments.

The use of direct broadcast imagery received at high-latitude stations enables derivation of polar winds with optimal timeliness.

Additionally, ERS-2 GOME and scatterometer data are now available in near real time (within 30 minutes) in the coverage region of ESA (e.g., Europe and North Atlantic) and cooperating ground stations (e.g., Beijing and Perth).

Next Actions Jul 08: WMO and the RARS Implementation Group to complete the implementation of the RARS network; to encourage the implementation of similar plans for LEO imagery from high-latitude stations for the timely derivation of polar winds; to consider an
extension of the RARS project to include FY-3 sounding data.

WMO and the RARS Implementation Group, in cooperation with the NPOESS Integrated Program Office, to prepare an extension of the RARS project to include NPP and NPOESS sounding data as a gap filling measure until timely availability of this data can be ensured worldwide through the SafetyNet; to consider a possible demonstration step with Aqua/AIRS data.

S6. **LEO temporal coverage** - Coordination of orbits for operational LEO missions is necessary to optimize temporal coverage while maintaining some orbit redundancy.

**Comment:** Coordinated orbital planning for both nominal and contingency situations is a permanent action of CGMS. On one hand, the orbital planes of sun-synchronous operational missions should be distributed to take advantage of the available spacecraft to improve the temporal coverage. On the other hand, Equatorial Crossing Times (ECT) should be stable to ensure homogeneity of long-term climate data records. Following the Re-design and Optimization Workshop in June 2007, a recommended scenario is to maintain the core operational LEO satellites in a 3-orbit configuration, with 4-hour nominal separation between ECT. If two or more satellites can perform comparable missions in the same orbital plan, they should preferably be synchronized and maintained with a phase difference allowing an optimal refresh cycle and ground track separation.

**Progress Jul 08:** A 3-orbit configuration (13:30, 17:30, 21:30 LST) for core LEO sun-synchronous missions has been proposed as part of the new vision for the GOS in 2025 and discussed with CGMS and CEOS. There are plans for populating these 3 orbits over the coming decades, however the planned missions currently do not include sounding on the early morning orbit. The CEOS Strategic Implementation Team agreed that WMO should propose a plan for operational IR and MW sounding from the early morning orbit.

**Next Action Jul 08:** To refine the new Vision of the GOS to 2025 with respect to orbital configuration of sun-synchronous operational missions, and discuss its implementation with CGMS and CEOS satellite operators.

S7. **LEO Sea Surface Wind** - Sea-surface wind data from R&D satellites should continue to be made available for operational use; 6-hourly coverage is required.

**Comment:** GCOS (GIP, Action A11) calls for continuous operation of AM and PM satellite scatterometers or equivalent. QuikScat scatterometer data have been available to the NWP community since 1999, and will continue through the life of QuikScat (NASA has no current plans for a successor SeaWinds scatterometer). Oceansat-2 has scatterometer capability that may be made available to the world community (this availability needs to be confirmed). The relative performance of the multi-polarisation passive MW radiometry versus scatterometry requires further assessment.

**Progress Jul 08:** For scatterometry, ERS-2 scatterometer has been followed by ASCAT on METOP, sea surface wind is thus being observed in an operational framework since 2007. There are plans for a scatterometer aboard the Indian Oceansat-2 and the Chinese HY-2 series, although data availability still needs confirmation.

Following the Windsat demonstration mission, early assessments of the microwave imagery polarimetric capabilities to provide information on sea surface wind direction suggest that, while this technology will not be competitive with scatterometry at low wind speed, good information is available at high wind speed.

The revised NPOESS baseline includes a microwave imager/sounder (MIS) expected to provide wind speed and direction information at sea surface starting with NPOESS-C2 in 2016.
A preliminary proposal for an Ocean Surface Wind constellation was presented by NOAA, EUMETSAT and ISRO at the CEOS Strategic Implementation Team and it was agreed to prepare a full proposal.

**Next Actions Jul 08:** Satellite operators should maintain at least 2 scatterometers and 2 full polarimetric microwave imaging missions in order to achieve both sufficient accuracy and coverage. WMO shall bring this recommendation to the attention of CGMS.

**S8. LEO Altimeter** - Missions for ocean topography should become an integral part of the operational system.

**Comment:** GCOS (GIP, Action O12) requires continuous coverage from one high-precision altimeter and two lower-precision but higher-resolution altimeters.

**Progress Jul 08:** Jason-1 continues to provide global ocean topography data to the NWP community. Jason-2 was successfully launched in June 2008. ESA has plans for a Sentinel-3 ocean mission that will include an altimeter. Cryosat-2 is planned for 2009, HY-2A in 2010. Jason-2 follow-on funding is still to be confirmed. China has not yet confirmed the availability of HY-2A data for WMO Members, noting that the HY-2A mission is not managed by CMA but by the State Oceanic Administration (SOA). Substantial agreement of the community was achieved on the concept of a constellation for Ocean Surface Topography including at least one reference altimetry mission plus 2 additional altimeter systems on higher inclination to ensure global coverage.

**Next Actions Jul 08:** WMO Space Programme to continue to work with CGMS Satellite operators and CEOS Constellation on Ocean Surface Topography in order to confirm the plans and ensure continuity of at least one reference altimetry mission plus 2 additional altimeter systems on higher inclination to ensure global coverage.

WMO Space Programme to request China to clarify intentions for sharing HY-2A data.

**S9. LEO Earth Radiation Budget** - Continuity of ERB type global measurements for climate records requires immediate planning to maintain broadband radiometers on at least one LEO satellite.

**Comment:** Plans for ERB-like measurements after Aqua remain uncertain. There are also concerns about the continuity of absolute measurements of incoming solar radiation. This is a high priority item for GCOS (GIP, Action A24).

**Progress Jul 08:** FY-3A and FY-3B will have a prototype Earth Radiation Budget Unit (ERBU) in 2008/2009. NPP in 2010 and possibly the first NPOESS satellite (likely launch in 2013) are expected to carry the CERES instrument. The observation strategy proposed by the GOS Re-design and Optimization workshop, and confirmed by GCOS AOPC, calls upon one LEO broad-band multi-angle viewing radiometer, complemented by collocated cloud properties, aerosol and water vapour measurements, complementary geostationary diurnal cycle information, as well as Total Solar Irradiance measurement. In particular, satellite-derived information on the absorption properties of aerosols are urgently required to better understand the ERB and evaluate the contribution of aerosol radiative forcing.

**Next Actions Jul 08:** To confirm or refine the recommended observation strategy with support of GCOS and the science community and to work with satellite operators towards its implementation.

**R&D satellites**

**S10. LEO Doppler Winds** - Wind profiles from Doppler lidar technology demonstration programmes (such as ADM-Aeolus) should be made available for initial operational testing; a follow-on
long-standing technological programme is solicited to achieve improved coverage characteristics for operational implementation.

Progress Jul 08: Plans for ADM-Aeolus demonstration are proceeding with a launch now planned for May 2010; ESA and ECMWF are developing software for processing Doppler winds prior to their assimilation into NWP models; resulting winds will be available on the GTS. Scenarios for a preparatory mission and operational follow on are under consideration. EUMETSAT is considering the requirements for observations of the 3D wind field as part of their planning for post-EPS missions. NASA/GSFC has performed an accommodation study for a Doppler wind lidar on next generation NPOESS.

Next Actions Jul 08: WMO Space Programme will continue to discuss with space agencies, via CGMS and WMO Consultative Meetings on High-level Policy on Satellite Matters, to ensure that the demonstration with ADM-Aeolus can be followed by a transition to operational systems for wind profile measurement. Plans for continuity of a Doppler Winds capability following ADM-Aeolus should be further discussed by CGMS satellite operators in 2008.

S11. GPM - The concept of the Global Precipitation Measurement Missions (combining active precipitation measurements with a constellation of passive microwave imagers) should be supported and the data realized should be available for operational use, thereupon, arrangements should be sought to ensure long-term continuity to the system.

Comment: GCOS (GIP Action A7) requires stable operation of relevant operational satellite instruments for precipitation and associated products.

Progress Jul 08: TRMM continues to provide valuable data for operational use. Early termination of TRMM after 2004 was averted after user community appeals for its continuation. NASA has assured continued operation into 2009. In 2005, ESA’s European GPM was not selected as the next Earth Explorer Mission. At the fifth International planning workshop WMO expressed its support and its readiness to facilitate partnerships to expand the GPM constellation. It was recognized that ISRO’s Megha-tropiques has a passive microwave capability that is not yet part of the GOS but could be useful in the GPM constellation (availability needs to be confirmed). Other R&D and operational satellites in polar orbit may contribute to the constellation with their microwave radiometers. GPM was addressed at the 6th Consultative Meeting (Buenos Aires, January 2006) and its importance was stressed. The GPM core satellite is now planned for launch in July 2013. Timely implementation of the GPM mission was identified as an action in the GEO work plan. CEOS has created a “Global Precipitation Constellation” initiative in order to coordinate efforts to take advantage of existing instruments while preparing the GPM mission.

Next Actions Jul 08: WMO Space Programme to continue to support initiatives for the timely implementation of GPM.

S12. RO-Sounders - The opportunities for a constellation of radio occultation sounders should be explored and operational implementation planned. International sharing of ground support network systems (necessary for accurate positioning in real time) should be achieved to minimize development and running costs.

Comment: GCOS (GIP Action A20) requires sustained, operational, real-time availability of GPS RO measurements.

Progress Jul 08: SAC-C, CHAMP and COSMIC data have been successfully used in an operational context and the use of METOP/GRAS is starting. NWP OSEs have shown positive impact with small number of occultations. Climate applications are being explored. The GOS Re-design and Optimization Workshop clearly recommended constellations of small satellites with radio-occultation sensors. Upon proposal by WMO, CGMS-34 took an action to explore opportunities for cooperation on ground support network.
Next Actions Jul 08: Within the CEOS Strategic Implementation Team (Apr 08), NOAA agreed to complete by end September 2008 the assessment of requirements needed to perform an OSSE to compare the operational benefits of the various ROS constellation options identified by the WMO Re-design and Optimization Workshop in June 2007. OSSEs would then be undertaken in 2009. Plan for a constellation providing operational follow-on to COSMIC should be discussed by CGMS.

S13. GEO Sub-mm for precipitation and cloud observation - An early demonstration mission on the applicability of sub-mm radiometry for precipitation estimation and cloud property definition from geostationary orbit should be provided, with a view to possible operational follow-on.

Progress Jul 08: Geo sub-mm is one of two systems being considered for IGeoLab. A task team evaluated the IGeoLab possibilities for a Geostationary Observatory for Microwave Atmospheric Sounding (GOMAS) as well as other possible instruments. This type of instrument in geosynchronous orbit is high priority for meeting existing user requirements in numerical weather prediction (NWP), nowcasting, hydrology and other applications areas. GOMAS was not accepted by ESA as a core Explorer mission.

Studies on GEO MW have continued in the context of IGeoLab. A GEO MW IGeoLab Focus Group workshop was held in April 2007 in Beijing and made a proposal to CGMS-XXXV to investigate two scenarios, one based on filled aperture antenna and the other based on synthetic aperture antenna. Choice between the two technologies is also linked to the relative priority given to the detection of precipitation and rapid vertical sounding.

Next Actions Jul 08: WMO Space Programme will continue supporting this IGeoLab action and subsequent dialogue with space agencies, via CGMS.

New comment Jul 08: It is planned to convene the IGeoLab GEO MW focus Group in October 2008 in Beijing, during IPWG timeframe. Mission requirements for a Phase A study of a microwave sounder on FY-4M will be discussed.

S14. LEO soil moisture and ocean salinity - The capability to observe ocean salinity and soil moisture for weather and climate applications (possibly with limited horizontal resolution) should be demonstrated in a research mode (as with ESA’s SMOS and NASA’s Aqua, and NASA/CONAE Aquarius/SAC-D) for possible operational follow-on. Note that the horizontal resolution from these instruments is unlikely to be adequate for salinity in coastal zones and soil moisture on the meso-scale.

Progress Jul 08: ERS scatterometer data sets have provided monthly global soil moisture maps since 1991 at 50 km resolution. EUMETSAT delivers an operational global NRT soil moisture product from Metop/ASCAT data. WindSat and AMSR-E are being studied for possible utility of 6 and 10 GHz measurements for soil moisture for sparsely vegetated surfaces. SMOS is scheduled for launch in April 2009. Aquarius is scheduled for launch in May 2010.

Next Actions Jul 08: WMO Space Programme will discuss at CGMS progress and options for provision of soil moisture and salinity products including real-time delivery of soil moisture products for NWP.

S15. LEO SAR - Data from SAR should be acquired from R&D satellite programmes and made available for operational observation of a range of geophysical parameters such as wave spectra, sea ice, and land surface cover.

Progress Jul 08: The wave spectra from ENVISAT are available in near real-time from an ESA ftp server. CSA’s RADARSAT data are used in deriving ice products by the National Ice Center. Continuity of ESA SAR mission is considered as part of the Sentinel programme.
**Next Actions Jul 08**: WMO Space Programme to continue to discuss with space agencies, via CGMS, (1) broader access by WMO Members to ENVISAT SAR data, (2) availability of SAR data from other agencies, and (3) continuity of such missions.

S16. **LEO Aerosol** - Data from process study missions on clouds and radiation as well as from R&D multi-purpose satellites addressing aerosol distribution and properties should be made available for operational use.

**Comment**: Terra and Aqua carry the MODIS sensor that is providing global aerosol products over ocean and most land regions of the world at 10 km spatial resolution. Additional R&D satellites currently providing aerosol optical thickness and optical properties include Terra/MISR, PARASOL and Aura/OMI. CALIOP carries an R&D lidar for monitoring the vertical distribution of aerosols along the orbital ground track of the spacecraft, which is in the A-train orbit along with Aqua, PARASOL, CloudSat, and Aura. NASA's Glory mission (2008) has added APS, an aerosol polarimetry sensor. ESA and JAXA are preparing the Earthcare (cloud/aerosol mission) for launch in 2013.

**Next Actions Jul 08**: WMO Space Programme will continue discussions with space agencies, via CGMS, CM, and via CEOS Constellation for Atmospheric Composition, regarding availability of these data for operational use.

S17. **Cloud Lidar** - Given the potential of cloud lidar systems to provide accurate measurements of cloud top height and to observe cloud base height in some instances (stratocumulus, for example), data from R&D satellites should be made available for operational use.

**Comment**: GLAS data are currently able to determine vertical distribution of cloud top altitude along the nadir ground track of ICESat, but this spacecraft operates in ~100 day epochs and is not continuous. CALIOP on CALIPSO makes such data routinely available in the A-train orbit (with Aqua, PARASOL, CloudSat, and Aura). ADM-Aeolus is expected to contribute to cloud measurements.

**Next Actions Jul 08**: WMO Space Programme will discuss with space agencies, via CGMS and at CM, near real time operational use of these data and operational follow-on planning.

S18. *(Recommendation S18 is to be found in Section “Process studies” below)*

S19. **Limb Sounders** - Temperature profiles in the higher stratosphere from already planned missions oriented to atmospheric chemistry exploiting limb sounders should be made operationally available for environmental monitoring.

**Progress Jul 08**: MIPAS and SCIAMACHY data are available in near real time from the ESA ftp server.

**Next Actions Jul 08**: WMO Space Programme will discuss with space agencies, via CGMS, progress/plans for distribution of data from MIPAS and SCIAMACHY on ENVISAT, from MLS and HIRDLS on Aura, and from similar instruments.

S20. **Active Water Vapour Sensing** - There is need for a demonstration mission of the potential of high-vertical resolution water vapour profiles by active remote sensing (for example by DIAL) for climate monitoring and, in combination with hyper-spectral passive sensing, for operational NWP.

