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INTEGRATED OBSERVING SYSTEMS

SUMMARY

ISSUE TO BE DISCUSSED:

Draft Recommendations 6.1/1 to 6.1/7

ADDITIONAL FINANCIAL IMPLICATION:

None

DECISIONS/ACTIONS REQUIRED:

(a) Adoption of the draft text for inclusion in the general summary of CBS-XIV;
(b) Adoption of draft Recommendations 6.1/1 to 6.1/7.

REFERENCES:

1. Report of the Expert Team on the Evolution of the GOS, third session (Geneva, Switzerland, 9-13 July 2007, and fourth session (Geneva, Switzerland, 7-11 July 2008)
2. Report of the Expert Team on Requirements and Representation of Data from Automatic Weather Stations, fifth session (Geneva, Switzerland, 5-9 May 2008)
3. Report of the Expert Team on Satellite Utilization and Products, third session (Geneva, Switzerland, 3-7 September 2007), and fourth session (Langen, Germany, 2-5 September 2008)
4. Report of the Expert Team on Satellite Systems, third session (Geneva, Switzerland, 3-7 September 2007), and fourth session (Langen, Germany, 2-5 September 2008)
5. Report of the Implementation Coordination Team on Integrated Observing Systems, fifth session (Geneva, Switzerland, 15-18 September 2008)
6. Report of the Fourth WMO Workshop on the Impact of Various Observing Systems on Numerical Weather Prediction (Geneva, Switzerland, 19-21 May 2008)
7. Report of the CBS Lead Centers for GCOS Coordination Meeting/Workshop, first session (Teheran, 5-8 November 2007)
8. CBS-XIV/INF. 6.1: Integrated Observing System - Progress/Activity Report

CONTENT OF DOCUMENT:

Appendices for inclusion in the final report:

A. Draft text for inclusion in the general summary of CBS-XIV
B. Draft Recommendation 6.1/1 (CBS-XIV) – “Vision for the GOS in 2025”
C. Draft Recommendation 6.1/2 (CBS-XIV) – Implementation Plan for the evolution of the GOS
D. Draft Recommendation 6.1/3 (CBS-XIV) – Virtual Laboratory Training Strategy
E. Draft Recommendation 6.1/4 (CBS-XIV) – Revised functional specifications for Automatic Weather Stations
F. Draft Recommendation 6.1/5 (CBS-XIV) – Basic set of variables for a standard Automatic Weather Station for multiple users
G. Draft Recommendation 6.1/6 (CBS-XIV) – Revised list of CBS Lead Centres for the GOS including their areas of responsibility and their Terms of Reference

DRAFT SUMMARY FOR INCLUSION IN THE GENERAL SUMMARY OF CBS-XIV

6.1 INTEGRATED OBSERVING SYSTEMS (*agenda item 6.1)*

6.1.1 The Commission expressed its appreciation to the Chair of the OPAG-IOS, Dr James Purdom and his Co-Chair Dr Sue Barrell, for their comprehensive report on the performance and further development of the surface-based and space-based subsystem of the GOS. It noted that the GOS, through coordinated efforts of Members, continued to provide sustainable observational data and information on the state of the Earth and its atmosphere to meet evolving requirements of various users. It underlined that along with the broadening satellite data and services, especially through R&D satellites, further improvements were achieved in the availability of data produced by other components of the GOS, notably marine and AMDAR data.

6.1.2 The Commission noted with satisfaction that in accordance with standing TORs and work plans, the major activities of the OPAG-IOS were concentrated on the evolution of the GOS, coordination and advice on satellite system matters, satellite utilization and products, requirements and representation of data from AWSs, scientific evaluation of OSEs and OSSEs, cooperation with GCOS, integration of AMDAR in WWW operations, revision and updating of GOS regulatory material. The Commission expressed its gratitude to all experts who contributed to the effective work of expert teams and rapporteurs established under OPAG-IOS.

6.1.3 Based on the activities and results achieved under various areas under the OPAG-IOS responsibilities, the Commission:

Implementation and operation of the GOS

6.1.4 Noted with satisfaction increased sustainability in implementation of surface based subsystem of the GOS;

6.1.5 Recognized the need to develop simple tools to assist Regional Rapporteurs on GOS with the design and optimization of Regional Basic Synoptic Networks (RBSNs) or Regional Basic Climate Networks (RBCNs);

Evolution of the GOS

6.1.6 Reviewed the “Vision for the GOS in 2025”, noted the valuable contributions from various expert teams and other collaborators and adopted draft Recommendation 6.1/1 (CBS-XIV);

6.1.7 Requested OPAG-IOS to maintain and update the Implementation Plan for Evolution of Space and Surface-Based Sub Systems of the GOS (EGOS-IP), taking into account the developments with respect to GEOSS, in close cooperation with the regional associations, their Working Groups on Planning and Implementation of the WWW and concerned technical commissions;

6.1.8 Following the review of the “Vision for the GOS in 2025” and the Implementation Plan for Evolution of Space and Surface-Based Sub Systems of the GOS (EGOS-IP) adopted Recommendation 6.1/2 (CBS-XIV), including requesting OPAG-IOS to develop a new version of the EGOS-IP that will incorporate information included in the adopted “Vision for the GOS in 2025”;

6.1.9 Requested those Members who have not yet nominated a National Focal for reporting progress and plans in their country related to EGOS-IP to do so;

6.1.10 Requested OPAG-IOS to find ways of improving the engagement of Members related to EGOS-IP;

6.1.11 Reviewed the need to establish a new Expert Team on Surface-based Remotely-Sensed (ET-SBRSO) and adopted its establishment;

6.1.12 Requested the OPAG-IOS, in collaboration with CAS, CIMO and other relevant Commissions and programmes within WMO to consider the development of a strategy to sustain key components of IPY and THORPEX observational networks beyond the end of their respective experiments;

6.1.13 Requested the OPAG-IOS to continue assisting ASECNA management in its role of providing long-tern sustainability of the AMMA network;

Satellite systems

6.1.14 Welcomed the substantial enhancement of space-based observations called for by the new Vision of the GOS to 2025 and highlighted the new paradigm it implied for global satellite mission planning, data sharing and interoperability;

6.1.15 Endorsed the guidelines developed to facilitate the transition of relevant R&D missions to operational status, as a critical process for the implementation of this new Vision;

6.1.16 Acknowledged the set of four reference documents describing respectively the satellite programmes of the GOS, the Earth Observation satellites and their instruments, the Gap Analysis of planned capabilities against user requirements and the expected product accuracy, and requested the further maintenance of such reference documentation to support planning activities;

6.1.17 Stressed that the CEOS-WMO Database on User Requirements and Observing Capabilities needs to be maintained within the Secretariat and recommended that a review be undertaken to redesign the current database with the aim of reducing resources required for maintenance;

6.1.18 Invited CBS and CAeM to investigate the establishment of an Inter-Commission Team on Space Weather;

Satellite utilization and products

6.1.19 Confirmed the need to monitor the progress of satellite data access and use by WMO Members through the biennial questionnaire or other means;