**Next Actions Jul 08**: WMO Space Programme will discuss with space agencies, via CGMS.

S21. **Lightning Observation** - There is a requirement for global observations of lightning. Several initiatives for operational space-based implementation exist. These should be encouraged to fruition.
Comment: NASA’s observations of lightning from OrbView-1/OTD and TRMM/LIS have demonstrated that 90% of lightning occurs over land, and that it is heavily tied to deep convection. In addition to its importance in severe storms and warnings for safety, lightning is an importance source of NOx and thus contributes to elevated levels of tropospheric ozone.

Progress Jul 08: The dynamics of lightning occurrence and its importance for nowcasting has been recognized by NOAA that plans to include a lightning sensor on GOES-R and CMA that plans a lightning mapper on FY-4. It is under consideration by EUMETSAT for MTG.

Next Actions Jul 08: WMO Space Programme will continue to monitor the issue with space agencies, via CGMS.

S22. Formation Flying - Advantages of formation flying need to be investigated.

Comment: NASA has already demonstrated both a morning constellation (involving Landsat 7, EO-1, SAC-C, and Terra) and an afternoon constellation (Aqua, PARASOL, Aura, CloudSat and CALIPSO, soon to be joined by OCO (December 2008)). These multi-agency and multi-country constellations demonstrate the added value of coordination of Earth observations to make a polar orbiting system greater than the sum of the parts, but able to launch when sensors and spacecraft are ready and available.

Next Actions Jul 08: The utility of data from sensors flying in formation need to be assessed. WMO Space Programme will discuss with space agencies, via CGMS.

Process studies

In reviewing the Implementation Plan for the Evolution of the Global Observing System, and notwithstanding other potential requirements, the need for following process study mission was identified:

S18. LEO Far IR - An exploratory mission should be implemented, to collect spectral information in the Far IR region, with a view to improve understanding of water vapour spectroscopy (and its effects on the radiation budget) and the radiative properties of ice clouds.

Next Actions Jul 08: WMO Space Programme to discuss with space agencies, via CGMS.

Additional recommendations for Climate Monitoring

Long-term continuity of observations shall be ensured for the following Essential Climate Variables, which are not addressed within the recommendations above:

- Ocean colour (GIP, Action O18);
- Sea ice (GIP, Action O23);
- Cryosphere (GIP, Action T14); and,
- Land cover (GIP, Action T24).

Detailed requirements for these observations are contained in the Satellite Supplement to the GCOS Implementation Plan (GIP) “GCOS Systematic Observations Requirements for Satellite-based Products for Climate” (GCOS-107, September 2006, WMO/TD N°1338).
4. Considerations for evolution of the GOS in developing countries

4.1 In preparing this Implementation Plan, it was noted that redesign of the GOS included several special considerations and issues that involve developing countries. In many areas of Africa, Asia, and Latin America (Regions I, II, and III and some tropical areas between 25N and 25S), the current GOS provides no observations, whereas in other areas observations should be improved. When looking at candidate observing systems, consideration must be given not only to NWP but also to many other applications, including human forecasting. The evolution of the GOS in developing countries must address some of the issues that fall in three categories: (a) lack of public infrastructure such as electricity, telecommunication, transport facilities, etc., (b) lack of expertise from people to do the job, training, etc., and (c) funding for equipment, consumables, spare parts, manpower, etc. The lack of infrastructure and expertise may be the result of a lack of funding.

4.2 The evolution must take into account upgrading, restoring, substitution and capacity building (especially in the use of new technologies). Two aspects need to be considered: the data production and the data use. It is possible that some countries do not and will not be able to produce data and will therefore only be users of data. To help developing countries produce data for international exchange, due consideration must be given to the three issues previously identified i.e. public infrastructure, expertise and funding.

4.3 Possible approaches towards the redesign have been discussed. A first step should be to identify observing systems that are less dependent on local infrastructure. In some circumstances, these include satellite, AMDAR, dropsondes, and AWS. Nonetheless, a minimum set of reliable RAOBs is required as a backbone to the GUAN and RBCN; these are also used to validate the satellite observations. Migration toward the table-driven codes (BUFR or CREX) as a reliable representation of the data is expected.

4.4 However, obtaining vertical profiles by AMDAR in many data sparse areas is worth testing. It must be recognized that AMDAR ascent/descent and *en route* data will provide little stratospheric information and currently no humidity data (although humidity sensors are being tested). It is imperative that useful approaches be drafted for studying the impact of additional observations (e.g. AMDAR) in regions of scarce conventional observations (e.g. RAOBS) and discuss possible observing system experiments to explore enhancing the observations on these areas. More generally the role of developing countries in the THORPEX through the regional associations should be explored.

4.5 Capacity building in some countries needs further attention. Some countries have satellite-receiving stations or receive satellite data through the GTS, but lack the expertise to utilize the information to their benefit. Some countries are acquiring Doppler radar but need training on how to retrieve the information. For example, Region I has benefited with expanded access to conventional data and satellite imagery through the PUMA project. This type of project should be expanded to include other data types for routine application (synoptic, aviation, nowcasting). Developments through the AMMA project offer a proposing route forward in some parts of Region I, and special attention should be paid to maintaining the selected parts of the network once the AMMA project has concluded.

4.6 If resources are available, the highest priority should go to (a) maintaining the RBSN and RBCN, noting that GSN and GUAN stations are part of the RBSN, and (b) to rehabilitate observing sites in critical locations.

4.7 Finally, the following recommendations should be taken into account when addressing the evolution of the GOS in developing countries:

- Define geographical areas using advanced techniques to help identify where priority should be if additional funding were available;
- Encourage regional associations in concert with CBS to define trial field experiments over data sparse areas, for a limited time, to evaluate how additional data would
contribute to improve performance at the regional and global scale. A clearly demonstrated impact might make it easier to agree on some coordinated funding mechanism for areas concerned including funding from GEF (Global Environmental Facilities) for climate stations;

- Examine whether automated stations could become a viable, cost effective alternative to manned stations for the surface network in the future;
- In data-sparse areas of the world, make full use of AMDAR ascent/descent data at major airports; however the RAOB network still plays an important role in human forecasting;
- When changes are made to the climate observing systems, the GCOS Climate Monitoring Principles should be followed;
- The telecommunication problems should be referred to the OPAG on ISS and looked at as a priority;
- Prioritize where the needs are most pressing for VCP or other funding.
- High priority should be given by the region and secretariat to maintain a minimum RAOB network with acceptable performance within data-sparse regions.
ANNEX A

ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>4DVAR</td>
<td>Four-Dimensional Variational Assimilation</td>
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<tr>
<td>ADM-Aeolus</td>
<td>Atmospheric Dynamics Mission (ESA)</td>
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<tr>
<td>AES</td>
<td>Atmospheric Environment Service (Canada)</td>
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<tr>
<td>AFIRS</td>
<td>Automated Flight Information Reporting System</td>
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<td>AIRS</td>
<td>Advanced Infra-red Sounder</td>
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<td>AMDAR</td>
<td>Aircraft Meteorological Data Delay</td>
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<td>AMSU</td>
<td>Advanced Microwave Sounding Unit</td>
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<td>AMV</td>
<td>Atmospheric Motion Vector</td>
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<tr>
<td>AOPC</td>
<td>Atmospheric Observation Panel for Climate</td>
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<tr>
<td>Argo</td>
<td>Array for Real-time Geostrophic Oceanography</td>
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<tr>
<td>ASCAT</td>
<td>Advanced Scatterometer</td>
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<tr>
<td>ASAP</td>
<td>Automated Shipboard Aerological Programme</td>
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<tr>
<td>ATOVS</td>
<td>Advanced TIROS Operational Vertical Sounder</td>
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<tr>
<td>AVHRR</td>
<td>Advanced Very High Resolution Radiometer</td>
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<td>AWS</td>
<td>Automatic Weather Station</td>
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<tr>
<td>BUFR</td>
<td>Binary Universal Form for the Representation of Meteorological Data</td>
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<tr>
<td>CALIOP</td>
<td>Cloud Aerosol Lidar with Orthogonal Polarization</td>
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<tr>
<td>CAS</td>
<td>Commission for Atmospheric Sciences</td>
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<td>CBS</td>
<td>Commission for Basic Systems</td>
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<tr>
<td>CGMS</td>
<td>Coordination Group for Meteorological Satellites</td>
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<tr>
<td>CHAMP</td>
<td>CHAllenging Minisatellite Payload</td>
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<tr>
<td>CIMO</td>
<td>Commission for Instruments and Methods of Observation</td>
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<td>CMA</td>
<td>China Meteorological Administration</td>
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<tr>
<td>COSMIC</td>
<td>Constellation Observing System for Meteorology, Ionosphere and Climate</td>
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<tr>
<td>COSNA</td>
<td>Composite Observing System for the North Atlantic</td>
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<tr>
<td>CREX</td>
<td>Character Form for the Representation and Exchange of Data</td>
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<tr>
<td>DIAL</td>
<td>Differential Absorption Lidar</td>
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<tr>
<td>E-AMDaR</td>
<td>EUMETNET-AMDaR</td>
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<tr>
<td>EARS</td>
<td>EUMETSAT ATOVS (now Advanced) Retransmission Service</td>
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<tr>
<td>ECMWF</td>
<td>European Centre for Medium-Range Weather Forecasts</td>
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<tr>
<td>EGPM</td>
<td>European (contribution to) Global Precipitation Measurement</td>
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<td>ERB</td>
<td>Earth Radiation Budget</td>
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<td>ESA</td>
<td>European Space Agency</td>
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<td>ET-EGOS</td>
<td>Expert Team (ET) on the Evolution of the Global Observing System (EGOS)</td>
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<td>EUCOS</td>
<td>EUMETNET Composite Observing System</td>
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<td>EUMETNET</td>
<td>European Meteorological Services Network</td>
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<tr>
<td>FASTEX</td>
<td>Fronts and Atlantic Storm Track Experiment</td>
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<tr>
<td>FY-4</td>
<td>Feng Yun-4 (Chinese geostationary satellite series)</td>
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<tr>
<td>GAW</td>
<td>Global Atmosphere Watch</td>
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<td>GCOS</td>
<td>Global Climate Observing System</td>
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<td>GEF</td>
<td>Global Environment Facility</td>
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<tr>
<td>GEO</td>
<td>Geostationary Orbit Satellite</td>
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<tr>
<td>GFTS</td>
<td>Geosynchronous Imaging Fourier Transform Spectrometer</td>
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<tr>
<td>GLAS</td>
<td>Geoscience Laser Altimeter System</td>
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</tbody>
</table>
GMES  Global Monitoring of Environment and Security
GNSS  Global Navigation Satellite System
GOES  Geostationary Operational Environmental Satellite
GOME  Global Ozone Monitoring Experiment
GOS  Global Observing System
GPM  Global Precipitation Measurement
GRAS  GNSS Receiver for Atmospheric Sounding
GSICS  Global Space-based Inter-Calibration System
GSN  GCOS Surface Network
GTS  Global Telecommunication System
GUAN  GCOS Upper-Air Network

HIRDLS  High Resolution Dynamic Limb Sounder
HIRS  High Resolution Infra-red Sounder

IASI  Infra-red Atmospheric Sounding Interferometer
IGDDS  Integrated Global Data Dissemination Service
IGEOLab  International Geostationary Laboratory for demonstration missions
IGOSS  Integrated Global Ocean Services System
IMD  India Meteorological Department
IOC  Intergovernmental Oceanographic Commission
IOS  IGOSS Observing System
IP  Implementation Plan
ISRO  Indian Space Research Organization

JASON  Ocean surface topography mission
JAXA  Japan Aerospace Exploration Agency
JCOMM  Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology
JMA  Japan Meteorological Agency

LEO  Low Earth Orbit
LIS  Lightning Imaging Sensor

MDS  Meteorological Data System
MERIS  Medium Resolution Imaging Spectrometer
METOP  Meteorological Operational Satellite (EUMETSAT)
MIPAS  Michelson Interferometer for Passive Instrument Sounding
MLS  Microwave Limb Sounder
MODIS  Moderate Resolution Imaging Spectroradiometer
MTG  Meteosat Third Generation
MTSAT-FO  Multi-purpose Transport Satellite Follow-On

NAOS  North Atlantic Ocean Stations
NASA  National Aeronautics and Space Administration
NESDIS  National Environmental Satellite, Data and Information Service
NMHSs  National Meteorological and Hydrological Service(s)
NOAA  National Oceanic and Atmospheric Administration
NPOESS  National Polar-orbiting Operational Environmental Satellite System
NPP  NPOESS Preparatory Program
NRT  Near-Real Time
NWP  Numerical Weather Prediction

OPAG  Open Programme Area Group
OSE  Observing System Experiments

PUMA  Preparation for the Use of Meteosat Second Generation (MSG) in Africa
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>R&amp;D</td>
<td>Research and Development (satellite)</td>
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<tr>
<td>RAOB</td>
<td>Radiosonde Observations</td>
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<td>RBCN</td>
<td>Regional Basic Climatological Network</td>
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<td>RRR</td>
<td>Rolling Requirements Review</td>
</tr>
<tr>
<td>SAC-C</td>
<td>Earth-observation satellite (CONAE, Argentina)</td>
</tr>
<tr>
<td>SAR</td>
<td>Synthetic Aperture Radar</td>
</tr>
<tr>
<td>SCHIAMACHY</td>
<td>Scanning Imaging Absorption Spectrometer for Instrumental Cartography</td>
</tr>
<tr>
<td>SEG</td>
<td>Scientific Evaluation Group of COSNA</td>
</tr>
<tr>
<td>SEVIRI</td>
<td>Spinning Enhanced Visible and Infrared Imager</td>
</tr>
<tr>
<td>SMOS</td>
<td>Soil Moisture and Ocean Salinity satellite</td>
</tr>
<tr>
<td>SVPB</td>
<td>Surface Velocity Program Barometer drifter</td>
</tr>
<tr>
<td>TAMDAR</td>
<td>Tropospheric Airborne Meteorological Data Reporting</td>
</tr>
<tr>
<td>THORPEX</td>
<td>The Observing System Research and Predictability EXperiment</td>
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<tr>
<td>TRMM</td>
<td>Tropical Rainfall Measuring Mission</td>
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<tr>
<td>UAV</td>
<td>Unmanned Aerial Vehicle</td>
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<tr>
<td>VCP</td>
<td>Voluntary Co-operation Programme</td>
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<tr>
<td>VIIRS</td>
<td>Visible Infrared Imager Radiometer Suite</td>
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<tr>
<td>WIGOS</td>
<td>WMO Integrated Global Observing System</td>
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<tr>
<td>WMO</td>
<td>World Meteorological Organization</td>
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<tr>
<td>WOTAN</td>
<td>Wind Observation Through Ambient Noise</td>
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<tr>
<td>WVSS</td>
<td>Water Vapour Sensing System</td>
</tr>
<tr>
<td>WWWW</td>
<td>World Weather Watch</td>
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<tr>
<td>XBT</td>
<td>Expendable Bathy Thermograph</td>
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<tr>
<td>ZTD</td>
<td>Zenith Total Delay</td>
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</tbody>
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ANNEX B

VISION FOR THE GOS in 2015

In drafting the recommendations for an evolved GOS and then the Implementation Plan, the ET was guided by the following vision for the GOS in 2015 and beyond, as adopted by CBS (CBS-Ext(06)), Cairns, 1-12 December 2002.

For the space-based sub-system, there would be:

6 operational GEOs
- all with multi-spectral imager (IR/VIS)
- some with hyper-spectral sounder (IR)

4 operational LEOs
- optimally spaced in time
- all with multi-spectral imager (MW/IR/VIS/UV)
- all with sounder (MW)
- three with hyper-spectral sounder (IR)
- all with radio occultation (RO)
- two with altimeter
- three with conical scan MW or scatterometer

Several R&D satellites serving WMO members
- constellation of small satellites for radio occultation (RO)
- LEO with wind lidar
- LEO with active and passive microwave precipitation instruments
- LEO and GEO with advanced hyper-spectral capabilities
- GEO lightning
- possibly GEO microwave

All with improved inter-calibration and operational continuity.