6.1.20 Requested that Members respond to the biennial questionnaire of the status of availability and use of satellite data and products and that Regional Rapporteurs to the WMO Space Programme assist with this activity;

6.1.21 Requested to consider actions to address the limitations expressed by WMO Members for satellite data access and use;

6.1.22 Reviewed the training conducted by the GCMS/WMO Virtual Laboratory for Satellite Data Utilization, confirmed the need for this training to continue, and endorsed the expansion of the network of Centres of Excellence to include centres in South Africa and the Russian Federation, and a further possible centre to be established in India;

6.1.23 Endorsed the new five-year strategy for the Virtual Laboratory and adopted draft Recommendation 6.1/3 (CBS-XIV).

6.1.24 Noted the progress of the Integrated Global Data Dissemination Strategy (IGDDS) project and the need to express requirement for data access; stressed the need for GEO imagery to be available in all regions primarily through DVB-S services and requested that OPAG-IOS investigate the continuity of such services over South America;

6.1.25 Recommended to expand the Space Programme Office in order to enable providing all the benefit expected from this programme, including the satellite utilization aspects.

Requirements and representation of data from AWSs

6.1.26 Reviewed the revised Functional Specifications for Automatic Weather Stations based on input from other technical commissions and adopted draft Recommendation 6.1/4 (CBS-XIV);

6.1.27 Requested the OPAG-ISS to develop BUFR descriptors for all the variables listed in the "Functional Specifications for Automatic Weather Stations";

6.1.28 Reviewed the "Basis Set of variables to be Reported by a Standard AWS for Multiple Users" and adopted draft Recommendation 6.1/5 (CBS-XIV);

6.1.29 Requested the OPAG-IOS to continue development of the four AWS metadata catalogues, namely: (a) variables measured; (b) instruments used; (c) data processing procedures used; and (d) data QC procedures;

6.1.30 Noted that there is no dedicated expert team within the Commission dealing with the operational issues related to the surface observing networks, agreed to rename the ET on Requirements and Representation of Data from AWS (ET-AWS) to the ET on Requirements and Implementation of AWS Platforms (ET-AWS) and agreed on new Terms of Reference for the ET-AWS.

Scientific evaluation of Observing System Experiments (OSEs) and Observing System Simulation Experiments (OSSEs)

6.1.31 Reviewed the conclusions and recommendations of the fourth Workshop on the Impact of New Observing Systems on the NWP, and noted the appearance of new satellite observing systems and that, as a consequence, although the overall impact of observations has increased, the impact of most individual observing systems has decreased since the last Workshop in 2004;

6.1.32 Endorsed the recommendations from the Workshop, including recommendations about: (a) interactions between NWP centres, data providers and data users; (b) recommendations about observational data requirements; and (c) recommendations about future studies that are indicated in the Annex to this paragraph;

6.1.33 Requested the OPAG-IOS to interact more closely on observational issues with CAS and the EC Working Group on Antarctic Meteorology in accordance with THORPEX, AMMA and IPY activities; taking into account the need for legacy of these experiments and campaigns for the future of the GOS, establish a sustainable coordination mechanism with regional associations;

6.1.34 Encouraged NWP centres to keep stimulating the studies of observation targeting strategies in coordination with the THORPEX ad hoc groups;

6.1.35 Requested the OPAG-IOS and the Secretariat to organize the fifth Workshop on the Impact of New Observing Systems on the NWP to be held in 2012.

AMDAR matters

6.1.36 The Commission acknowledged that following the assessment of the global availability and sustainability of the provision of AMDAR data for the operations of the NMHSs, the AMDAR Panel declares the AMDAR Programme operational. Currently, this declaration refers to wind, temperature and pressure observations collected through AMDAR systems and in use by the meteorological community. It also noted that the AMDAR, as a GOS observing system component, has the potential for expanding its capabilities to increase data coverage and add other observational elements. Following the AMDAR being operational, the AMDAR activities are expected to gradually integrate into WMO WWW Programme, CBS and CIMO structures.

6.1.37 The Commission noted the development of a water vapour sensor to provide AMDAR humidity data and supported the OPAG-IOS suggestion that data validation be performed not only with operational radiosondes and NWP models but also with dedicated sensors in research aircraft.

6.1.38 The Commission noted that the integration of AMDAR into the Commissions working structure necessitated the need for a new Expert Team on Airborne Observation (ET-AIR) and adopted its establishment.

6.1.39 Many areas of the world are considered as data sparse in regard to the availability of upper-air observations. The Commission noted that AMDAR data could alleviate this problem, and encouraged all operational AMDAR programmes to collect and distribute AMDAR data outside their national territories as part of their contribution to WWW.

6.1.40 It was also recognized that there is a requirement for increased horizontal density of AMDAR data, particularly over Africa and the tropics, and the Commission requested AMDAR programmes to support this requirement.

Marine Systems

6.1.41 The Commission invited more Members to participate in the ASAP Panel of the JCOMM Ship Observations Team (SOT) for providing in situ aerological profiles from data sparse ocean areas as complementary data to AMDAR.

6.1.42 The Commission invited Members to continue efforts for adding pressure sensors to the complete drifting buoy network of 1250 buoys. The Commission noted that approximately half of the network has now been upgraded to provide pressure data.

6.1.43 The Commission noted with appreciation that the Argo profiling float programme reached completion in November 2007 with the establishment of 3000 operational units. The Commission stressed that the Argo network requires sustainability over decadal timescales, and encouraged that such support be found.

6.1.44 The Commission recalled that the concerns of ship owners and masters regarding availability of VOS ship position and identification data on public web sites - mainly for ship security reasons for VOS recruited by Members - had been addressed quite effectively through Resolution 27 (EC-LIX) as complying masking schemes have been implemented. However, the Commission noted the concerns expressed by marine climate users, through JCOMM, regarding some limitations concerning access in delayed mode of unmasked VOS reports that may impact the quality of marine climatology products made available to end users. The Commission urged its Members to work out a solution in cooperation with the maritime authorities in order for the unmasked VOS data to be eventually released after a period of time to be agreed upon.

6.1.45 The Commission noted with appreciation that the Statement of Guidance (SoG) for Ocean Applications has been substantially updated to reflect requirements and gap analysis for

Met-Ocean Forecasts and Services (MOFS), including marine services and ocean mesoscale forecasting. It urged Members to address the deficiencies noted in the SoG (waves, sea-level, visibility).

GCOS matters

6.1.46 The Commission noted that there are now nine CBS Lead Centres for GCOS and that new Terms of Reference for these CBS Lead Centres for GCOS have been developed and adopted draft Recommendation 6.1/6 (CBS-XIV).

6.1.47 The Commission was advised that the GCOS Reference Upper-Air Network (GRUAN), a specialized network of 30 to 40 reference sites to provide long-term high quality climate data, is being developed. The Richard Assmann Observatory in Lindenberg has been designated by WMO as the lead centre for the GRUAN network. The Commission requested the OPAG-IOS to investigate the feasibility of establishing GRUAN as a WIGOS Pilot Project.

6.1.48 The Commission noted that there has been discussion about the need to continue CLIMAT TEMP reports and that further investigation is being performed before any recommendation is made.

Impact of new instrumentation on the GOS

6.1.49 The Commission was advised that 50 Members had replied to a questionnaire on the Impact of New Instrumentation on the GOS. The questionnaire identified that a global priority was investment in AWS systems. Additionally satellite reception equipment and upper-air systems also featured highly in Members instrumentation procurements.

Future composite GOS and its impact on developing countries

6.1.50 The Commission recommended that the evolution of the GOS must take into account upgrading, restoring, substitution and capacity building (especially in the use of new technologies), taking into consideration both the use of the data and the production of the data.

GOS-related regulatory material

6.1.51 The Commission noted that the revised *Guide on the GOS* (WMO-No. 488) was published in 2007. In addition, Volume II of the *Manual on the GOS* (Regional Aspects) (WMO-No. 544) is in the process of adoption by the regional associations. The Commission invited regional associations to ensure the updating of their component of the Manual be completed as soon as possible.

6.1.52 The Commission was advised that there are certain regional elements in the *Manual on the GOS* that would benefit from better harmonization, including classification of stations, procedures for updating and amending RBSN/RBCN and basic definitions. The Commission requested the OPAG-IOS to ensure harmonization occurred.

Future Working Structure of OPAG-IOS and Revised Terms of Reference (TOR) of OPAG IOS teams and rapporteurs

6.1.53 The Commission agreed with the OPAG-IOS proposal of its future structure as presented in the Annex to this paragraph.

6.1.54 The Commission agreed with the revised TOR of the ICT-IOS, expert teams and rapporteurs as described in Annex I to Annex XI to this paragraph.

Future Work Plans of OPAG IOS teams and rapporteurs

6.1.55 The Commission agreed with the Work Plan of the ICT-IOS, its expert teams and rapporteurs as described in Annex I to Annex VI to this paragraph.

Annex to paragraph 6.1.32 of the general summary

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 the 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.

1.1 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; and (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).

1.2 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 priorities 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 utilization 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.

1.3 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-EGOS proposed that CBS-XIV makes a recommendation for holding the 5th NWP “Impact” workshop in 2012.

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Annex to paragraph 6.1.53 of the general summary

FUTURE WORKING STRUCTURE OF THE OPAG-IOS

1. Implementation Coordination Team on Integrated Observing Systems (ICT-IOS);
2. Expert Team on Requirements and Implementation of AWS Platforms (ET-AWS);
3. Expert Team on Evolution of the Global Observing System (ET-EGOS);
4. Expert Team on Satellite Systems (ET-SAT);
5. Expert Team on Satellite Utilization and Products (ET-SUP);
6. Expert Team on Surface-based Remotely-Sensed (ET-SBRSO);
7. Expert Team on Airborne Observation (ET-AIR);
8. Co-Rapporteurs on Scientific Evaluation of Impact Studies undertaken by NWP Centres;
9. Rapporteur on GCOS Matters;
10. Rapporteur on Regulatory Material;
11. Co-Rapporteurs on the Impacts of New Instrumentation on the GOS.

Annex I to paragraph 6.1.54 of the general summary

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.

Annex II to paragraph 6.1.54 of the general summary

TERMS OF REFERENCE OF THE 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 in situ contributions to the GOS to address the identified requirements and overcome known deficiencies and gaps.

Annex III to paragraph 6.1.54 of the general summary

TERMS OF REFERENCE OF THE 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 CCl 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 the ICT-IOS to CBS;

(g) Prepare documents to assist Members, summarizing the results from the above activities.

Annex IV to paragraph 6.1.54 of the general summary

TERMS OF REFERENCE OF THE 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 an 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 the ICT-IOS.

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Annex V to paragraph 6.1.54 of the general summary

TERMS OF REFERENCE OF THE 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 of 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.

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Annex VI to paragraph 6.1.54 of the general summary

TERMS OF REFERENCE OF THE ET-SBRSO

In the area of weather radar and other surface-based remotely-sensed observations, the team should:

(a) Assess the potential capabilities of such observing systems, in terms of their observing characteristics (spatial and temporal resolution, accuracy, timeliness, etc.);

(b) Assess the status of implementation of and plans for such observing systems by WMO Members;

(c) Document the above capabilities and implementation status/plans, through updates to the WMO/CEOS database of observing system capabilities;

(d) In collaboration with ET-EGOS, assess the contribution of such observing systems to meeting the user requirements for observations for all application areas represented by WMO and WMO-sponsored programmes, as captured by the WMO/CEOS database of user requirements for observations and the Statements of Guidance;

(e) Make recommendations on how the integration of such observing systems within the GOS might be taken forward;

(f) Assess the systems for collection and distribution of data from such observing systems, and make appropriate recommendations;

(g) Monitor the status of operational networks of such observing systems and provide technical advice on such systems, including both operational and R&D systems, to WMO Members and RAs.

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Annex VII to paragraph 6.1.54 of the general summary

DRAFT TERMS OF REFERENCE OF THE ET-AIR

(a) Coordinate with the AMDAR Panel to develop a harmonized AMDAR work plan;

(b) Review and report to CBS on the AMDAR Programme activities including the integration of AMDAR into WIGOS;

(c) Develop future governance for the AMDAR Programme;

(d) Steer the implementation of the WIGOS AMDAR Pilot Project;

(e) Develop a data policy for AMDAR;

(f) Develop standard practices for AMDAR;

(g) Provide input into the EGOS-IP for AMDAR;

(h) Report on training requirements and activities for AMDAR.

Annex VIII to paragraph 6.1.54 of the general summary

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) Organize the fifth Workshop on the Impact of Various Observing Systems on Numerical Weather Prediction in 2012 and chair the organizing committee;

(c) Provide input to the ET-EGOS regarding the Evolution of the GOS and to the ET-SAT on findings that might influence future satellite missions.

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Annex IX to paragraph 6.1.54 of the general summary

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 the ET-EGOS on user requirements relevant to climate monitoring and to the OPAG-IOS on issues relevant to CBS.

Annex X to paragraph 6.1.54 of the general summary

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.

Annex XI to paragraph 6.1.54 of the general summary

TERMS OF REFERENCE OF THE CO-RAPPORTEURS ON THE IMPACTS OF NEW INSTRUMENTATION ON THE GOS

Liaise with the HMEI, CIMO and others as appropriate for the development and introduction of new in situ surface-based 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.