For the surface-based sub-system, there would be:

Automation to enable
- targeting of observations in data sensitive areas
- optimal operation of
  - radiosondes
  - ASAP systems
  - aircraft in flight

Radiosondes
- optimized utilization
- stable and functioning RBSN, RBCN and GUAN
- supplemented by
  - AMDAR ascent/descent
  - ground-based GPS water vapour information
  - wind profilers
  - satellite soundings
- automatically launched
- computerized data processing
- real-time data transmission
- high vertical resolution
Commercial aircraft observations
- of temperature & wind plus humidity on some aircraft
- In-flight and ascent/descent data
- high temporal resolution
- available from most airports including currently data void airports in Asia, Africa and South America.
- possibly supplemented with UAVs

Surface observations
- stable and functioning RBSN, RBCN and GSN
- automated systems
- land sensors at high spatial resolution, supporting local applications such as road weather
- ocean platforms (ship, buoys, profiling floats, moorings) in adequate number to complement satellite measurements

Radar observing systems measuring
- radial winds
- hydrometeor distribution and size
- precipitation phase, rate, and accumulation
- multiple cloud layers, including base and top height.

Data collection and transmission
- digital in a highly compressed form
- entirely computerized data processing
- role of humans in observing chain reduced to minimum
- information technology in all areas of life will provide new opportunities for obtaining and communicating observations
- for satellite data in particular
  - use of ADM including regional/special DCPC in the context of FWIS
  - DB for special local applications in need on minimal time delay and as backup
VISION FOR THE GOS IN 2025
(Draft dated 18 September 2008)

PREAMBLE

This Vision provides high-level goals to guide the evolution of the Global Observing System in the coming decades. These goals are intended to be challenging but achievable.

The future GOS will build upon existing sub-systems, both surface- and space-based, and capitalize on existing and new observing technologies not presently incorporated or fully exploited. Incremental additions to the GOS will be reflected in better data, products and services from the National Meteorological and Hydrological Services (NMHSs); this will be particularly true for developing countries and LDCs.

The scope of these changes to the GOS will be major and will involve new approaches in science, data handling, product development and utilization, and training.

1. GENERAL TRENDS AND ISSUES

Response to user needs

• The GOS will provide comprehensive observations in response to the needs of all WMO Members and Programmes for improved data products and services, for weather, water and climate;
• It will continue to provide effective global collaboration in the making and dissemination of observations, through a composite and increasingly complementary system of observing systems;
• It will provide observations when and where they are needed in a reliable, stable, sustained and cost-effective manner;
• It will respond to user requirements for observations of specified spatial and temporal resolution, accuracy and timeliness; and,
• It will evolve in response to a rapidly changing user and technological environment, based on improved scientific understanding and advances in observational and data-processing technologies.

Integration

• The GOS will have evolved to become part of the WIGOS1, which will integrate current GOS functionalities, which are intended primarily to support operational weather forecasting, with those of other applications: climate monitoring, oceanography, atmospheric composition, hydrology, and weather and climate research;
• Integration will be developed through the analysis of requirements and, where appropriate, through sharing observational infrastructure, platforms and sensors, across systems and with WMO Members and other partners.

Expansion

• There will be an expansion in both the user applications served and the variables observed;
• This will include observations to support the production of Essential Climate Variables, adhering to the GCOS climate monitoring principles;
• Sustainability of new components of the GOS will be secured, with some R&D systems integrated as operational systems;
• The range and volume of observations exchanged globally (rather than locally) will be increased;
• Some level of targeted observations will be achieved, whereby additional observations are acquired or usual observations are not acquired, in response to the local meteorological situation.

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1 Assuming CBS endorse the move to the WIGOS structure
Automation

- The trend to develop fully automatic observing systems, using new observing and information technologies will continue, where it can be shown to be cost-effective;
- Access to real-time and raw data will be improved;
- Observing system test-beds will be used to intercompare and evaluate new systems and develop guidelines for integration of observing platforms and their implementation; and
- Observational data will be collected and transmitted in digital forms, highly compressed where necessary. Data processing will be highly computerised.

Consistency and homogeneity

- There will be increased standardisation of instruments and observing methods;
- There will be improvements in calibration of observations and the provision of metadata, to ensure data consistency and traceability to absolute standards;
- There will be increased interoperability, between existing observing systems and with newly implemented systems; and,
- There will be improved homogeneity of data formats and dissemination via the WIS.

2. THE SPACE-BASED COMPONENT

<table>
<thead>
<tr>
<th>Instruments:</th>
<th>Geophysical variables and phenomena:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operational geostationary satellites. At least 6, separated by no more than 70 deg longitude</strong></td>
<td></td>
</tr>
<tr>
<td>High-resolution multi-spectral Vis/IR imagers</td>
<td>Cloud amount, type, top height/temperature; wind (through tracking cloud and water vapour features); sea / land surface temperature; precipitation; aerosols; snow cover; vegetation cover; albedo; atmospheric stability; fires; volcanic ash</td>
</tr>
<tr>
<td>IR hyper-spectral sounders</td>
<td>Atmospheric temperature, humidity; wind (through tracking cloud and water vapour features); rapidly evolving mesoscale features; sea / land surface temperature; cloud amount and top height / temperature; atmospheric composition</td>
</tr>
<tr>
<td>Lightning imagers</td>
<td>Lightning (in particular cloud to cloud), location of intense convection.</td>
</tr>
</tbody>
</table>

**Operational polar-orbiting sun-synchronous satellites distributed within 3 orbital planes (~13:30, 17:30, 21:30 ECT)**

<table>
<thead>
<tr>
<th>Instruments:</th>
<th>Geophysical variables and phenomena:</th>
</tr>
</thead>
<tbody>
<tr>
<td>IR hyper-spectral sounders</td>
<td>Atmospheric temperature, humidity and wind; sea / land surface temperature; cloud amount, water content and top height / temperature; atmospheric composition</td>
</tr>
<tr>
<td>MW sounders</td>
<td></td>
</tr>
<tr>
<td>High-resolution multi-spectral Vis/IR imagers (including thermal IR water vapour absorption channel)</td>
<td>Cloud amount, type, top height / temperature; wind (high latitudes, through tracking cloud and water vapour features); sea / land surface temperature; precipitation; aerosols; snow and ice cover; vegetation cover; albedo; atmospheric stability</td>
</tr>
</tbody>
</table>

**Additional operational missions in appropriate orbits (classical polar-orbiting, geostationary, others)**

<table>
<thead>
<tr>
<th>Instruments:</th>
<th>Geophysical variables and phenomena:</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW imagers – at least 3 – some polarimetric</td>
<td>Sea ice; total column water vapour; precipitation; sea surface wind speed [and direction]; cloud liquid water; sea/land surface temperature; soil moisture</td>
</tr>
<tr>
<td>Scatterometers - at least 2 on well separated orbital planes</td>
<td>Sea surface wind speed and direction; sea ice; soil moisture</td>
</tr>
<tr>
<td>Radio occultation constellation – at least 8 receivers</td>
<td>Atmospheric temperature and humidity; ionospheric electron density</td>
</tr>
<tr>
<td>Allimeter constellation including a reference mission in a precise orbit, and polar-orbiting allimeters for global coverage</td>
<td>Ocean surface topography; sea level; ocean wave height; lake levels; sea and land ice topography</td>
</tr>
<tr>
<td>IR dual-angle view imager</td>
<td>Sea surface temperature (of climate monitoring quality); aerosols; cloud properties</td>
</tr>
</tbody>
</table>
| Instrument Type | Measurement | Oceanography/Remote Sensing
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Narrow-band high-spectral and hyperspectral resolution Vis/NIR imagers</td>
<td>Ocean colour; vegetation (including burnt areas); aerosols; cloud properties; albedo</td>
<td>Land-surface imaging for land use and vegetation; flood monitoring</td>
</tr>
<tr>
<td>High-resolution multi-spectral Vis/IR imagers – constellation</td>
<td>Precipitation (liquid and solid)</td>
<td>Earth radiation budget (supported by imagers and sounders on polar-orbiting and geostationary satellites) and colocated aerosols and cloud properties measurements</td>
</tr>
<tr>
<td>Precipitation radars operated in conjunction with passive MW imagers in various orbits</td>
<td>Ozone; other atmospheric chemical species; aerosols – for greenhouse gas monitoring, ozone/UV monitoring, air quality monitoring</td>
<td>Wave heights, directions and spectra; floods; sea ice leads; ice shelf and icebergs</td>
</tr>
<tr>
<td>Broad-band Vis/IR radiometer + total solar irradiance sensor - at least 1</td>
<td>Land-surface imaging for land use and vegetation; flood monitoring</td>
<td>Wave heights, directions and spectra; floods; sea ice leads; ice shelf and icebergs</td>
</tr>
<tr>
<td>Atmospheric composition instruments constellation, including high spectral resolution UV sounder on geostationary orbit and at least a UV sounder on am + pm orbit</td>
<td>Land-surface imaging for land use and vegetation; flood monitoring</td>
<td>Wave heights, directions and spectra; floods; sea ice leads; ice shelf and icebergs</td>
</tr>
<tr>
<td>Synthetic aperture radar</td>
<td>Land-surface imaging for land use and vegetation; flood monitoring</td>
<td>Wave heights, directions and spectra; floods; sea ice leads; ice shelf and icebergs</td>
</tr>
</tbody>
</table>

**Operational pathfinders and technology demonstrators, including**

| Instrument Type | Measurement | Oceanography/Remote Sensing
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Doppler wind lidar on LEO</td>
<td>Wind; aerosol; cloud-top height [and base]</td>
<td>Ocean surface salinity; soil moisture</td>
</tr>
<tr>
<td>Low-frequency MW radiometer on LEO</td>
<td>Precipitation; cloud water / ice; atmospheric humidity and temperature</td>
<td>Ocean colour, cloud studies and disaster monitoring</td>
</tr>
<tr>
<td>MW imager / sounder on GEO</td>
<td>Winds and clouds at high latitudes; sea ice; high latitude volcanic ash plumes; snow cover; vegetation; fires</td>
<td>Water volume in lakes, rivers, ground, etc.</td>
</tr>
<tr>
<td>High-resolution, multi-spectral narrow-band Vis/NIR and CCD imagers on GEOs</td>
<td>Aerosol optical depth, atmospheric composition variables (aerosols, greenhouse gases, ozone, air quality, precipitation chemistry, reactive gases)</td>
<td>Water volume in lakes, rivers, ground, etc.</td>
</tr>
<tr>
<td>Vis / IR imagers on satellites in high inclination, highly elliptical orbits (HEO)</td>
<td>Aerosol optical depth, atmospheric composition variables (aerosols, greenhouse gases, ozone, air quality, precipitation chemistry, reactive gases)</td>
<td>Water volume in lakes, rivers, ground, etc.</td>
</tr>
<tr>
<td>Gravitmetric sensors</td>
<td>Aerosol optical depth, atmospheric composition variables (aerosols, greenhouse gases, ozone, air quality, precipitation chemistry, reactive gases)</td>
<td>Water volume in lakes, rivers, ground, etc.</td>
</tr>
<tr>
<td>Synthetic aperture radar</td>
<td>Aerosol optical depth, atmospheric composition variables (aerosols, greenhouse gases, ozone, air quality, precipitation chemistry, reactive gases)</td>
<td>Water volume in lakes, rivers, ground, etc.</td>
</tr>
<tr>
<td>Operational pathfinders and technology demonstrators, including</td>
<td>Aerosol optical depth, atmospheric composition variables (aerosols, greenhouse gases, ozone, air quality, precipitation chemistry, reactive gases)</td>
<td>Water volume in lakes, rivers, ground, etc.</td>
</tr>
</tbody>
</table>

**Polar and geo platforms / instruments for space weather**

| Instrument Type | Measurement | Oceanography/Remote Sensing
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar imagery</td>
<td>Solar radiation storms, high-energy particle rain, ionospheric and geomagnetic storms, radio black-out by X-ray photons</td>
<td>Solar radiation storms, high-energy particle rain, ionospheric and geomagnetic storms, radio black-out by X-ray photons</td>
</tr>
<tr>
<td>Particle detection</td>
<td>Solar radiation storms, high-energy particle rain, ionospheric and geomagnetic storms, radio black-out by X-ray photons</td>
<td>Solar radiation storms, high-energy particle rain, ionospheric and geomagnetic storms, radio black-out by X-ray photons</td>
</tr>
<tr>
<td>Electron density</td>
<td>Solar radiation storms, high-energy particle rain, ionospheric and geomagnetic storms, radio black-out by X-ray photons</td>
<td>Solar radiation storms, high-energy particle rain, ionospheric and geomagnetic storms, radio black-out by X-ray photons</td>
</tr>
</tbody>
</table>

### 3. **The Surface-based Component**

**Station type:**

**Land – upper-air**

- Upper-air synoptic and reference stations: Wind, temperature, humidity, pressure
- Remote sensing upper-air profiling remote stations: Wind, cloud base and top, cloud water, temperature, humidity, aerosols
- Aircraft: Wind, temperature, pressure, humidity, turbulence, icing, thunderstorms, dust / sandstorms, volcanic ash / activity, and atmospheric composition variables (aerosols, greenhouse gases, ozone, air quality, precipitation chemistry, reactive gases)
- Atmospheric composition stations: Aerosol optical depth, atmospheric composition variables (aerosols, greenhouse gases, ozone, air quality, precipitation chemistry, reactive gases)
- GNSS receiver stations: water vapour

**Land – surface**

- Surface synoptic and climate reference stations: Surface pressure, temperature, humidity, wind; visibility; clouds; precipitation; present and past weather; radiation; soil temperature; evaporation; soil moisture; obscurations
- Atmospheric composition stations: Atmospheric composition variables (aerosols, greenhouse gases, ozone, air quality, precipitation chemistry, reactive gases)
- Lightning detection system stations: Lightning (location, density, rate of discharge, polarity, volumetric distribution)
- Application specific stations (road weather, airport / heliport weather stations, agromet stations, urban meteorology, etc): Application specific observations

**Land – hydrology**

- Hydrological reference stations: Water level

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**Notes:**

- **Operational pathfinders and technology demonstrators, including**
  - Doppler wind lidar on LEO
  - Low-frequency MW radiometer on LEO
  - MW imager / sounder on GEO
  - High-resolution, multi-spectral narrow-band Vis/NIR and CCD imagers on GEOs
  - Vis / IR imagers on satellites in high inclination, highly elliptical orbits (HEO)
  - Gravitmetric sensors
  - Synthetic aperture radar

**Polar and geo platforms / instruments for space weather**

- Solar imagery
- Particle detection
- Electron density

**3. **The Surface-based Component**

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- Application specific stations (road weather, airport / heliport weather stations, agromet stations, urban meteorology, etc): Application specific observations

**Land – hydrology**

- Hydrological reference stations: Water level
National hydrological network stations | Precipitation, snow depth, snow water content, lake and river ice thickness/date of freezing and break-up, water level, water flow, water quality, soil moisture, soil temperature, sediment loads
---|---
Ground water stations | Ground water measurements
**Land – weather radar**
Weather radar station | Precipitation (hydrometeor size distribution, phase, type), wind, humidity (from refractivity), sand and dust storms
**Ocean – upper air**
Automated Shipboard Aerological Platform (ASAP) ships | Wind, temperature, humidity, pressure
**Ocean – surface**
HF Coastal Radars | Surface currents, waves
Synoptic sea stations (ocean, island, coastal and fixed platform) | Surface pressure, temperature, humidity, wind; visibility; cloud amount, type and base-height; precipitation; weather; sea-surface temperature; wave direction, period and height; sea ice
Ships | Surface pressure, temperature, humidity, wind; visibility; cloud amount, type and base-height; precipitation; weather; sea-surface temperature; wave direction, period and height; sea ice
Buoys – moored and drifting | Surface pressure, temperature, humidity, wind; visibility; sea-surface temperature; 3D & 2D wave spectrum, wave direction, period and height
Ice buoys | Surface pressure, temperature, wind, ice thickness
Tide stations | Sea water height, surface air pressure, wind, salinity, water temperature
**Ocean – sub-surface**
Profiling floats | Temperature, salinity, current, dissolved oxygen, CO₂ concentration
Ice tethered platforms | Temperature, salinity, current
Ships of opportunity | Temperature
**R&D and Operational pathfinders – examples**
UAVs | Wind, temperature, humidity, atmospheric composition
Gondolas | Wind, temperature, humidity
GRUAN stations | Reference quality climate variables, cloud structure
Aircraft | Chemistry, aerosol, wind (lidar)
Instrumented marine animals | Temperature
Ocean gliders | Temperature, salinity, current, dissolved oxygen, CO₂ concentration

4. **SYSTEM-SPECIFIC TRENDS AND ISSUES**

4.1 **Space-based**

- There will be an **expanded** space-based observing **capability** both on operational and research satellites.
- There will be an **expanded community** of space agencies contributing to the GOS.
- There will be **increased collaboration** between space agencies, to ensure that a broad spectrum of user requirements for observations are met in the most cost-effective manner, and that system reliability is assured through arrangements for mutual back-up.
- Observational capability demonstrated on **R & D** satellites will be progressively transferred to **operational** platforms, to assure the reliability and sustainability of measurements.
- **R & D satellites** will continue to play an important role in the GOS; although they cannot guarantee continuity of observations, they offer important contributions beyond the current means of operational systems. Partnerships will be developed between agencies to extend the operation of functional **R & D** and other satellites to the maximum useful period.
- Some user requirements will be met through **constellations** of satellite, often involving collaboration between space agencies. Expected constellations include: altimetry, precipitation, radio occultation, atmospheric composition and Earth radiation budget.
• **Higher spatial, temporal and spectral resolution** will considerably enhance the information available, particularly to monitor and predict rapidly-evolving, small-scale phenomena, whilst increasing the demand on data exchange, management and processing capability.