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Annex I to paragraph 6.1.55 of the general summary

ET-AWS WORK PLAN FOR 2009-2012

Task	Action
Update AWS Functional Specifications (FS) for all WMO-related Programmes *(Expected Result 4)*	Monitor the requirements for update of FS
Develop the requirements (RQ) for a robust AWS, particularly those in remote locations. *(Expected Result 4)*	Finalize the draft version of ET-AWS-5
Develop requirements for AWS to contribute directly to the calibration and ground truth of space-based observations *(Expected Result 4)*	Finalize the draft version of ET-AWS-5
Develop the requirements for new sensors or the integration of sensors to address the deficiencies of AWS following the migration from manual observations *(Expected Result 4)*	Finalize the draft version of ET-AWS-5
Develop tools for network design and optimization *(Expected Result 4)*	Testing of proposed tools on all RBSNs
Develop guidelines and procedures to assist in the transition from manual to automatic surface observing stations *(Expected Result 4)*	Finalize the draft version of ET-AWS-5
Develop requirements for new data types from AWS sensors *(Expected Result 4)*	Finalize the draft version of ET-AWS-5
Develop AWS metadata catalogues for WIS *(Expected Result 4)*	Prepare tables of AWS metadata for WIS based on BUFR descriptors
Develop guidelines for the siting classification of surface observing stations *(Expected Result 4)*	In coordination with CIMO and other relevant TCs, finalize the guideline materials for Members

Update the list of basic set of variables to be reported by a standard AWS for multiple users *(Expected Result 4)*	Monitor the requirements for updating the list
Review BUFR descriptors related to AWS measurements according to requirements *(Expected Result 4)*	Review BUFR descriptors and propose new ones if needed. Implement and validate BUFR template for SYNOP/AWS reporting (including new station identification)
Monitor advances in AWS technology *(Expected Result 4)*	Review progress and advances in AWS technologies

Annex II to paragraph 6.1.55 of the general summary

ET-EGOS WORK PLAN FOR 2009-2012

Task	Action
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.
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.
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.
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.
	Organize and hold next NWP Impact Studies Workshop in 2012.
5. Promote CBS activities in support of GCOS goals *(Expected Result 4)*	Review the implications of the GCOS Adequacy Report and the GCOS Implementation Plan for the activities of CBS
	Bring relevant issues to the attention of the ET-EGOS
6. Prepare an updated version of the Implementation Plan for the Evolution of the GOS, fully responding to the “Vision for the GOS in 2025” *(Expected Result 4)*	Upon successful endorsement of the “Vision for the GOS in 2025” by CBS-XIV, that the ET-EGOS prepare a revised version of the EGOS-IP that will incorporate the information included in the Vision.

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Annex III to paragraph 6.1.55 of the general summary

ET-SAT WORK PLAN FOR 2009-2012

Task	Action
Review capabilities of operational and R&D satellites	Provide update on current and planned satellite missions
	Assist in formulating or updating a Vision for the GOS, as concerns space-based aspects and related observation strategies
(Expected Result 4)	Identify opportunities for transition of relevant R&D missions to operations
	Recommendations to prepare the transition of relevant R&D missions to operations and to promote the use of R&D mission data
Assist CBS on coordinating global planning of satellite missions to implement the Vision for the GOS in 2025	Reviewing the status of implementation of the space-based component of the GOS
	Identify and assess opportunities and/or problem areas concerning plans of relevant satellite operators
	Support international cooperation on future demonstration missions
(Expected Result 4)	Review and update the Gap Analysis related to the fulfilment of WMO requirements by the space-based component of the GOS
	Provide technical advice with respect to both operational and R&D environmental satellites to assist in the integration of WMO-coordinated observing systems and in particular as concerns WIGOS pilot projects
Advise CBS on other relevant matters	Provide response to the WMO Consultative Meetings on High-level Policy on Satellite Matters
(Expected Results 4, 5, 9)	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.
	Advise on other subjects such as radio frequency utilization,
Coordination and reporting	Provide relevant input to ET-SUP on education and training and other appropriate capacity-building measures related to satellite meteorology
(Expected Result 10)	Coordinate with other relevant CBS teams with a view to making recommendations on relevant matters,
	Support cooperation with CGMS, CEOS and other satellite-related organizations
Space Weather	Provide initial contribution to the implementation of an inter-Commission activity related to Space Weather coordination

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Annex IV to paragraph 6.1.55 of the general summary

ET-SUP WORK PLAN FOR 2009-2012

Task	Action
Expand the **use** of satellite data & products across WMO Members with focus on the needs of less well developed Members *(Expected Result 9)*	Prepare and distribute a questionnaire on the availability and use of satellite data and products on a biannual basis
	Gather, record and analyse questionnaire responses and present in published Technical Document (TD)
	Consider follow-up actions for Key Findings and Recommendations from the analysis of responses.
	Monitor progress of the R/SSC-CM initiative and consider extending the concept to other application areas
	Promote the wide use of established and standard satellite data formats, processing techniques and tools
	Monitor enhanced use of R&D mission data, in particular for developing countries, through components of information provision and capacity building tasks
Promote and implement harmonized, efficient, timely, enhanced data **access** *(Expected Result 5)*	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
	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&D mission data, in particular for developing countries
Provide up-to-date and comprehensive **information** on satellite plans, systems, products *(Expected Results 4, 5, 9)*	Provide support to the development and maintenance of comprehensive descriptive information on satellite data and products (including those from R&D missions) with focus on on-line Internet based delivery of information
	Provide support to the development and maintenance of comprehensive information on means of access to satellite data and products (including those from R&D missions) with focus on on-line Internet based delivery of information
Maximise exploitation of satellite data through **capacity building** *(Expected Result 9)*	Implement the Virtual Laboratory (VL) Training Strategy with routine management devolved to the Virtual Laboratory Management Group (VLMG)
	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
Cooperation and Reporting *Expected Result 10)* 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	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
	Coordinate with ET-SAT and CGMS information issues regarding availability, use, benefits, lacks of satellite data and related risks
	Document the assessment results of Performed VL training activities

Annex V to paragraph 6.1.55 of the general summary

ET-SBRSO WORK PLAN FOR 2009-2012

Task	Action
Assess the potential capabilities of SBRS observing systems, in terms of their observing characteristics	Review available technologies and document their observing characteristics
Assess the status of implementation of and plans for such observing systems by WMO Members	Review and document the status and plans of WMO Members
Document the above capabilities and implementation status/plans, through updates to the WMO/ CEOS database of observing system capabilities	Represent the information documented above in terms of appropriate updates and additional entries within the WMO/ CEOS database of observing system capabilities
In collaboration with ET-EGOS, assess the contribution of such observing systems to meeting the user requirements for observations for all application areas represented by WMO and WMO-sponsored programmes	Review the Statements of Guidance for accuracy and completeness in relation to SBRS observing systems, referring to user requirements as captured by the WMO/ CEOS database as necessary
Make recommendations on how the integration of such observing systems within the GOS might be taken forward	Review the Implementation Plan for the Evolution of the GOS and propose changes and additions for SBRS observing systems
Assess the systems for collection and distribution of data from such observing systems, and make appropriate recommendations	Review systems for collection and global distribution of SBRS observational data and make recommendations for their improvement in response to stated user requirements
Monitor the status of operational networks of such observing systems and provide technical advice on such systems, including both operational and R&D systems, to WMO Members and RAs	Report on the operational networks and on key developments in SBRS observing systems to ICT-IOS, drawing attention to actions required by CBS to promote the development of such systems within the WIGOS
	Respond to requests for advice on SBRS observing systems from other CBS entities, as necessary