• **Improved availability and timeliness** will be achieved through operational cooperation among agencies and new communications infrastructure.

• **Improved calibration and inter-calibration** will be achieved through mechanisms such as GSICS.

### 4.2 Surface-based

The surface-based GOS will provide:

- improved detection of meso-scale phenomena;
- data that cannot be measured by space-based component;
- data for calibration and validation of space-based data;
- enhanced data exchange of regional scale observing data and product from weather radar, hydrological networks, etc.;
- high vertical resolution profiles from radiosondes and other ground based remote-sensing systems, integrated with other observations to represent the atmospheric structure;
- improved data quality with defined standards on availability, accuracy and quality control; and,
- long-term datasets for the detection and understanding of environmental trends and changes to complement those derived from space-based systems;
- maintenance of stations with long historically-uninterrupted observing records.

**Radiosondes networks** will:

- be optimised, particularly in terms of horizontal spacing which will increase in data-dense areas, and taking account of observations available from other profiling systems;
- be complemented by the **aircraft (AMDA)**R ascent / descents profiles and other ground-based profiling systems;
- maintain the **GUAN** subset of stations for climate monitoring; and
- include a **GCOS Reference Upper-Air Network (GRUAN)** to serve as a reference network for other radiosonde sites, for calibration and validation of satellite records, and for other applications.

**Aircraft observing systems**

- will be available from most airport locations, in all regions of the world;
- flight-level and ascent / descent data will be available at user-selected temporal resolution;
- will observe humidity and some components of atmospheric composition, in addition to temperature, pressure and wind;
- will also be developed for smaller, regional aircraft with flight levels in the mid-troposphere and providing ascent / descent profiles into additional airports.

**Land-surface observations systems**

- will come from a wider variety of surface networks (e.g., road networks, mobile platforms) and multi-application networks;
- will be primarily automated and capable of reproducing or substituting for measurements previously obtained subjectively (weather phenomena, cloud type, etc.);
- will include the **GSN** subset of surface stations for climate monitoring.

**Surface marine observations**

- from drifting buoys, moored buoys, ice buoys and Voluntary Observing Ships will complement satellite observations;
- with improved temporal resolution and timeliness, through reliable and cost-effective satellite data communication systems;
Ocean sub-surface observing technology will be improved, including cost-effective multi-purpose in-situ observing platforms, ocean gliders, and instrumented marine animals.

Remote-Sensing observing systems:

- **Weather radar** systems will provide enhanced precipitation products but with increased data coverage. They will increasingly provide information on other atmospheric variables. There will be much improved data consistency and new radar technology. Collaborative multi-national networks will deliver composite products.
- **Coastal HF Radars** will provide for ocean currents and wave data
- **Profilers** will be developed and used by more applications. A wider variety of technologies will be used, including lidars, radars and microwave radiometers. These observing systems will be developed into coherent networks and integrated with other surface networks.
- **Global Navigation Satellite System** (e.g., GPS, GLONASS and GALILEO) receiver networks, for observing total column water vapour, will be extended.
- These systems will be integrated into “intelligent” profiling systems and integrated with other surface observing technologies.

Lightning detection systems

- **Long-range lightning detection systems** will provide cost-effective, homogenized, global data with a high location accuracy, significantly improving coverage in data sparse regions including oceanic and polar areas.
- **High-resolution lightning detection systems** with a higher location accuracy, cloud-to-cloud and cloud-to-ground discrimination for special applications.

Surface-based observations of atmospheric composition (complemented by balloon- and aircraft-borne measurements) will contribute to an integrated three-dimensional global atmospheric chemistry measurement network, together with a space-based component. New measurement strategies will be combined to provide near real-time data delivery.

Surface-based observations will support nowcasting and very short-range forecasting through the widespread integration of radar, lightning and other detection systems, with extension to continental and global scales of the networks.
Guidelines to WMO
for facilitating the transition of relevant R&D missions
or instruments to operational status

• Support the user requirements process
  – Organize a rolling review of user requirements
  – Update and document the user requirements

• Foster a “Vision for the GOS”
  – Define an observation strategy
  – Propose a high-level architecture
  – Perform a gap analysis
  – Identify complementary roles for international partners

• Identify opportunities for transition
  – Highlight required improvements
  – Monitor emerging capabilities

• Support user readiness
  – Raise user awareness
  – Facilitate near real-time data access
  – Encourage early use of R&D data, product development and mechanism for user feedback
  – Facilitate partnerships on development of new products
  – Encourage training on new systems and products
  – Encourage integration into operational applications

• Promote the case at policy level
  – Highlight the needs and benefits (business case)
  – Advocate weather/climate issues
  – Support OSSEs to quantify benefits
  – Assist in assessments of need for transition
  – Recommend institutional framework (mandate/expertise/user interaction)

• Value and support partnership
  – Among R&D and Operational agencies
  – Among agencies and pilot users
  – Among international players including CEOS, CGMS and WMO
1. **Expanded training needs**
   - Wider range of users beyond classical weather forecasting, e.g. for environmental services;
   - Increased satellite capabilities result in increased training needs in new application areas, e.g. climate change;

\[\rightarrow\] Training on exploitation of both operational and R&D satellite data and products;

\[\rightarrow\] Training will involve increasingly use of satellite data in combination with other data as e.g. radar, NWP, lightning, etc.

2. **Expanded training areas**
   - Resulting from the ongoing establishment of the various elements of the GEOSS and the emphasis being placed upon GEO capacity building efforts, especially for the developing countries, the VL training activities may in the future have to address the training needs of some of relevant GEO Societal Benefit Areas as e.g.: climate, disasters, ecosystems, energy, water and health and others.

   - First focus of VL training activities: satellite remote sensing, meteorology, climate; where appropriate and user requirements exist, VL training activities could be widened to support training in: ocean and land applications, hydrology and water management, atmospheric chemistry and air quality, environmental quality.

3. **Implementation aspects**
   - Enlarging the VL network:
     - Additional sponsoring satellite agencies,
     - More Centres of Excellence (CoE);
   - Access to the Virtual Resource Library (VRL) through a centralised Web portal;
   - Increased e-learning and blended learning;
   - Strengthening of the Regional Focus Groups (RFGs) established by each CoE (Centre of Excellence);
   - Regular Regional Training Events.

\[\rightarrow\] Fundamental principles to implement the Strategic goals:
   - Commitment: to put effort and resources into the VL;
   - Cooperation: building relationships, e.g. via setup of RFGs;
   - Collaboration: jointly developing, delivering and exchanging training resources.

4. **Assessment of benefit**
   - Assessment and demonstration of benefit from training resulting: improved services.
# Functional Specifications for Automatic Weather Stations

<table>
<thead>
<tr>
<th>VARIABLE 1)</th>
<th>Maximum Effective Range 2)</th>
<th>Minimum Reported Resolution 3)</th>
<th>Mode of Observation 4)</th>
<th>BUFR / CREX 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATMOSPHERIC PRESSURE</td>
<td></td>
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</tr>
<tr>
<td>Atmospheric Pressure</td>
<td>500 – 1080 hPa</td>
<td>10 Pa</td>
<td>I, V</td>
<td>0 10 004</td>
</tr>
<tr>
<td>TEMPERATURE 6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient air temperature (over specified surface)</td>
<td>-80 °C – +60 °C</td>
<td>0.1 K</td>
<td>I, V</td>
<td>0 12 101</td>
</tr>
<tr>
<td>Dew-point temperature</td>
<td>-80 °C – +60 °C</td>
<td>0.1 K</td>
<td>I, V</td>
<td>0 12 103</td>
</tr>
<tr>
<td>Ground (surface) temperature (over specified surface)</td>
<td>-80 °C – +80 °C</td>
<td>0.1 K</td>
<td>I, V</td>
<td>0 12 113</td>
</tr>
<tr>
<td>Soil temperature</td>
<td>-50 °C – +50 °C</td>
<td>0.1 K</td>
<td>I, V</td>
<td>0 12 130</td>
</tr>
<tr>
<td>Snow temperature</td>
<td>-80 °C – 0 °C</td>
<td>0.1 K</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Water temperature - river, lake, sea, well</td>
<td>-2 °C – +100 °C</td>
<td>0.1 K</td>
<td>I, V</td>
<td>0 13 082</td>
</tr>
<tr>
<td>HUMIDITY 7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative humidity</td>
<td>0 – 100%</td>
<td>1%</td>
<td>I, V</td>
<td>0 13 003</td>
</tr>
<tr>
<td>Mass mixing ratio</td>
<td>0 – 100%</td>
<td>1%</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Soil moisture, volumetric or water potential</td>
<td>0 – 10³ g kg⁻¹</td>
<td>1 g kg⁻¹</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Water vapour pressure</td>
<td>0 – 100 hPa</td>
<td>10 Pa</td>
<td>I, V</td>
<td>0 13 004</td>
</tr>
<tr>
<td>Evaporation / evapotranspiration</td>
<td>0 – 0.2 m</td>
<td>0.1 kg m⁻², 0.0001 m</td>
<td>T</td>
<td>0 13 033</td>
</tr>
<tr>
<td>Object wetness duration</td>
<td>0 – 86 400 s</td>
<td>1 s</td>
<td>T</td>
<td>N</td>
</tr>
<tr>
<td>WIND</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direction</td>
<td>0⁰, 1⁰ – 360⁰</td>
<td>1⁰</td>
<td>I, V</td>
<td>0 11 001</td>
</tr>
<tr>
<td>Speed</td>
<td>0 – 75 m s⁻¹</td>
<td>0.1 m s⁻¹</td>
<td>I, V</td>
<td>0 11 002</td>
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<tr>
<td>Gust Speed</td>
<td>0 – 150 m s⁻¹</td>
<td>0.1 m s⁻¹</td>
<td>I, V</td>
<td>0 11 041</td>
</tr>
<tr>
<td>X,Y,Z component of wind vector (horizontal and vertical profile)</td>
<td>0 – 150 m s⁻¹</td>
<td>0.1 m s⁻¹</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Turbulence type (Low levels and wake vortex)</td>
<td>up to 15 types</td>
<td>BUFR Table</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Turbulence intensity</td>
<td>up to 15 types</td>
<td>BUFR Table</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>RADIATION 8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Sunshine duration</td>
<td>0 – 86 400 s</td>
<td>60 s</td>
<td>T</td>
<td>0 14 031</td>
</tr>
<tr>
<td>Background luminance</td>
<td>1·10⁻⁶ – 2·10⁻³ Cd m⁻²</td>
<td>1·10⁻⁶ Cd m⁻²</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Global downward solar radiation</td>
<td>0 – 6·10⁶ J m⁻²</td>
<td>1 J m⁻²</td>
<td>I, T, V</td>
<td>N</td>
</tr>
<tr>
<td>Global upward solar radiation</td>
<td>0 – 4·10⁶ J m⁻²</td>
<td>1 J m⁻²</td>
<td>I, T, V</td>
<td>N</td>
</tr>
<tr>
<td>Diffuse solar radiation</td>
<td>0 – 4·10⁶ J m⁻²</td>
<td>1 J m⁻²</td>
<td>I, T, V</td>
<td>0 14 023</td>
</tr>
<tr>
<td>Direct solar radiation</td>
<td>0 – 5·10⁶ J m⁻²</td>
<td>1 J m⁻²</td>
<td>I, T, V</td>
<td>0 14 025</td>
</tr>
<tr>
<td>Downward long-wave radiation</td>
<td>0 – 3·10⁶ J m⁻²</td>
<td>1 J m⁻²</td>
<td>I, T, V</td>
<td>0 14 002</td>
</tr>
<tr>
<td>Upward long-wave radiation</td>
<td>0 – 3·10⁶ J m⁻²</td>
<td>1 J m⁻²</td>
<td>I, T, V</td>
<td>0 14 002</td>
</tr>
<tr>
<td>Net radiation</td>
<td>0 – 6·10⁷ J m⁻²</td>
<td>1 J m⁻²</td>
<td>I, T, V</td>
<td>0 14 016</td>
</tr>
<tr>
<td>UV-B radiation 6)</td>
<td>0 – 1·2·10³ J m⁻²</td>
<td>1 J m⁻²</td>
<td>I, T, V</td>
<td>N</td>
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<tr>
<td>Photosynthetically active radiation</td>
<td>0 – 3·10⁵ J m⁻²</td>
<td>1 J m⁻²</td>
<td>I, T, V</td>
<td>N</td>
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<tr>
<td>Surface albedo</td>
<td>1 – 100%</td>
<td>1%</td>
<td>I, V</td>
<td>0 14 019</td>
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<tr>
<td>VARIABLE 1)</td>
<td>Maximum Effective Range 2)</td>
<td>Minimum Reported Resolution 3)</td>
<td>Mode of Observation 4)</td>
<td>BUFR / CREX 5)</td>
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<tr>
<td>-------------</td>
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<tr>
<td>CLOUDS</td>
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</tr>
<tr>
<td>Cloud base height</td>
<td>0 – 30 km</td>
<td>10 m</td>
<td>I, V</td>
<td>0 20 013</td>
</tr>
<tr>
<td>Cloud top height</td>
<td>0 – 30 km</td>
<td>10 m</td>
<td>I, V</td>
<td>0 20 014</td>
</tr>
<tr>
<td>Cloud type, convective vs. other types</td>
<td>up to 30 classes</td>
<td>BUFR Table</td>
<td>I</td>
<td>0 20 012</td>
</tr>
<tr>
<td>Cloud hydrometeor concentration</td>
<td>1 – 700 hydrometeors dm$^{-3}$</td>
<td>1 hydrometeor dm$^{-3}$</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Effective radius of cloud hydrometeors</td>
<td>$2 \cdot 10^{-5} – 32 \cdot 10^{-5}$ m</td>
<td>$2 \cdot 10^{-5}$ m</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Cloud liquid water content</td>
<td>$1 \cdot 10^{-5} – 1.4 \cdot 10^{-2}$ kg m$^{-3}$</td>
<td>$1 \cdot 10^{-5}$ kg m$^{-3}$</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Optical depth within each layer</td>
<td>Not specified yet</td>
<td>Not specified yet</td>
<td>I, V</td>
<td>N</td>
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<tr>
<td>Optical depth of fog</td>
<td>Not specified yet</td>
<td>Not specified yet</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Height of inversion</td>
<td>0 – 1 000 m</td>
<td>10 m</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Cloud cover</td>
<td>0 – 100%</td>
<td>1%</td>
<td>I, V</td>
<td>0 20 010</td>
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<tr>
<td>Cloud amount</td>
<td>0 – 8/8</td>
<td>1/8</td>
<td>I, V</td>
<td>0 20 011</td>
</tr>
<tr>
<td>PRECIPITATION</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Accumulation 7)</td>
<td>0 – 1000 mm</td>
<td>0.1 kg m$^{-2}$, 0.0001 m</td>
<td>T</td>
<td>0 13 011</td>
</tr>
<tr>
<td>Depth of fresh snowfall</td>
<td>0 – 1000 cm</td>
<td>0.001 m</td>
<td>T</td>
<td>0 13 015</td>
</tr>
<tr>
<td>Duration</td>
<td>up to 86 400 s</td>
<td>60 s</td>
<td>T</td>
<td>0 26 020</td>
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<tr>
<td>Size of precipitating element</td>
<td>$1 \cdot 10^{-3} – 0.5$ m</td>
<td>$1 \cdot 10^{-3}$ m</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Intensity - quantitative</td>
<td>0 – 2000 mm h$^{-1}$</td>
<td>0.1 kg m$^{-2}$ s$^{-1}$, 0.1 mm h$^{-1}$</td>
<td>I, V</td>
<td>0 13 055</td>
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<tr>
<td>Type</td>
<td>up to 30 types</td>
<td>BUFR Table</td>
<td>I, V</td>
<td>0 20 021</td>
</tr>
<tr>
<td>Rate of ice accretion</td>
<td>0 – 1 kg dm$^{-2}$ h$^{-1}$</td>
<td>$1 \cdot 10^{-3}$ kg dm$^{-2}$ h$^{-3}$</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>OBSCURATIONS</td>
<td></td>
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<tr>
<td>Obscuration type</td>
<td>up to 30 types</td>
<td>BUFR Table</td>
<td>I, V</td>
<td>0 20 025</td>
</tr>
<tr>
<td>Hydrometeor type</td>
<td>up to 30 types</td>
<td>BUFR Table</td>
<td>I, V</td>
<td>0 20 025</td>
</tr>
<tr>
<td>Lithometeor type</td>
<td>up to 30 types</td>
<td>BUFR Table</td>
<td>I, V</td>
<td>0 20 025</td>
</tr>
<tr>
<td>Hydrometeor radius</td>
<td>$2 \cdot 10^{-5} – 32 \cdot 10^{-5}$ m</td>
<td>$2 \cdot 10^{-5}$ m</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Horizontal Extinction coefficient</td>
<td>0 – 1 m$^{-1}$</td>
<td>0.001 m$^{-1}$</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Slant – extinction coefficient</td>
<td>0 – 1 m$^{-1}$</td>
<td>0.001 m$^{-1}$</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Meteorological Optical Range 10)</td>
<td>1 – 100 000 m</td>
<td>1 m</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Runway visual range</td>
<td>1 – 4 000 m</td>
<td>1 m</td>
<td>I, V</td>
<td>0 20 061</td>
</tr>
<tr>
<td>Other weather type</td>
<td>up to 18 types</td>
<td>BUFR Table</td>
<td>I, V</td>
<td>0 20 023</td>
</tr>
<tr>
<td>LIGHTNING</td>
<td></td>
<td></td>
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<tr>
<td>Lightning rates of discharge</td>
<td>0 – 100 000</td>
<td>Number h$^{-1}$</td>
<td>I, V</td>
<td>0 13 059</td>
</tr>
<tr>
<td>Lightning discharge type (cloud to cloud, cloud to surface)</td>
<td>up to 10 types</td>
<td>BUFR Table</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Lightning discharge polarity</td>
<td>2 types</td>
<td>BUFR Table</td>
<td>I, V</td>
<td>N</td>
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<tr>
<td>Lightning discharge energy</td>
<td>Not specified yet</td>
<td>Not specified yet</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Lightning - distance from station</td>
<td>0 – 3·10$^4$ m</td>
<td>$10^3$ m</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Lightning - direction from station</td>
<td>1° – 360°</td>
<td>1 degree</td>
<td>I, V</td>
<td>N</td>
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<tr>
<td>VARIABLE ¹</td>
<td>Maximum Effective Range ²</td>
<td>Minimum Reported Resolution ³</td>
<td>Mode of Observation ⁴</td>
<td>BUFR / CREX ⁵</td>
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<td>------------</td>
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<tr>
<td>HYDROLOGIC AND MARINE OBSERVATIONS</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Flow discharge – river</td>
<td>0 – 2.5·10⁵ m³ s⁻¹</td>
<td>0.1 m³ s⁻¹</td>
<td>I, V</td>
<td>0 23 017</td>
</tr>
<tr>
<td>Flow discharge – well</td>
<td>0 – 50 m³ s⁻¹</td>
<td>0.001 m³ s⁻¹</td>
<td>I, V</td>
<td>0 23 017</td>
</tr>
<tr>
<td>Ground water level</td>
<td>0 – 1 800 m</td>
<td>0.01 m</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Ice surface temperature</td>
<td>-80 °C – +0 °C</td>
<td>0.5 K</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Ice thickness - river, lake</td>
<td>0 – 50 m</td>
<td>0.01 m</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Ice thickness - glacier, sea</td>
<td>0 – 4 270 m</td>
<td>1 m</td>
<td>I, V</td>
<td>0 20 031</td>
</tr>
<tr>
<td>Water level</td>
<td>0 – 100 m</td>
<td>0.01 m</td>
<td>I, V</td>
<td>0 13 071 0 13 072</td>
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<tr>
<td>Wave height</td>
<td>0 – 50 m</td>
<td>0.1 m</td>
<td>I, V</td>
<td>0 22 021</td>
</tr>
<tr>
<td>Wave period</td>
<td>0 – 100 s</td>
<td>1 s</td>
<td>V</td>
<td>0 22 011</td>
</tr>
<tr>
<td>Wave direction</td>
<td>0 ¹²); 1 – 360 degrees</td>
<td>1 degrees</td>
<td>V</td>
<td>0 22 001</td>
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<tr>
<td>1D spectral wave energy density</td>
<td>0 – 5x10⁵ m²Hz⁻¹</td>
<td>10⁻³ m²Hz⁻¹</td>
<td>V, T</td>
<td>0 22 069</td>
</tr>
<tr>
<td>2D spectral wave energy density</td>
<td>0 – 5x10⁵ m²Hz⁻¹</td>
<td>10⁻³ m²Hz⁻¹</td>
<td>V, T</td>
<td>0 22 069</td>
</tr>
<tr>
<td>Sea salinity</td>
<td>0 – 40 %</td>
<td>10⁻⁴ %</td>
<td>I, V</td>
<td>0 22 059</td>
</tr>
<tr>
<td>Conductivity</td>
<td>0 – 600 S m⁻¹</td>
<td>10⁻⁶ S m⁻¹</td>
<td>I, V</td>
<td>0 22 066</td>
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<tr>
<td>Water pressure</td>
<td>0 – 11x10⁷ Pa</td>
<td>100 Pa</td>
<td>I, V</td>
<td>0 22 065</td>
</tr>
<tr>
<td>Ice thickness</td>
<td>0 – 3 m</td>
<td>0.015 m</td>
<td>T</td>
<td>0 20 031</td>
</tr>
<tr>
<td>Ice mass</td>
<td>0 – 50 kg m⁻¹</td>
<td>0.5 kg m⁻¹</td>
<td>T</td>
<td>N</td>
</tr>
<tr>
<td>Snow density (liquid water content)</td>
<td>100 – 700 kg m⁻³</td>
<td>1 kg m⁻³</td>
<td>T</td>
<td>N</td>
</tr>
<tr>
<td>Tidal elevation with respect to local chart datum</td>
<td>-10 – +30 m</td>
<td>0.001 m</td>
<td>I, V</td>
<td>0 22 035 0 22 038</td>
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<tr>
<td>Tidal elevation with respect to national land datum</td>
<td>-10 – +30 m</td>
<td>0.001 m</td>
<td>I, V</td>
<td>0 22 037</td>
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<tr>
<td>Meteorological residual tidal elevation (surge or offset)</td>
<td>-10 – +16 m</td>
<td>0.001 m</td>
<td>I, V</td>
<td>0 22 036 0 22 039 0 22 040</td>
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<tr>
<td>Ocean Current - Direction</td>
<td>0 ¹³); 1° – 360°</td>
<td>1°</td>
<td>I, V</td>
<td>0 22 004 0 22 005</td>
</tr>
<tr>
<td>Ocean Current - Speed</td>
<td>0 – 10 m s⁻¹</td>
<td>0.01 m s⁻¹</td>
<td>I, V</td>
<td>0 22 031 0 22 032</td>
</tr>
<tr>
<td>OTHER SURFACE VARIABLES</td>
<td></td>
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<tr>
<td>Runway conditions</td>
<td>up to 10 types</td>
<td>BUFR Table</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>Braking action/friction coefficient</td>
<td>up to 7 types</td>
<td>BUFR Table</td>
<td>I, V</td>
<td>N</td>
</tr>
<tr>
<td>State of ground</td>
<td>up to 30 types</td>
<td>BUFR Table</td>
<td>I, V</td>
<td>0 20 062</td>
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<tr>
<td>Type of surface specified</td>
<td>up to 15 types</td>
<td>BUFR Table</td>
<td>I, V</td>
<td>0 08 010</td>
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<tr>
<td>Snow depth</td>
<td>0 – 25 m</td>
<td>0.01 m</td>
<td>T</td>
<td>0 13 013</td>
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<tr>
<td>OTHER</td>
<td></td>
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<tr>
<td>Gamma radiation dose</td>
<td>1 – 10 nSv h⁻¹</td>
<td>1 nSv h⁻¹</td>
<td>I, T</td>
<td>N</td>
</tr>
<tr>
<td>Categories of stability</td>
<td>9 types</td>
<td>BUFR Table</td>
<td>I, V</td>
<td>0 13 041</td>
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</tbody>
</table>
Notes:

The changes in comparison to the version approved by CBS-XIII are highlighted in red.

1. Name of variable, in line with WMO Vocabulary and Technical regulations.

2. Maximum Effective Range – Maximum range of measuring capability; units traceable to SI.

3. Minimum Reported Resolution – Lower resolution of reporting is not permitted.

4. Mode of Observation – Type of data being reported:

   I: Instantaneous – 1-minute value (instantaneous as defined in WMO-No.8, Part II, paragraph 1.3.2.4);

   V: Variability – Average (mean), Standard Deviation, Maximum, Minimum, Range, Median, etc. of samples – those reported depend upon meteorological variable;

   T: Total – Integrated value during defined period (over a fixed period(s)); maximum 24 hours for all parameters except radiation which requires a maximum of one hour (exception, see note 6), and precipitation accumulation (6 hours maximum).

   A: Average (mean) value.

5. BUFR/CREX – Present ability to represent variable by BUFR Tables, N = not existing, to be defined (registered).

6. Radiation energy amounts are given over a 24-hour period.

7. Maximum interval: 6 H.

8. Definition of UV-B according to WMO-No. 8 (Vol. 1, Chapter on Radiation).

9. Humidity related variables (i.e. dew point) expressed as temperature are collected under temperature.

10. MOR uniquely related to "extinction coefficient", \( \sigma \), by MOR = -ln(5%)/\( \sigma \).

11. Direction to indicate 0 (zero) if speed = 0.

12. Salinity of 1% (1 g of salt per 100 g of water), or 10 \( \% \) converts to 10.000 ppm (parts per million), which equals 10 psu (practical salinity units). Ocean water is about 3.5% salt, i.e. 35.000 ppm or 35 psu. Lake Assal (Ethiopia) is the most saline body of water on earth with 34.8% [348 psu] salt concentration. BUFR/CREX table references 0 22 0590, 22 0620 and 22 064, however, only allow for a maximum of 163.830 "Part per thousand" [or psu], less than the required maximum range.

13. Calm.

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### BASIC SET OF VARIABLES TO BE REPORTED BY THE STANDARD AWS FOR MULTIPLE USERS

<table>
<thead>
<tr>
<th>Variables</th>
<th>SYNOP Land Stations (^{14})</th>
<th>[Fixed] Ocean Weather Stations (^{14})</th>
<th>Ocean observing platforms (^{8})</th>
<th>Aeronautical meteorological station (^{6})</th>
<th>Principle climatological station (^{4})</th>
<th>STANDARD AWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atmospheric Pressure</td>
<td>M</td>
<td>A</td>
<td>M</td>
<td>X (^1)</td>
<td>X</td>
<td>A</td>
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<tr>
<td>Pressure tendency &amp; characteristics</td>
<td>[M]</td>
<td>M</td>
<td>[M] [A]</td>
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<td>[A]</td>
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<td>Air temperature</td>
<td>M(^2) A</td>
<td>M</td>
<td>M [A]</td>
<td>X</td>
<td>X(^3)</td>
<td>A</td>
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<tr>
<td>Humidity(^5)</td>
<td>M A</td>
<td>M</td>
<td>[M] [A]</td>
<td>X(^4)</td>
<td>X</td>
<td>A</td>
</tr>
<tr>
<td>Surface wind(^6)</td>
<td>M A</td>
<td>M</td>
<td>M [A]</td>
<td>X</td>
<td>X</td>
<td>A</td>
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<tr>
<td>Cloud Amount and Type</td>
<td>M</td>
<td>M</td>
<td>[M]</td>
<td>X(^11)</td>
<td>X</td>
<td>A(^11)</td>
</tr>
<tr>
<td>Extinction profile/Cloud-base</td>
<td>M [A]</td>
<td>M</td>
<td></td>
<td>X</td>
<td></td>
<td>A(^12)</td>
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<tr>
<td>Direction of Cloud movement</td>
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<td>Weather, Present &amp; Past</td>
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<td>M</td>
<td>M</td>
<td>X</td>
<td>X</td>
<td>A(^12)</td>
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<td>X(^7)</td>
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<td>M</td>
<td>[M]</td>
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<tr>
<td>Visibility</td>
<td>M [A]</td>
<td>M</td>
<td>M</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Amount of Precipitation</td>
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<td>[A]</td>
<td>[A]</td>
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<td>A</td>
<td>[A]</td>
<td>[A]</td>
<td>X</td>
<td></td>
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<tr>
<td>Intensity of precipitation</td>
<td>[A]</td>
<td></td>
<td></td>
<td></td>
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<td>[A]</td>
</tr>
<tr>
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<td>Waves</td>
<td>M [A]</td>
<td>[M] [A]</td>
<td></td>
<td></td>
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<td>A(^8)</td>
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<tr>
<td>Sea temperature</td>
<td>M A</td>
<td>[M] A</td>
<td></td>
<td></td>
<td></td>
<td>A(^8)</td>
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<td>Sea ice and/or icing</td>
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<td>M</td>
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<tr>
<td>Ship’s course and speed</td>
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<td>[M] [A]</td>
<td></td>
<td></td>
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<td>[A](^9)</td>
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<tr>
<td>Sea level</td>
<td>(^10)</td>
<td>[M] [A]</td>
<td>n/a</td>
<td></td>
<td></td>
<td>[A](^8)</td>
</tr>
</tbody>
</table>
Explanation

M = Required for manned stations
[M] = Based on a regional resolution
A = Required for automatic stations
[A] = Optional for automatic stations
X = Required

Notes:
1) Also QNH & QFE
2) Optional: extreme temperatures
3) Inclusive extreme temperatures
4) Dew point temperature
5) Dew point temperature and/or RH and air temperature
6) wind speed and direction
7) snow cover
8) sea and coastal stations only
9) Proposed by the representative of JCOMM, to become valid for VOS, drifting and moored buoys, rigs and platforms, tide gauges, profiling floats (for review after consultation with JCOMM Expert Teams)
10) Coastal stations and off shore platforms only
11) Cloud amount, TCU and CB only
12) Restricted to what is feasible
13) Only for helidecks on ships
14) Source: Manual on the GOS
CONCLUSIONS AND RECOMMENDATIONS FROM 4th WORKSHOP ON IMPACT OF VARIOUS OBSERVING SYSTEMS ON NWP

The discussions on the workshop presentations and results took also into account the reports from the preceding workshops and the latest comments made by ET-EGOS. They led to the following conclusions and recommendations.