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Annex VI to paragraph 6.1.55 of the general summary

ET-AIR WORK PLAN FOR 2009-2012

Task	Action
Coordination with the AMDAR Panel	Monitor work being undertaken by AMDAR Panel Science and Technical and Training Sub-Groups
	Report to the AMDAR Panel through AMDAR Panel Sessions
Develop future governance for AMDAR Programme	Examine requirements and make proposals to CBS and AMDAR Panel
	Make proposals for further integration of AMDAR into WWW
Develop an AMDAR data policy	Analyze the current status and requirements and develop proposal for data policy to CBS
	Develop guidelines for third party data providers such as TAMDAR
Steer the implementation of WIGOS PP for AMDAR	Coordinate WIGOS AMDAR PP activities
	Make proposals for further integration of AMDAR into WIGOS
Develop Standard Practices for AMDAR	Coordinate with established AMDAR programmes: (a) Development of a standardized BUFR Template for AMDAR; (b) Application of WMO Metadata relevant to AMDAR; (c) Development of a standardized Quality Management Framework for AMDAR data; (d) Validation and preparation for intercomparison of available water vapour sensor performance; (e) Update of the AMDAR Reference Manual WMO-No. 958; (f) Development of the framework for generic software specification for AMDAR.
Cooperation and Reporting	Report to CBS and its Expert Teams on the AMDAR Programme and its integration into CBS and WWW
	Review EGOS-IP and provide input to ET-EGOS
	Report to CIMO and CAeM training Expert Teams on requirements for instruments and AMDAR training

DRAFT RECOMMENDATION

Rec. 6.1/1 (CBS-XIV) – **"VISION FOR THE GOS IN 2025"**

THE COMMISSION FOR BASIC SYSTEMS,

Noting:

(1) ET-EGOS-3 preparation of a draft "Vision for the GOS in 2025",

(2) ET-EGOS-4 review and thorough update of the "Vision for the GOS in 2025" from both surface-based, and space-based perspectives,

Considering the consultation with other CBS ETs and interested parties regarding the "Vision for the GOS in 2025",

Recommends that the "Vision for the GOS in 2025" be adopted (see Annex).

Annex: 1

Annex to draft Recommendation 6.1/1 (CBS-XIV)

VISION FOR THE GOS IN 2025

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 WIGOS[1], 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;

[1] Assuming CBS endorse the move to the WIGOS structure

- 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.

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 computerized.

Consistency and homogeneity

- There will be increased standardization 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

Instruments:	**Geophysical variables and phenomena:**
Operational geostationary satellites. At least 6, separated by no more than 70 deg longitude	
High-resolution multi-spectral Vis/IR imagers	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
IR hyper-spectral sounders	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
Lightning imagers	Lightning (in particular cloud to cloud), location of intense convection.
Operational polar-orbiting sun-synchronous satellites distributed within 3 orbital planes (~13:30, 17:30, 21:30 ECT)	
IR hyper-spectral sounders	Atmospheric temperature, humidity and wind; sea/land surface temperature; cloud amount, water content and top height/temperature; atmospheric composition
MW sounders	
High-resolution multi-spectral Vis/IR imagers (including thermal IR water vapour absorption channel)	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

Additional operational missions in appropriate orbits (classical polar-orbiting, geostationary, others)	
MW imagers – at least 3 – some polarimetric	Sea ice; total column water vapour; precipitation; sea surface wind speed [and direction]; cloud liquid water; sea/land surface temperature; soil moisture
Scatterometers - at least 2 on well separated orbital planes	Sea surface wind speed and direction; sea ice; soil moisture
Radio occultation constellation – at least 8 receivers	Atmospheric temperature and humidity; ionospheric electron density
Altimeter constellation including a reference mission in a precise orbit, and polar-orbiting altimeters for global coverage	Ocean surface topography; sea level; ocean wave height; lake levels; sea and land ice topography
IR dual-angle view imager	Sea surface temperature (of climate monitoring quality); aerosols; cloud properties
Narrow-band high-spectral and hyperspectral resolution Vis/NIR imagers	Ocean colour; vegetation (including burnt areas); aerosols; cloud properties; albedo
High-resolution multi-spectral Vis/IR imagers – constellation	Land-surface imaging for land use and vegetation; flood monitoring
Precipitation radars operated in conjunction with passive MW imagers in various orbits	Precipitation (liquid and solid)
Broad-band Vis/IR radiometer + total solar irradiance sensor - at least 1	Earth radiation budget (supported by imagers and sounders on polar-orbiting and geostationary satellites) and collocated aerosols and cloud properties measurements
Atmospheric composition instruments constellation, including high spectral resolution UV sounder on geostationary orbit and at least a UV sounder on am + pm orbit	Ozone; other atmospheric chemical species; aerosols – for greenhouse gas monitoring, ozone/UV monitoring, air quality monitoring
Synthetic aperture radar	Wave heights, directions and spectra; floods; sea ice leads; ice shelf and icebergs
Operational pathfinders and technology demonstrators, including	
Doppler wind lidar on LEO	Wind; aerosol; cloud-top height [and base]
Low-frequency MW radiometer on LEO	Ocean surface salinity; soil moisture
MW imager/sounder on GEO	Precipitation; cloud water/ice; atmospheric humidity and temperature
High-resolution, multi-spectral narrow-band Vis/NIR and CCD imagers on GEOs	Ocean colour, cloud studies and disaster monitoring
Vis/IR imagers on satellites in high inclination, highly elliptical orbits (HEO)	Winds and clouds at high latitudes; sea ice; high latitude volcanic ash plumes; snow cover; vegetation; fires
Gravimetric sensors	Water volume in lakes, rivers, ground, etc.
Polar and geo platforms / instruments for space weather	
Solar imagery Particle detection Electron density	Solar radiation storms, high-energy particle rain, ionospheric and geomagnetic storms, radio black-out by X-ray photons

3. THE SURFACE-BASED COMPONENT

Station type:	**Geophysical variables and phenomena:**
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
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, CO_2 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, CO_2 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;
- 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 optimized, 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 (AMDAR)** ascent/descents profiles and other ground-based profiling systems;
- Maintain the **GUAN** subset of stations for climate monitoring;
- 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.

DRAFT RECOMMENDATION

Rec. 6.1/2 (CBS-XIV) – IMPLEMENTATION PLAN FOR THE EVOLUTION OF THE GOS

THE COMMISSION FOR BASIC SYSTEMS,

Noting the need for continuing update and review of the Implementation Plan for the Evolution of the GOS,

Considering that:

(1) Several new actions have been identified for addition to the Implementation 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,

(2) Recent ET-SAT and ET-SUP sessions have endorsed the report on progress on the EGOS-IP,

Recommends that:

(1) The report on progress on the Implementation Plan for the Evolution of the GOS be adopted;

(2) A new version of EGOS-IP be undertaken that will incorporate the information included in the newly adopted “Vision for the GOS in 2025”.