Almost all centres were able to identify positive impacts on forecast skill of practically all parts of the observing system. This is a testament both to the quality of the Global Observing System and to the increasing level of maturity of the models and assimilation systems used to ingest the information for numerical weather prediction. A tremendous activity is now evident in regional NWP using variational assimilation systems to explore new data types. The methodology has converged, and rapid progress is being made in many countries.

Several studies seem to indicate that the impact of simultaneous use of mass (temperature) and wind observations exceeds the sum of the individual impacts in experiments where the two types of information were used separately, especially in the tropical regions. This will have implications for the requirements of the observing system of the future as far as the balance between observations pertaining to the different model variables is concerned.

3.1. Interaction between NWP centres, data providers and data users

a) Some regional observation data sets appear to be more and more useful for regional NWP and will soon be useful also for global NWP. It is recommended to implement a global exchange of these data sets, starting by (i) Radar data radial wind and reflectivities as the highest priority, (ii) GPS surface networks as second priority.

b) For polar orbiting satellite instruments, the quick availability of data in real-time NWP is important for operational NWP (global and regional). It is then recommended to develop and maintain ad hoc telecommunication means allowing the quick re-transmission of some data (like the existing systems EARS and AP-RARS).

3.2. Observational data requirements

a) Because of the lack of profile-type observations in the polar latitudes, every effort should be made to maintain the existing radiosonde sites, and/or find new systems to observe the vertical structure of the atmosphere (wind, temperature, humidity) in the polar areas. The IPY year is an opportunity to have new systems deployed (e.g. drifting balloons and unmanned aerial vehicles). An exhaustive list of these IPY-specific observations should be made available to all NWP users, and the extension of some of these systems beyond the IPY should be considered.

b) One of the highest priority in terms of observation requirements is to add more profile observations in many data-poor areas. Thus, all the AMDAR opportunities should be used to improve the wind and temperature data coverage, especially in data-poor areas like the inter-tropical regions or Central and South Africa. This implies collecting new wind and temperature profiles at certain airports by equipping some aircraft flying regularly to these airports, and also to get the data from cruise levels in these regions (which are otherwise data-poor regions). The long-term future of the AMDAR system is also an issue to consider.

c) Remote radiosonde stations are still of exceptional value (as shown with isolated islands, ASAP observations and AMMA radiosonde observations). They are essential and should not be closed although they are the most expensive. We have not yet reached the point of satellite utilisation that makes it possible to close down such stations. The work done for the AMMA campaign to re-activate some radiosonde sites and improve the radiosonde
network over West Africa has been extremely beneficial and has shown the large existing potential for improving data sparse radiosonde networks.

d) The importance of hyperspectral infra-red sounders (with respect to for example AMSU) for meeting the upper-air observation requirements is a major finding of this 2008 workshop, with respect to the 2004 workshop. The assimilation of cloudy radiances from these sounders has started to give very encouraging results.

e) The rapid development of GPS-RO data has led to a situation where their role in operational global data assimilation is almost as important as the ones of the microwave or infra-red sounders. However the current satellites providing the GPS-RO measurements are research satellites with no guarantee of continuity in the future. It becomes very important to study the issue of future GPS-RO observing systems and their operational role in the GOS.

f) The key role of THORPEX, IPY and campaigns such as AMMA, for defining observation requirements is acknowledged. This includes the activities related to observation targeting. For each research campaign, all observations should be made available on the GTS whenever possible depending on the data volumes, for real-time evaluation of these extra observations, and a list of expected extra observations should be made available to NWP centres before the campaign.

3.3. Proposals for future studies

a) The use of the adjoint technique to compute a FIO (Forecast Impact to Observation, via an adjoint computation) is highly recommended to complement OSEs and DFS, to all the centres which can afford it (the adjoint of a forecast model is needed). A somewhat systematic exchange of results between some centres (as is currently done for monitoring of observation availability and quality) is also desirable.

b) For studying rapidly and objectively the optimization of stations of the Regional Basic Synoptic Network in the WMO Regions (especially radiosondes to start with), it is recommended to study the design of a simple mathematical tool, in the form of a portable software, based on the optimal estimation theory (along the lines of Pokrovsky, 2008, in the present proceedings, but using appropriate NWP background statistics rather than climatology, and taking into account the cost of each individual station).

c) More attention should be given to the forecasts at ranges 7 to 14 days, in some future impact studies. In this context, some studies should address the requirements in surface variables such as soil moisture, SST and sea-ice and also the observation requirements in the stratosphere. Ensemble prediction systems could be a helpful tool for these future studies.

d) Concerning the stratosphere, the requirements for conventional observations will have to be studied again in the new context where GPS-RO has started to play a major role, and when ADM-AEOLUS wind data are likely to be available within few years. The current Joint OSSE project provides a testbed for studies to answer the general question of observation requirements in the stratosphere.

e) Consistent with the outcome of the previous Workshop in Alpbach, the Workshop again recognized the potential value of a properly calibrated OSSE system as a tool to provide guidance for the evolution of the GOS. The Workshop took note of the emerging Joint OSSE collaboration that is coordinated within the US by the Joint Center for Satellite Data Assimilation and that includes input also from ECMWF and KNMI. Hope was expressed that the Joint OSSE collaboration will be further developed and expanded, and that the developers of space-based observing systems in particular will participate in funding the
system and will make use of its output in their decision-making processes. One typical example is GPS radio-occultation which should be studied through OSSEs.

f) Studies related to surface emissivity over land are highly required for regional NWP in order to fully exploit the satellite observations. Some are already available, but the efforts should be increased.

g) The same approach for the organization of future observing systems impact studies and the reporting on their outcomes should be used again in a similar workshop planned for 2012. However, several other organizations are possible and worth discussing, taking into account the existence of the THORPEX Programme, active on the same scientific subject. The ET proposed that CBS-XIV makes a recommendation for holding the 5th NWP “Impact” workshop in 2012.
REVISED TERMS OF REFERENCE OF THE CBS LEAD CENTERS FOR GCOS

1. Diagnose problems in the GSN and GUAN by using the monitoring reports produced by the GCOS Monitoring and Analysis Centers;

2. Liaise with nominated National Focal Points for GCOS and related Climatological Data, and other responsible officials, to improve data and meta data availability and quality;

3. Co-ordinate activities with other GCOS Centers and/or other centers as appropriate;

4. Monitor and report to CBS and GCOS on actions taken, progress achieved, concerns and recommendations on a yearly basis in a time frame that corresponds to planned AOPC and CBS meetings;

5. Assist AOPC in the revisions of GSN and GUAN stations;

6. Assist the WMO Secretariat in maintaining the list of National Focal Points for GCOS and related Climatological Data.
THE LIST OF CBS LEAD CENTERS FOR GCOS AND THEIR AREAS OF RESPONSIBILITY

- **Morocco (RA I)** is responsible for GSN and GUAN Stations in: Algeria, Benin, Burkina Faso, Cameroon, Cape Verde, Central African Republic, Chad, Congo, Côte d'Ivoire, Egypt, Gabon, Ghana, Gambia, Guinea, Guinea Bissau, Guinea Equatorial, Liberia, Libyan Arab Jamahiriya, Madagascar, Mali, Niger, Nigeria, Mauritania, Morocco, Senegal, Sierra Leone, Sao Tome and Principe, Sudan, Togo, Tunisia.

- **Mozambique (RA I)** is responsible for GSN and GUAN Stations in: Angola, Botswana, Burundi, Canary Island, Comoros Island, Democratic Republic of the Congo, Djibouti, Eritrea, Ethiopia, Kenya, Lesotho, Malawi, Mauritius, Mozambique, Namibia, the Ocean Islands (St. Helena Island, Ascension Island, Martin de Vivies, Iles Crozet, Iles Kerquelen), Rwanda, Seychelles, Somalia, South Africa, Swaziland, Uganda, United Republic of Tanzania, Zambia, Zimbabwe.

- **Iran (RA II and part of RA VI)** is responsible for GSN and GUAN Stations in: Afghanistan, Armenia, Azerbaijan, Bahrain, India, Iran, Jordan, Kazakhstan, Kyrgyzstan, Maldives, Nepal, Oman, Pakistan, Qatar, Russian Federation, Saudi Arabia, Sri Lanka, Syria, Tajikistan, Turkey, United Arab Emirates, Yemen.

- **Japan (RA II)** is responsible for GSN and GUAN Stations in: Brunei, Cambodia, China, Japan, Laos, Malaysia, Mongolia, Myanmar, Philippines, Republic of Korea, Singapore, Vietnam.

- **Chile (RA III)** is responsible for all GSN and GUAN Stations in RA III.

- **USA (RA IV)** is responsible for most GSN and GUAN Stations in RA IV plus Hawaii.

- **Australia (RA V)** is responsible for most RA V, except those countries noted for Japan and Hawaii (USA).

- **Germany (RA VI)** is responsible for most RA VI, except those countries noted for Iran.

- **UK (British Antarctic Survey)** is responsible for all GSN and GUAN stations in Antarctica.
DRAFT TERMS OF REFERENCE OF THE ICT-IOS

(a) Monitor, report and make recommendations on the capability and utilization of composite observing systems comprising different observing networks to meet the requirements of the WMO and other international programmes/projects such as THORPEX and IPY, including the plan for the evolution of the GOS taking into account the development with respect to GEOSS;

(b) Review deficiencies in coverage and performance of the existing GOS, in particular in the implementation of the RBSNs, the GSN and GUAN (of GCOS) as well as related RBCNs, on the basis of monitoring results and regional studies, and to make proposals to improve the availability of data to meet stated requirements;

(c) Coordinate and consolidate the development of standardized high quality observing practices and prepare related recommendations;

(d) Assess the impacts of introducing new technology systems into the GOS on the status of regional observing networks, particularly those affecting the role of developing countries;

(e) Consider and report on the issues of costing, joint funding and management of the GOS;

(f) Strengthen collaboration between CBS and the regional associations, by providing advice on possible solutions for newly identified requirements.
DRAFT TERMS OF REFERENCE OF ET-AWS

a) Address the evolution of the AWS observing network;

b) Address requirements for integration, interoperability, standardization and homogeneity of the WIGOS concept;

c) Monitor advances in AWS technology;

d) Develop draft recommendation for updating of the Manual and the Guide on the GOS in the context of WIGOS concept;

e) Provide advice to ET-EGOS and OPAG-IOS on surface-based in situ contributions to the GOS to address the identified requirements and overcome known deficiencies and gaps.
DRAFT TERMS OF REFERENCE OF ET-EGOS

(a) Update and report on observational data requirements of the WWW as well as other WMO and international programmes supported by WMO;

(b) Review and report on the capability of both surface-based and space-based systems that are candidate components of the evolving composite GOS;

(c) Carry out the rolling requirements review of several application areas using subject area experts (including atmospheric chemistry through liaison with CAS, marine meteorology and oceanography through liaison with JCOMM, aeronautical meteorology through liaison with CAeM, agrometeorology through liaison with CAgM, hydrology through liaison with CHy, and climate variability and change detection through liaison with CCI and GCOS);

(d) Review the implications of the Statements of Guidance concerning the strengths and deficiencies in the existing GOS and evaluate the capabilities of new observing systems and possibilities for improvements and efficiencies in the GOS;

(e) Carry out studies of real and hypothetical changes to the GOS with the assistance of NWP centres;

(f) Maintain and update the Implementation Plan for Evolution of the GOS, taking into account developments with respect to GEOSS; monitor progress against the Plan, report progress and updated Plan through ICT-IOS to CBS;

(g) Prepare documents to assist Members, summarizing the results from the above activities.
DRAFT TERMS OF REFERENCE OF ET-SAT

a) Provide technical advice with respect to both operational and R&D environmental satellites to assist in the integration of WMO-coordinated observing systems;

b) Advise CBS through ICT-IOS on matters requiring feedback to the WMO Consultative Meetings on High-level Policy on Satellite Matters;

c) Assess the observation, collection, and analysis systems relating to the use of operational and R&D environmental satellites contributing, or with the potential to contribute, to the space-based subsystem of the GOS, and to suggest improvements of system capabilities, particularly with respect to developing countries;

d) Assist CBS in assessing the status of implementation of the space-based subsystem of the GOS and the adequacy of plans for implementation for meeting established requirements for satellite data and products;

e) Make recommendations with respect to the transition of relevant R&D instruments to operational environmental satellites;

f) Coordinate with other relevant CBS teams with a view to making recommendations on matters, such as the exchange, management, and archiving of satellite data and products, radio frequency utilization, as well as education and training and other appropriate capacity-building measures related to satellite meteorology;

g) Identify and assess opportunities and/or problem areas concerning satellite technology and plans of relevant satellite operators, and inform CBS timely and comprehensively through ICT.
DRAFT TERMS OF REFERENCE OF ET-SUP

(a) In following the rolling requirements review for the Strategy to Improve Satellite System Utilization, analyze the biennial questionnaire on availability and use of satellite data and products by WMO Members, compile a list of recommended actions based on that analysis and prepare a new WMO SP Technical Document, including a summary analysis from the Virtual Laboratory for Satellite Data Utilization’s Centers of Excellence;

(b) Review present and future R&D satellite data and products including their availability and applications in view of increased utilization by WMO Members;

(c) Initiate activities and monitor their progress to achieve the availability of operational and R&D satellite data and products at users according to their needs, in close coordination with the relevant CGMS working group on this issue and with WIS activities aimed at harmonizing the service;

(d) In conjunction with the WMO Space Programme Office further clarify the information needs of WMO Members regarding access to and utilization of satellite data and products and associated capacity building, and best ways to meet these requirements;

(e) Represent WMO Member needs to the Virtual Laboratory for Satellite Data Utilization in relevant areas, including:
   (i) Organize regular training events in all WMO Regions aiming at further increasing the number of staff and their skills in full utilization of satellite data, from both operational and R&D satellite data;
   (ii) Help ensure Members have access to training materials and courses, as well as provide advice on ways to access data, products, and algorithms from both operational and R&D satellites;
   (iii) Evaluate, with the support of the Virtual Library Focus Group, the success and needs of the Virtual Library components and suggest strategies for improving its performance;
   (iv) Review the implementation and achievements of the new Virtual Laboratory Training Strategy for 2009 – 2014;

(f) Coordinate with ET-SAT and ET-EGOS on the Evolution of the GOS;

(g) Assess and further the concept of Regional/Specialized Satellite Centres (R/SSC);