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DRAFT RECOMMENDATION

Rec. 6.1/3 (CBS-XIV) – VIRTUAL LABORATORY TRAINING STRATEGY

THE COMMISSION FOR BASIC SYSTEMS,

Noting:

(1) CGMS requirements for satellite data utilization,

(2) Outcomes of the recent Virtual Laboratory Management Group meeting (VLMG-4),

(3) Conclusions of the 36th meeting of the Coordination Group for Meteorological Satellites that approved the proposed five-year strategy for the Virtual Laboratory,

Considering that:

(1) Training is needed on exploitation of both operational and R&D satellite data and products,

(2) Training will involve increasingly use of satellite data in combination with other data such as radar, NWP and lightning,

(3) Increased satellite capabilities result in increased training needs in new application areas, such as climate change,

(4) The Regional Focus Groups (RFGs) established by the Centres of Excellence are essential for strengthening regional capacities and cooperation,

Recommends that the Virtual Laboratory Training Strategy (see Annex) for the next 5 years is approved.

Annex: 1

Annex to draft Recommendation. 6.1/3 (CBS-XIV)

FIVE-YEAR STRATEGY FOR THE CGMS VIRTUAL LABORATORY FOR EDUCATION AND TRAINING IN SATELLITE METEOROLOGY

1. INTRODUCTION

1.1 Scope and definition

The CGMS Virtual Laboratory for Education and Training in Satellite Meteorology (VL) was established to help improve the world wide utilization of satellite data and products by WMO Members.

The CGMS Virtual Laboratory (VL) is a global network of specialized training centres, named “Centres of Excellence in Satellite Meteorology (CoE)”, that are supported by one or more CGMS satellite operators. These CoE, often co-located with WMO Regional Training Centres (RTC), are established in the various WMO Regions to meet user needs for increased skills and knowledge in using satellite data within their Region. Each CoE is responsible for conducting training activities and normally supports one or more Regional Focus Groups involving NMHSs from its Region.

1.2 High-level goals

Current top-level goals of the VL are:

i) To provide high quality and up-to-date training and supporting resources on current and future meteorological and other environmental satellite systems, data, products and applications;

ii) To enable the Centres of Excellence to facilitate and foster research and the development of socio-economic applications at the local level by the NMHS through the provision of effective training and links to relevant science groups.

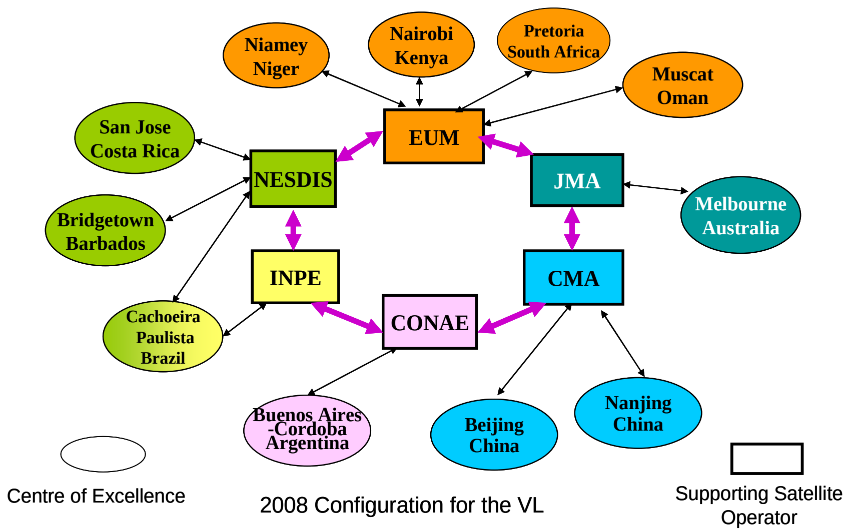
The VL activity aims at achieving these top-level goals through providing access to:

- Case study material and near real time data;
- Training and educational resources; and
- Software and expertise on how to best utilize satellite data and products.

1.3 Current status

At the present time, the VL is a collaboration between CMA, EUMETSAT, INPE, JMA and NOAA, as concerns the satellite operators; and nine CoEs that are located in Argentina, Australia, Barbados, Brazil, China, Costa Rica, Kenya, Niger, and Oman.

The figure below shows the various linkages within the VL between CoEs and their supporting satellite operators in September 2008. The continuing growth in the VL community is seen with the recent additions of INPE/CPTEC in Brazil; CMATC in Beijing, China; SAWS in South Africa; CONAE, SMN and UBA in Argentina.



2008 Configuration for the VL

1.4 Evolving user needs

In the coming years there will be significant changes in the user community requiring training, the way teaching and learning is carried out and the subject matter of the training. There will be significant advances in e-learning technology and increased availability of high speed low cost communications across the globe. Increased satellite capabilities will lead to new data and product application areas, over and above the traditional weather forecasting, which will become increasingly important. For example, the ability to measure precisely and understand climate change and its impact is now a global priority.

As more NMHSs take advantage of automated services, weather forecasters will require regular training to provide an expanded set of products that meet the needs of a wider range of users including for instance environmental scientists, software engineers and developers of new user-driven services. It is clear that with new satellite technologies, advanced training will become an imperative to ensure full utilization of this valuable resource.

1.5 New strategy

Building upon the experiences and successes of the VL over recent years, and taking into account the evolving user needs, this document presents a five-year strategy for the VL. It is complemented by a plan for implementing this strategy.

2. STRATEGIC OBJECTIVES FOR THE VL

2.1 Target users

The VL will aim at providing training and training resources for NMHS staff, noting that this includes a diversity of profiles from core synoptic weather forecasting to a wide range of applications to related fields, as the activity of NMHSs tends to expand.

2.2 Training areas

First of all, the VL will provide training that exploits the full potential of satellite data and products from both operational ***and*** several R&D satellites and, in so doing, prepare the various user communities for the next generation of space-borne Earth observing systems.

Secondly, and bearing in mind the ongoing establishment of various elements of the GEOSS and the emphasis now being placed upon GEO capacity building efforts, especially for the developing countries, VL training activities may in the future consider the training needs of some other GEO Societal Benefit Areas in addition to Weather and Climate: Agriculture, Biodiversity, Disasters, Ecosystems, Energy, Health and Water.

The training programmes of the CoEs and satellite operators comply with the principles and recommendations described in the satellite meteorology component of WMO publication No. 258 “Guidelines for the Education and Training of Personnel in Meteorology and Operational Hydrology”. This document places major emphasis on the training of trainers and sets the standard for competence training. Therefore, VL training activities will have to closely follow any evolution in WMO publication No. 258 to meet new training needs.

Building upon the currently available expertise within the VL network, training activities should first focus upon the following topics:

(i) Satellite Remote Sensing
- Satellite capabilities
- Spectral bands and their applications
- Cloud analysis and image interpretation
- Microwave applications
- Products – Precipitation, Winds, Soundings, etc.
- Resolution, calibration, product quality

(ii) Meteorology
- Severe convective systems
- Heavy rain and floods
- Winter storms
- Tropical storms
- Impact on transportation (land, aviation, water, space, etc.)