(h) Prepare documents to assist Members, summarizing the results from the above activities.
In the area of surface-based remote sensing the team should:

a) Review the status of the surface-based component of the GOS (taking into account WIGOS concept), including surface, upper-air, and weather radar contributions;

b) Based on the outcome of (a), review and make recommendation on the composition of the GOS as described in the Manual on the GOS (WMO-NO. 544);

c) Based on the outcome of (b), develop functional specifications for a new catalogue of stations (evolving from Vol. A) and make recommendation on practically achievable implementation;

d) Review and make recommendations on the database structure used to document the performance of surface-based observing systems, as needed to support the RRR process;

e) Populate and periodically update the content of the database of the performance of surface based observing systems;

f) Provide advice to ET-EGOS and OPAG-IOS on surface-based contributions to the GOS to meet the identified requirements and gaps;

g) Provide advice to WMO Members and RAs on agreed composition of the GOS and steps needed to implement surface based components of the GOS.
DRAFT TERMS OF REFERENCE OF ET-AIR

a) Review and report to CBS on the AMDAR Programme activities related to the integration of AMDAR into WIGOS;

b) Develop governance for the AMDAR Programme;

c) Steer the implementation of the WIGOS AMDAR Pilot Project;

d) Develop a data policy for AMDAR;

e) Undertake the EGOS IP for AMDAR;

f) Report on training requirements for AMDAR.
DRAFT TERMS OF REFERENCE OF THE RAPPORTEUR ON AMDAR ISSUES

a) Represent CBS in WMO AMDAR Panel meetings, workshops and seminars;

b) Represent WMO AMDAR Panel in relevant CBS meetings and CBS sessions;

c) Coordinate CBS and AMDAR activities relating to the evolution to the GOS and WIGOS;

d) Assist in coordination with Regional Associations and relevant Technical Commissions to ensure that WMO Members are aware of the capabilities of AMDAR and are familiar with the availability and benefits of AMDAR data;

e) Assist in collaboration with the AMDAR Technical Coordinator and WMO AMDAR Panel Chairperson, in coordination and implementation of national and regional AMDAR Programmes;

f) Assist in collaboration with the WMO AMDAR Panel members, in coordination, update and development of training materials, and implementation of AMDAR training and capacity building activities.
DRAFT TERMS OF REFERENCE OF THE CO-RAPPORTEURS ON SCIENTIFIC EVALUATION OF IMPACT STUDIES UNDERTAKEN BY NWP CENTRES

(a) Prepare and maintain reviews of OSEs, OSSEs and other studies that are being undertaken by various NWP Centres around the globe and provide information for consideration by the OPAG on IOS;

(b) Provide input to ET-EGOS regarding the Evolution of the GOS and to ET-SAT on findings that might influence future satellite missions.
DRAFT TERMS OF REFERENCE OF THE RAPPORTEUR ON GCOS MATTERS

(a) Continue the preparation and maintenance of reviews of observing systems that are being designed under the auspices of GCOS, e.g. GUAN, GSN, GRUAN and space-based observing systems (GOSSP and CGMS); and provide feedback to Members in maintaining the quality of the networks;

(b) Provide input to ET-EGOS on user requirements relevant to Climate monitoring and to OPAG-IOS on issues relevant to CBS.
DRAFT TERMS OF REFERENCE OF THE RAPPORTEUR ON REGULATORY MATERIAL

Review and update regulatory and guidance material on the GOS, as required, and make recommendations for amendments
Liaise with the HMEI, CIMO and others as appropriate for the development and introduction of new in situ instrumentation, and provide information and advice to the OPAG on IOS on the possible impacts of these on the GOS and strategies for mitigating any adverse impacts.
## DETAILED WORK PLAN AND PROPOSAL FOR ALLOCATION OF TASKS – ET-AWS 2009-2011

<table>
<thead>
<tr>
<th>Task</th>
<th>Action</th>
<th>Responsible</th>
<th>Deadline</th>
<th>Deliverable (KPI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Update AWS Functional Specifications (FS) for all WMO related Programme</td>
<td>Monitor the requirements for update of FS</td>
<td>J.P. van der Meulen</td>
<td>Feb 2010</td>
<td>Updated version of AWS FS for inclusion in the regulatory material</td>
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<tr>
<td>(Expected Result 4)</td>
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<tr>
<td>Develop the requirements (RQ) for a robust AWS, particularly those in remote locations.</td>
<td>Finalize the draft version of ET-AWS-5</td>
<td>R. Nitu</td>
<td>Feb 2010</td>
<td>Technical guidance to Members</td>
</tr>
<tr>
<td>(Expected Result 4)</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Assess capabilities for AWS to contribute directly to the calibration and ground truth of space-based observation</td>
<td>Responding to the recommendations of relevant ETs.</td>
<td>K. Monnik</td>
<td>Feb 2010</td>
<td>Assessment of capabilities for CBS</td>
</tr>
<tr>
<td>(Expected Result 4)</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Develop the requirements for new sensors or the integration of sensors to address the deficiencies of AWS following the migration from manual observations</td>
<td>Finalize the draft version of ET-AWS-5</td>
<td>R. Nitu</td>
<td>Feb 2010</td>
<td>Technical guidance to Members</td>
</tr>
<tr>
<td>(Expected Result 4)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Develop tools for network design and optimization</td>
<td>Testing of proposed tools on all RBSNs</td>
<td>J.P. van der Meulen</td>
<td>Feb 2010</td>
<td>Technical guidance to Members</td>
</tr>
<tr>
<td>(Expected Result 4)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Develop guidelines and procedures to assist in the transition from manual to automatic surface observing stations</td>
<td>Finalize the draft version of ET-AWS-5</td>
<td>K. Monnik</td>
<td>Feb 2010</td>
<td>Guidelines to be incorporated into the Guide on GOS</td>
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2 Tentative, pending designation of CBS expert teams
<table>
<thead>
<tr>
<th>(Expected Result 4)</th>
<th>Finalize the draft version of ET-AWS-5</th>
<th>H. Zhou</th>
<th>Feb 2010</th>
<th>Technical guidance to Members</th>
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<tbody>
<tr>
<td>Develop requirements for new data types from AWS sensors</td>
<td>Prepare tables of AWS metadata for WIS based on BUFR descriptors</td>
<td>K. Monnik</td>
<td>Feb 2010</td>
<td>Relevant AWS metadata catalogues for WIS</td>
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<tr>
<td>(Expected Result 4)</td>
<td>In coordination with CIMO and other relevant TCs, finalize the guidelines materials for Members</td>
<td>M. Leroy</td>
<td>Feb 2010</td>
<td>Guidelines for submission to CBS and inclusion into Guide to GOS and recognition as a joint ISO-WMO standard</td>
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<tr>
<td>Develop AWS metadata catalogues for WIS</td>
<td>Monitor the requirements for updating the list</td>
<td>J.P. van der Meulen</td>
<td>Feb 2010</td>
<td>Technical guidance to Members</td>
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<tr>
<td>(Expected Result 4)</td>
<td>Review BUFR descriptors and propose new ones if needed</td>
<td>I. Zahumensky</td>
<td>Feb 2010</td>
<td>List of BUFR descriptors related to AWS</td>
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<td>(Expected Result 4)</td>
<td>Implement and validate BUFR template for SYNOP/AWS reporting (including new station identification)</td>
<td>M. Leroy</td>
<td>Dec 2008</td>
<td>Validated templates for approval by CBS</td>
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<tr>
<td>Review BUFR descriptors related to AWS measurements according to requirements</td>
<td>Review progress and advances in AWS technologies</td>
<td>M. Leroy</td>
<td>Feb 2010</td>
<td>Guidance material for Members and ET-EGOS</td>
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<tr>
<td>Monitor advances in AWS technology</td>
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<tr>
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## DETAILED WORK PLAN AND PROPOSAL FOR ALLOCATION OF TASKS – ET-EGOS 2009-2012

<table>
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<tr>
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<th>Action</th>
<th>Responsibility</th>
<th>Deadline for action</th>
<th>Deliverable</th>
</tr>
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</table>
| 1. Survey and collate user requirements for observations for WMO and WMO-sponsored programmes  
 *(Expected Result 4)* | Review and update CEOS/WMO database of user requirements for observations, through Points of Contact for application areas. | Ch ET-EGOS | Update annually or as required | Updated versions of user requirements database |
| 2. Survey and collate observing systems capabilities for surface-based and space-based systems that are candidate components of WIGOS  
 *(Expected Result 4)* | Review and update CEOS/WMO database of observing system capabilities, in collaboration with other OPAG IOS ETs. | Ch ET-EGOS | Update annually or as required | Updated versions of observing system capabilities database |
| 3. Maintain Rolling Review of Requirements (RRR) for observations in several application areas, using subject area experts, including appropriate liaison with CAS, JCOMM, CAeM, CAgM, CHy, CCl and GCOS.  
 *(Expected Result 4)* | Continue RRR process for 12 application areas and expand to new areas as required: review and update as necessary Statements of Guidance on the extent to which present/planned observing system capabilities meet user requirements, through Points of Contact on application areas. | Ch ET-EGOS | Update annually or as required | Updated Statements of Guidance (gap analyses) |
| 4. Prepare and maintain reviews of OSEs, OSSEs and other studies undertaken by NWP centres and to provide information for consideration by ET-EGOS and OPAG-IOS  
 *(Expected Result 4)* | Rapporteurs on Impact Studies and NWP experts, review results of impact studies relevant to the evolution of GOS. | Rapporteurs on Impact Studies | To each ICT-IOS meeting | Summary reports |
<table>
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<tr>
<th></th>
<th>Task Description</th>
<th>Responsible Party</th>
<th>Frequency</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Promote CBS activities in support of GCOS goals</td>
<td>GCOS Rapporteur</td>
<td>To each ICT IOS meeting</td>
<td>Summary reports</td>
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<td></td>
<td><em>(Expected Result 4)</em></td>
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<td></td>
<td>Review the implications of the GCOS Adequacy Report and the GCOS Implementation Plan for the activities of CBS</td>
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<td></td>
<td>Bring relevant issues to the attention of ET-EGOS</td>
<td>GCOS Rapporteur</td>
<td>To each ET-EGOS meeting and at least annually</td>
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<td><em>(Expected Result 4)</em></td>
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<td>6</td>
<td>Prepare an updated version of the Implementation Plan for the Evolution of the GOS, fully responding to the “Vision for the GOS in 2025”</td>
<td>Ch ET-EGOS</td>
<td>To next ICT IOS meeting</td>
<td>Updated version of EGOS-IP</td>
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<td><em>(Expected Result 4)</em></td>
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<tr>
<td>Task</td>
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<td>Deadline for action</td>
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<tr>
<td>Review capabilities of operational and R&amp;D satellites</td>
<td>Provide update on current and planned satellite missions</td>
<td>All sat. operators represented at ET-SAT</td>
<td>Every year by the ET-SAT meeting</td>
<td>Tables</td>
</tr>
<tr>
<td>(Expected Result 4)</td>
<td>Assist in formulating or updating a Vision for the GOS, as concerns space-based aspects and related observation strategies</td>
<td>ET-SAT Chair and Members</td>
<td>Every year by the ET-SAT meeting</td>
<td>Recommendations to WMO Secretariat (SP) and ET-EGOS</td>
</tr>
<tr>
<td></td>
<td>Identify opportunities for transition of relevant R&amp;D missions to operations</td>
<td>ET-SAT Chair and Members</td>
<td>Every year by the ET-SAT meeting</td>
<td>Report to CBS through ICT-IOS</td>
</tr>
<tr>
<td></td>
<td>Recommendations to prepare the transition of relevant R&amp;D missions to operations and to promote the use of R&amp;D mission data</td>
<td>ET-SAT Chair and Members</td>
<td>Every year by the ET-SAT meeting</td>
<td>Recommendations to CBS via ICT-IOS, and to ET-SUP</td>
</tr>
<tr>
<td>Assist CBS on coordinating global planning of satellite missions to implement the Vision for the GOS in 2025</td>
<td>Reviewing the status of implementation of the space-based component of the GOS</td>
<td>ET-SAT Chair and Members</td>
<td>Every year by the ET-SAT meeting</td>
<td>Report to CBS through ICT-IOS</td>
</tr>
<tr>
<td>(Expected Result 4)</td>
<td>Identify and assess opportunities and/or problem areas concerning plans of relevant satellite operators</td>
<td>ET-SAT Chair and Members</td>
<td>Every year by the ET-SAT meeting</td>
<td>Report to CBS through ICT-IOS</td>
</tr>
<tr>
<td></td>
<td>Support international cooperation on future demonstration missions</td>
<td>ET-SAT Chair and Members</td>
<td>Every year by the ET-SAT meeting</td>
<td>Workshops and their reports</td>
</tr>
<tr>
<td></td>
<td>Review and update the Gap Analysis related to the fulfilment of WMO requirements by the space-based component of the GOS</td>
<td>ET-SAT Chair and Members</td>
<td>Every year by the ET-SAT meeting</td>
<td>Report to CBS through ICT-IOS</td>
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<td></td>
<td>Provide technical advice with respect to both operational and R&amp;D environmental</td>
<td>ET-SAT Chair and Members</td>
<td>Every year by the ET-SAT meeting</td>
<td>Report to CBS through ICT-IOS</td>
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<tr>
<td>Area</td>
<td>Task Description</td>
<td>Responsible Parties</td>
<td>Frequency</td>
<td>Reporting Path</td>
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<tr>
<td><strong>Advise CBS on other relevant matters</strong></td>
<td>Provide response to WMO Consultative Meetings on High-level Policy on Satellite Matters</td>
<td>ET-SAT Chair and Members</td>
<td>Before CM</td>
<td>Report to CBS through ICT-IOS</td>
</tr>
<tr>
<td><em>(Expected Results 4, 5, 9)</em></td>
<td>Assess the capabilities of systems relating to the access and use of environmental satellites and suggest improvements of these capabilities, particularly with respect to developing countries.</td>
<td>ET-SAT Chair and Members</td>
<td>Every year by the ET-SAT meeting</td>
<td>Report to CBS through ICT-IOS</td>
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<td></td>
<td>Advise on other subjects such as radio frequency utilization,</td>
<td>ET-SAT Chair and Members</td>
<td>Every year by the ET-SAT meeting</td>
<td>Report to CBS through ICT-IOS</td>
</tr>
<tr>
<td><strong>Coordination and reporting</strong></td>
<td>Provide relevant input to ET-SUP on education and training and other appropriate capacity-building measures related to satellite meteorology</td>
<td>ET-SAT Chair and Members</td>
<td>Every year by the ET-SAT meeting</td>
<td>Report to ET-SUP</td>
</tr>
<tr>
<td><em>(Expected Result 10)</em></td>
<td>Coordinate with other relevant CBS teams with a view to making recommendations on relevant matters,</td>
<td>ET-SAT Chair</td>
<td></td>
<td>Inputs to ET-EGOS, ET-SUP, ET-AWS</td>
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<td></td>
<td>Support cooperation with CGMS, CEOS and other satellite-related organizations</td>
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<td><strong>Space Weather</strong></td>
<td>Provide initial contribution to the implementation of an inter-Commission activity related to Space Weather coordination</td>
<td>Chair, ET-SAT</td>
<td>End 2009</td>
<td>Recommendations on tasks, report on related activities of satellite operators</td>
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<tr>
<td>Task</td>
<td>Action</td>
<td>Responsibility</td>
<td>Deadline for action</td>
<td>Deliverable(s)</td>
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<td>Expand the use of satellite data &amp; products across WMO Members with focus on the needs of less well developed Members</td>
<td>Prepare and distribute a questionnaire on the availability and use of satellite data and products on a biannual basis</td>
<td>ET-SUP members (probably through sub-group in cooperation with WMO)</td>
<td>January 2010 (thereafter every two years)</td>
<td>Published questionnaire (including a web-based online version)</td>
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<td></td>
<td>Gather, record and analyse questionnaire responses and present in published Technical Document (TD)</td>
<td>ET-SUP members (probably through sub-group) in cooperation with WMO Secretariat</td>
<td>Draft TD by Sept 2010 and Final TD by December 2010 (thereafter every two years)</td>
<td>Published WMO Technical Document</td>
</tr>
<tr>
<td></td>
<td>Consider follow-up actions for Key Findings and Recommendations from the analysis of responses.</td>
<td>ET-SUP members and Regional Rapporteurs</td>
<td>At all ET-SUP meetings</td>
<td>Recorded and tracked actions for each Key Finding identified as requiring action.</td>
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<td></td>
<td>Monitor progress of the R/SSC-CM initiative and consider extending the concept to other application areas</td>
<td>ET-SUP members</td>
<td>End 2009</td>
<td>Recommendation to CGMS and CBS</td>
</tr>
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<td></td>
<td>Promote the wide use of established and standard satellite data formats, processing techniques and tools</td>
<td>ET-SUP members</td>
<td>At all ET-SUP meetings</td>
<td>Workshops and/or published guidance as appropriate</td>
</tr>
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<td></td>
<td>Monitor enhanced use of R&amp;D mission data, in particular for developing countries, through components of information provision and capacity building tasks</td>
<td>ET-SUP members and Regional Rapporteurs</td>
<td>At all ET-SUP meetings</td>
<td>Increased use of R&amp;D data (evidence from questionnaire responses)</td>
</tr>
<tr>
<td>Promote and implement harmonized, efficient, timely, enhanced data access</td>
<td>Monitor and review progress of the IGDDS and RARS projects by review of the respective Implementation Group activities and ensure both projects fulfil their respective objectives</td>
<td>ET-SUP members</td>
<td>At all ET-SUP meetings</td>
<td>Updates to IGDDS and RARS project plans and documents. Achieve 90% global coverage by RARS systems with data content extended to include hyperspectral sounder data</td>
</tr>
<tr>
<td>Ensure the IGDDS and RARS project implementations proceed [in full conformance with the frameworks established by WIS and WIGOS]. This shall include enhanced access to R&amp;D mission data, in particular for developing countries</td>
<td>ET-SUP members</td>
<td>At all ET-SUP meetings</td>
<td>Global network of regional dissemination systems (following WIS standards)</td>
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<tr>
<td>Provide up-to-date and comprehensive information on satellite plans, systems, products</td>
<td>ET-SUP members</td>
<td>At all ET-SUP meetings</td>
<td>Comprehensive, up-to-date and maintained web pages</td>
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<tr>
<td>(Expected Results 4, 5, 9)</td>
<td>Provide support to the development and maintenance of comprehensive descriptive information on satellite data and products (including those from R&amp;D missions) with focus on on-line Internet based delivery of information</td>
<td>ET-SUP members</td>
<td>At all ET-SUP meetings</td>
<td>Comprehensive, up-to-date and maintained web pages</td>
</tr>
<tr>
<td>Maximise exploitation of satellite data through capacity building</td>
<td>VLMG</td>
<td>In accordance with VL Implementation Plan</td>
<td>As defined in the VL Implementation Plan</td>
<td></td>
</tr>
<tr>
<td>(Expected Result 9)</td>
<td>Provide support to the VL through regular review of status, progress and plans ensuring the needs of users, especially those from less well developed Members, are addressed</td>
<td>ET-SUP members (in cooperation with VLMG)</td>
<td>Periodically, primarily at ET-SUP meetings</td>
<td>Updated VL plans and actions to address identified problem areas</td>
</tr>
<tr>
<td>Cooperation and Reporting</td>
<td>ET-SUP members</td>
<td>All ET-SAT/SUP meetings</td>
<td>Documents for relevant meetings (Basis: to be published in WMO TD)</td>
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<tr>
<td>Expected Result 10)</td>
<td>Report to ET-EGOS and ET-SAT on most required but not available satellite data and products as assessed from responses to the biennial questionnaire on the availability and use of satellite data and other relevant Sources of information</td>
<td>ET-SUP members</td>
<td>All ET-SAT/SUP meetings</td>
<td>Documents for meetings</td>
</tr>
<tr>
<td>Note: Regular publication of a WMO TD reporting on the status of availability and use of satellite data and products by WMO Members is already mentioned as part of Task 1</td>
<td>Coordinate with ET-SAT and CGMS information issues regarding availability, use, benefits, lacks of satellite data and related risks</td>
<td>ET-SUP members</td>
<td>All ET-SAT/SUP meetings</td>
<td>Documents for meetings</td>
</tr>
<tr>
<td>Document the assessment results of Performed VL training activities</td>
<td>ET-SUP members (VL sub-team)</td>
<td>Once per year prior to ET-SUP Meetings</td>
<td>Report and web-based material demonstrating the benefits of training</td>
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</tbody>
</table>
RECOMMENDATION 4.5.1 “Validation of AMDAR humidity”

The ICT-IOS recommended that:

The AMDAR Panel ensure that validation of AMDAR humidity data be performed not only with operational radiosondes and NWP models but also with the dedicated sensors on research aircraft.

RECOMMENDATION 7.2.7 “Support to Generic Software Solution”

The ICT-IOS recommended that:

CBS support a proposal for the AMDAR Panel and WMO to request funds from WMO Members to develop a generic AMDAR software solution for all aircraft makes and models.

RECOMMENDATION 7.2.8 “Collection and distribution of AMDAR data”

The ICT-IOS recommended that:

CBS encourage all operational AMDAR Programmes to collect and distribute AMDAR data outside their national territories as part of their contribution to WWW.

RECOMMENDATION 7.2.9a) “Atmospheric profiles over Africa and the tropics”

The ICT-IOS recommended that:

CBS-XIV encourage Members to increase the horizontal density of AMDAR observations in all regions, particularly over Africa and generally across the tropics.

RECOMMENDATION 7.2.9b) “AMDAR data sharing negotiations”

The ICT-IOS recommended that:

CBS-XIV encourage Members to support the AMDAR Panel with its data sharing negotiations with third party data providers, such as TAMDAR, for the provision of upper-air data to the global meteorological community via the GTS.

RECOMMENDATION 9.1.4 a) “BUFR descriptors for Function Specification for AWS”

The ICT-IOS recommended that:

The OPAG-IOS requests OPAG-ISS to develop BUFR descriptors for all variables, listed in the table “The Functional specifications for Automatic Weather Stations”.
RECOMMENDATION 9.1.4 b) “AWS metadata catalogues”

The ICT-IOS recommended that:

The OPAG-IOS requests OPAG-ISS to use existing BUFR tables in the development and implementation of metadata catalogues for WIS.

RECOMMENDATION 9.1.4 c) “Siting classification”

The ICT-IOS recommended that:

The CBS and CIMO develop further the siting classification scheme for the inclusion in the Manual of the Global Observing System (WMO-No. 544) and Guide to Meteorological Instruments and Methods of Observations (WMO-No. 8). This classification scheme should subsequently be recognized as a joint WMO-ISO standard.

RECOMMENDATION 9.2.4 a) “China’s new polar satellite FY-3A”

Following the launch of China’s new 2nd generation polar satellite (FY-3A), whilst recognizing that it is still a R&D mission, the ICT-IOS recommended that some data (e.g. microwave sounder data) be made available as soon as possible in near real time for NWP purposes;

RECOMMENDATION 9.2.4 b) “Statements of Guidance for Climate Monitoring”

The ICT-IOS recommended that:

The GCOS Secretariat report in due course on any update to the Statements of Guidance for Climate Monitoring, and to the GCOS observation requirements associated with the updated GCOS Implementation Plan;

RECOMMENDATION 9.2.4 c) “WIGOS Pilot Project for GRUAN”

Noting that implementation of GRUAN was in the spirit of the WIGOS Pilot Projects the ICT-IOS recommended that the GCOS groups overseeing GRUAN consider following the example given by WIGOS Pilot projects;

RECOMMENDATION 9.2.4 d) “Addressing aspects of the EGOS-IP”

Noting that the EUCOS approach was addressing aspects of the EGOS-IP and of the implementation of observational networks in support of NWP and other applications, the ICT-IOS recommended that other Regions might benefit from considering and adopting aspects of the EUCOS approach;

RECOMMENDATION 9.2.4 e) “IPY”

The ICT-IOS recommended that:

The IPY should strive to make available appropriate data-sets in near real-time, possibly through WIS Pilot Projects;
RECOMMENDATION 9.2.4 f) “Collocation of wind and wave sensors”

Noting that extreme wave and wind gusts events significantly constrain shipping and other marine operations, the ICT-IOS recommended the collocation of wind and wave sensors;

RECOMMENDATION 9.2.4 g) “Barometers on drifting buoys”

Noting that sea surface pressure data from drifting and moored buoys were still limited, particularly in tropical regions where these data were vital to detect and monitor atmospheric phenomena over the oceans (e.g. tropical cyclones) that significantly constrain shipping, the ICT-IOS recommended the installation of barometers on all deployed drifters;

RECOMMENDATION 9.2.4 h) “Distribution of hourly observations”

The ICT-IOS recommended that:

CBS endorse distribution of hourly observations, globally and in real time;

RECOMMENDATION 9.2.4 i) “Distribution of radiosonde profiles”

The ICT-IOS recommended that:

CBS to encourage Members to migrate to internationally agreed BUFR templates, especially regarding radiosonde profiles for the distribution of high resolution data;

RECOMMENDATION 9.2.4 j) “Observations in the stratosphere”

The ICT-IOS recommended that:

CBS to encourage major NWP centres to assess the impacts of the stratospheric observing systems;

RECOMMENDATION 9.2.4 k) “AMDA optimization”

The ICT-IOS recommended that:

CBS to encourage the USA AMDAR Programme to make available its AMDAR data outside the USA as part of an AMDAR optimization system;

RECOMMENDATION 9.2.4 l) “Surface pressure over oceans”

The ICT-IOS recommended that:

CBS to encourage major NWP centres to conduct studies on the requirements for in-situ surface pressure observations, in terms of optimal horizontal resolution required in presence of satellite wind data;
RECOMMENDATION 9.2.4 m) “Argo sustainability”

The ICT-IOS recommended that:

Noting that most Argo national programmes are supported by research funding, CBS to urge Members to provide for long-term support of Argo national programmes in order to sustain the array over decadal timescales. CBS also to encourage Members to document the benefits gained from using Argo data.

RECOMMENDATION 9.2.4 n) “Focal Points for EGOS-IP”

The ICT-IOS recommended that:

The list of NMHSs for which a National Focal Point (NFP) for reporting progress and plans related to EGOS-IP has been nominated, showing reports received for 2007, be presented in an appropriate document for CBS-XIV;

RECOMMENDATION 9.3.5 a) “Guidelines to WMO for facilitating the transition of relevant R&D missions”

The ICT-IOS recommended that:

The guidelines developed by the ET-SAT be used by WMO for facilitating the transition of relevant R&D missions or instruments to operational status (Appendix IV);

RECOMMENDATION 9.4.4 a) “Virtual Laboratory”

The ICT-IOS recommended that:

There is a need for a technical support officer to support the planned training and education activities as elaborated through the new Virtual Laboratory (VL) strategy and the ET-SUP work plan; this technical officer could be located at a CoE and sponsored by satellite operators;

RECOMMENDATION 9.4.4 b) “Satellite data deficiencies”

The ICT-IOS recommended that:

The WMO Space Programme should initiate follow-up actions for those WMO Members which report some lack in the availability of satellite data and products or in knowledge of their use or other limiting factors. The Space Programme should have sufficient resources to perform such follow-up actions;

RECOMMENDATION 9.4.4 c) “Satellite data and utilisation questionnaire”

The ICT-IOS recommended that:

The Regional Rapporteurs to the WMO Space Programme should be involved to help achieve a higher return rate of the biennial questionnaire on the status of availability and use of satellite data and products by WMO Members, in particular from those who never return a questionnaire. More generally, the Rapporteurs could play some role in the gathering of Regional requirements, for example as concerns the IGDDS;
RECOMMENDATION 9.4.4 d) “EUMETCast-Americas”

The ICT-IOS recommended that:

Steps should be initiated in order to secure on a long-term basis the availability of such level 1 data to South American users which are currently made available via EUMETCast-Americas;

RECOMMENDATION 12.4 “Harmonization of Regional sections of Volume II of the Manual on the GOS”

The ICT-IOS recommended that:

The Rapporteur on Regulatory Material coordinates with all the Rapporteurs/Coordinators on the Regional Aspects of the GOS regarding possible harmonization of Regional differences related to the Manual on the GOS, Volume II and to provide a report to the next ICT-IOS;

RECOMMENDATION 12.5 “Tools for design and optimization of RBSNs/RBCNs”

The ICT-IOS recommended that:

Simple tools be developed to allow for harmonizing the criteria for inclusion of new stations in the regional networks, classification of existing stations according to their information weights (meteorological and economical impacts) and estimating the degradation of networks in the case of removal of existing operational stations from regional networks;

RECOMMENDATION 12.6 “WMO No. 9, Vol. A”

The ICT-IOS recommended that:

The WMO Secretariat to continue for now with the old Access-based version of Volume A currently ported on WMO computer platforms and it requested the Secretariat to try to find a major RSMC that would be prepared to host Volume A free of charge on behalf of WMO. However, the ownership should remain with WMO.
CONCLUSIONS AND RECOMMENDATIONS

PART B

ICT-IOS RECOMMENDATIONS FOR SUBMISSION TO CBS-XIV FOR CONSIDERATION

RECOMMENDATION 7.2.4 “Establishment of new Expert Team on Airborne Observations”

The ICT-IOS recommended that:

CBS-XIV consider establishment of an Expert Team on Airborne Observations (ET-AIR) that would assist with the integration of AMDAR into WWW programme and CBS working structure (See Appendix XI for TOR).

RECOMMENDATION 7.3.3 a) “Revised TORs of the CBS Lead Centres for GCOS”

The ICT-IOS recommended that:

CBS-XIV consider the revised Terms of Reference of the CBS Lead Centres for GCOS (Appendix IX).

RECOMMENDATION 7.3.3 b) “CBS Lead Centres for GCOS”

The ICT-IOS recommended that:

CBS-XIV consider the revised list of CBS Lead Centres for GCOS and their areas of responsibility (Appendix X).

RECOMMENDATION 8.2.5 “4th Workshop on the Impact of various Observing Systems on NWP”

The ICT-IOS recommended that:

CBS-XIV endorse recommendations from the 4th Workshop on “The impact of various observing systems on NWP” (Appendix VIII), including a proposal to organize the next Workshop in 2012;

RECOMMENDATION 9.1.4 d) “Function Specification for AWS”

The ICT-IOS recommended that:

CBS-XIV consider the approval of the revised Functional Specification for Automatic Weather Station (Appendix VI) for the inclusion in the Guide on the Global Observing System (WMO-No.488);
RECOMMENDATION 9.1.4 e) “Basic set of variables for standard AWS”

The ICT-IOS recommended that:

CBS-XIV consider the Basic set of variables to be reported by a standard AWS (Appendix VII) for inclusion in the Manual on the GOS (WMO-No. 544).

RECOMMENDATION 9.2.4 o) “Vision for the GOS in 2025”

The ICT-IOS recommended that:

CBS-XIV consider the adoption of “Vision for the GOS in 2025” (Appendix III) prepared by ET-EGOS-4;

RECOMMENDATION 9.2.4 p) “EGOS-IP”

The ICT-IOS recommended that:

CBS-XIV consider the report on progress on the Implementation Plan for the Evolution of the GOS (Appendix II) and, following adoption of the “Vision for the GOS in 2025” consider the development of a new version of EGOS-IP that will incorporate the information included in the Vision;

RECOMMENDATION 9.2.4 q) “New Expert Team on Surface-based Remote Sensing Observations”

The ICT-IOS recommended that:

CBS-XIV consider establishment of an Expert Team on Surface-Based Remote Sensing Observations (ET-SBRSO) that would, as one of its activities, provide support for the RRR process similarly to ET-SAT (See Appendix XI for TOR);

RECOMMENDATION 9.4.4 e) “VL Training Strategy”

The ICT-IOS recommended that:

CBS-XIV consider the new VL Training Strategy for the next five years (Appendix V), after approval by CGMS-36 in November 2008;

RECOMMENDATION 14.2 “PIW Sub-groups on the GOS in Regions”

Noting difficulties of Rapporteurs on Regional Aspects of GOS in conducting their duties according to their respective Terms of Reference, CBS-XIV encourage Regional Associations to establish Sub-groups on the GOS within their Working Groups on Planning and Implementation of WWW (PIW), similar to the practice of RA-VI. It also request Secretariat (especially the respective Regional Offices) to provide support to these Sub-groups and to make sure funding is available for their activities and for interaction with ICT-IOS and relevant CBS expert teams.