(iii) Climate
- Inter-calibration issues
- Radiation budget
- Ocean and cryosphere
- Aerosols and ozone

(iv) Hydrometeorological and other natural disasters
- Fire, wind, etc.

Where satellite observations are of benefit, and there is a user requirement, then the focus of VL activities could be widened to support training related to:

(v) Ocean applications
(vi) Land applications
(vii) Hydrology and water management
(viii) Atmospheric chemistry, air quality
(ix) Environmental quality

Applications and Service-based training will increasingly involve the use of satellite data ***in combination*** with other data sets such as weather radar, NWP, lightning, precipitation, land information, etc., and may well be carried out in partnership with other Institutes where the relevant expertise exists.

2.3 The Virtual Resource Library

The Virtual Resource Library (VRL) is a key asset of the VL. A key goal is to ensure that this valuable repository of training resources is secured, maintained and configured in such a way that effectively supports both the contribution and use of resources. To this end, it is proposed that the VRL should be accessible through a centralized Web portal. The host of such a portal must have experience in maintaining and managing such a system. Examples of such sites might be the Environmental Satellite Resource Centre (ESRC) hosted by COMET and the CEOS Educational Resources Portal maintained by EUMETSAT.

2.4 Role of the CoE

Each CoE is responsible for conducting international training activities, in one or more WMO working languages, for the benefit of NMHSs from its Region, along the lines of the Virtual Laboratory.

For that purpose, and considering the expanding training needs within the Regions, the CoE is expected to survey and maintain a list of training requirements for its Region, to organize and run training events, to develop and maintain proficiency in providing online training using tools such as VISITView, and to establish and support one or more Regional Focus Groups holding regular online sessions.

The CoE, through a nominated focal point and an alternate, will maintain coordination with the VL Management Group and provide the Co-chairs with a brief annual report outlining the relevant past training activities, the priority training needs for the Region, their plans to meet these needs in the coming twelve months, their overall situation and other information as appropriate.

2.5 Regional Focus Groups

For the VL to realize its potential and become a global provider of training, each CoE will need to establish and/or strengthen the Regional Focus Groups (RFG).

The RFG is a virtual meeting that is convened by the CoE on a regular basis through online sessions, using VisitView or equivalent tools, in order to maintain an active sharing of experience and know-how within the Region in between training events. The primary scope of RFG sessions can be to hold weather briefings. It also allows highlighting significant recent situations to keep abreast of new developments, and to ask and answer questions. Through this mechanism, the CoEs play an important networking role and help build a strong community of practice.

2.6 Tools and techniques

A key component of the advanced training will be greater use of blended learning, a training concept successfully implemented in recent years by a number of training centres. Blended learning combines online and traditional methods for training and is a very cost effective means of expanding the access to training materials while preserving many of the benefits of traditional training approaches. Its wider use should be regarded as a key goal of the VL. Conferencing and audio/video-supported training tools are now emerging and these developments will be assessed and incorporated by VL partners in their training programmes, as appropriate.

The course management system, Moodle, and distance learning tools like CENTRA are being adopted among the VL partners. The progression to new “tools” for use by trainers is important to the growth of the VL.

The quality of Internet connectivity is very important to support the use of video, voice and other high quality training tools in the VL environment. To provide effective training, CoEs need to have an Internet connection with a ***minimum*** data rate of 1 Mbs ***specifically dedicated*** to CoE training activities. Such a data rate is the absolute minimum needed. Status of Internet connection needs to be included in the CoE annual reports to VLMG every September.

2.7 Feedback mechanism

Increasingly, it is necessary to demonstrate the tangible benefits coming from human and financial resource investments in training. In particular, how training leads to an improvement in services provided by the NHMS. The VL will develop systematic feedback and reporting mechanisms that will lead to continuous improvement ensuring that this key objective is met.

2.8 Outreach

Past enquiries indicate that many users are not yet fully aware of the resources that the VL can provide. Information actions shall be considered to raise the awareness of WMO Members through the VL website; and at the regional level through the Centres of Excellence, the WMO Regional Associations and the Regional Rapporteurs for the Space Programme.

3. SECURING AND ENHANCING THE VL NETWORK

To implement the VL strategy in the coming years, the following three fundamentals of the VL have to be fully supported by the partners:

- ❖ Commitment = by all the partners to put effort and resources into the VL;
- ❖ Cooperation = building relationships, e.g. via the set up of Regional Focus Groups;
- ❖ Collaboration = jointly developing, delivering and exchanging training resources.

3.1 Commitment

As noted earlier, the long term effectiveness of the VL relies on the long-term commitment of the CoEs and the satellite operators to meet training requirements coming from their various user communities. In turn, the effectiveness and success of the CoEs is highly dependent on five factors; the support from their sponsoring satellite operator, the support from local management, the availability of trained personnel, the quality of the training technical infrastructure, and political stability.

3.2 Expansion of CoEs

While the VL has existed for less than a decade, both its growth and positive impact have been dramatic. This was recognized by the WMO Congress. We expect the growth of the VL to continue with sponsorship from additional satellite agencies and inclusion of more CoEs. This growth should ensure that all countries in a particular Region can benefit from VL training activities and that training can be provided in all WMO official languages. These additional CoEs will facilitate intercontinental cooperation in training and the development and exchange of training resources in additional languages, as well as provide a risk reduction measure should a nearby CoE need assistance.

3.3 Partnership

The Eumetcal Project of EUMETNET is addressing the meteorological training needs of much of WMO Region VI (RA VI). It is reasonable to consider that the VL network could take advantage of Eumetcal satellite related training activities in RA VI. The expansion of the VL network in this manner will be carried out in partnership with established European Training Centres and others in RA VI such as Russia with its WMO Training Centres in Moscow and St. Petersburg.

3.4 Coordination

Taking into account the dynamic expansion of the VL in terms of new CoEs, future Regional Focus Groups, wider scope of applications covered, and larger audiences, there is a clear need for strong project coordination. Given the decentralized nature of the VL, this can only be efficiently achieved if coordination is ensured by a dedicated person assigned to this function.

4. IMPLEMENTATION PLAN

An Implementation Plan should be developed for the five-year period and include tasks, actions, responsibles, deadline and deliverables, directly related to the strategic goals mentioned above. Progress in the implementation should be monitored on a yearly basis by the Virtual Laboratory Management Group (VLMG) and the Plan updated as appropriate.

DRAFT RECOMMENDATION

Rec. 6.1/4 (CBS-XIV) – REVISED FUNCTIONAL SPECIFICATIONS FOR AUTOMATIC WEATHER STATIONS

THE COMMISSION FOR BASIC SYSTEMS,

Noting:

(1) The request of CBS-Ext.(06) to revise the Functional Specifications for Automatic Weather Stations,

(2) ET-AWS Work Plan 2007 to 2008 to revise Functional Specifications for Automatic Weather Stations,

Considering that the Functional Specifications for Automatic Weather Stations has been reviewed and updated based on the inputs and proposals of other technical commissions,

Recommends that the revised Functional Specifications for Automatic Weather Stations (see Annex) be approved;,

Requests that the Secretary-General make arrangements for publishing the updated *Guide to the Global Observing System* (WMO-No. 488).

Annex: 1

Annex to draft Recommendation 6.1/4 (CBS-XIV)

Functional Specifications for Automatic Weather Stations

VARIABLE [1)]	Maximum Effective Range [2)]	Minimum Reported Resolution [3)]	Mode of Observation [4)]	BUFR / CREX [5)]
ATMOSPHERIC PRESSURE				
Atmospheric Pressure	500 – 1080 hPa	10 Pa	I, V	0 10 004
TEMPERATURE [9)]				
Ambient air temperature (over specified surface)	-80 °C – +60 °C	0.1 K	I, V	0 12 101
Dew-point temperature	-80 °C – +60 °C	0.1 K	I, V	0 12 103
Ground (surface) temperature (over specified surface)	-80 °C – +80 °C	0.1 K	I, V	0 12 113
Soil temperature	-50 °C – +50 °C	0.1 K	I, V	0 12 130
Snow temperature	-80 °C – 0 °C	0.1 K	I, V	N
Water temperature - river, lake, sea, well	-2 °C – +100 °C	0.1 K	I, V	0 13 082
HUMIDITY [9)]				
Relative humidity	0 – 100%	1%	I, V	0 13 003
Mass mixing ratio	0 – 100%	1%	I, V	N
Soil moisture, volumetric or water potential	0 – 10^3 g kg^{-1}	1 g kg^{-1}	I, V	N
Water vapour pressure	0 – 100 hPa	10 Pa	I, V	0 13 004
Evaporation/evapotranspiration	0 – 0.2 m	0.1 kg m^{-2}, 0.0001 m	T	0 13 033
Object wetness duration	0 – 86 400 s	1 s	T	N
WIND				
Direction	0 [11,13)]; 1° – 360°	1°	I, V	0 11 001
Speed	0 – 75 m s^{-1}	0.1 m s^{-1}	I, V	0 11 002
Gust Speed	0 – 150 m s^{-1}	0.1 m s^{-1}	I, V	0 11 041
X,Y,Z component of wind vector (horizontal and vertical profile)	0 – 150 m s^{-1}	0.1 m s^{-1}	I, V	N
Turbulence type (Low levels and wake vortex)	up to 15 types	BUFR Table	I, V	N
Turbulence intensity	up to 15 types	BUFR Table	I, V	N
RADIATION [6)]				
Sunshine duration	0 – 86 400 s	60 s	T	0 14 031
Background luminance	$1 \cdot 10^{-6}$ – $2 \cdot 10^{4}$ Cd m^{-2}	$1 \cdot 10^{-6}$ Cd m^{-2}	I, V	N
Global downward solar radiation	0 – $6 \cdot 10^{6}$ J m^{-2}	1 J m^{-2}	I, T, V	N
Global upward solar radiation	0 – $4 \cdot 10^{6}$ J m^{-2}	1 J m^{-2}	I, T, V	N
Diffuse solar radiation	0 – $4 \cdot 10^{6}$ J m^{-2}	1 J m^{-2}	I, T, V	0 14 023
Direct solar radiation	0 – $5 \cdot 10^{6}$ J m^{-2}	1 J m^{-2}	I, T, V	0 14 025
Downward long-wave radiation	0 – $3 \cdot 10^{6}$ J m^{-2}	1 J m^{-2}	I, T, V	0 14 002
Upward long-wave radiation	0 – $3 \cdot 10^{6}$ J m^{-2}	1 J m^{-2}	I, T, V	0 14 002
Net radiation	0 – $6 \cdot 10^{6}$ J m^{-2}	1 J m^{-2}	I, T, V	0 14 016
UV-B radiation [8)]	0 – $1.2 \cdot 10^{3}$ J m^{-2}	1 J m^{-2}	I, T, V	N
Photosynthetically active radiation	0 – $3 \cdot 10^{6}$ J m^{-2}	1 J m^{-2}	I, T, V	N
Surface albedo	1 – 100%	1%	I, V	0 14 019

VARIABLE [1]	Maximum Effective Range [2]	Minimum Reported Resolution [3]	Mode of Observation [4]	BUFR / CREX [5]
CLOUDS				
Cloud base height	0 – 30 km	10 m	I, V	0 20 013
Cloud top height	0 – 30 km	10 m	I, V	0 20 014
Cloud type, convective vs. other types	up to 30 classes	BUFR Table	I	0 20 012
Cloud hydrometeor concentration	1 – 700 hydrometeors dm^{-3}	1 hydrometeor dm^{-3}	I, V	N
Effective radius of cloud hydrometeors	$2{\cdot}10^{-5} – 32{\cdot}10^{-5}$ m	$2{\cdot}10^{-5}$ m	I, V	N
Cloud liquid water content	$1{\cdot}10^{-5}$–$1.4{\cdot}10^{-2}$ kg m^{-3}	$1{\cdot}10^{-5}$ kg m^{-3}	I, V	N
Optical depth within each layer	Not specified yet	Not specified yet	I, V	N
Optical depth of fog	Not specified yet	Not specified yet	I, V	N
Height of inversion	0 – 1 000 m	10 m	I, V	N
Cloud cover	0 – 100%	1%	I, V	0 20 010
Cloud amount	0 – 8/8	1/8	I, V	0 20 011
PRECIPITATION				
Accumulation [7]	0 – 1000 mm	0.1 kg m^{-2}, 0.0001 m	T	0 13 011
Depth of fresh snowfall	0 –1000 cm	0.001 m	T	0 13 015
Duration	up to 86 400 s	60 s	T	0 26 020
Size of precipitating element	$1{\cdot}10^{-3}$ – 0.5 m	$1{\cdot}10^{-3}$ m	I, V	N
Intensity - quantitative	0 – 2000 mm h^{-1}	0.1 kg m^{-2} s^{-1}, 0.1 mm h^{-1}	I, V	0 13 055
Type	up to 30 types	BUFR Table	I, V	0 20 021
Rate of ice accretion	0 – 1 kg dm^{-2} h^{-1}	$1{\cdot}10^{-3}$ kg dm^{-2} h^{-1}	I, V	N
OBSCURATIONS				
Obscuration type	up to 30 types	BUFR Table	I, V	0 20 025
Hydrometeor type	up to 30 types	BUFR Table	I, V	0 20 025
Lithometeor type	up to 30 types	BUFR Table	I, V	0 20 025
Hydrometeor radius	$2{\cdot}10^{-5} – 32{\cdot}10^{-5}$ m	$2{\cdot}10^{-5}$ m	I, V	N
~~Horizontal~~ Extinction coefficient	0 – 1 m^{-1}	0.001 m^{-1}	I, V	N
~~Slant – extinction coefficient~~	~~0 – 1 m^{-1}~~	~~0.001 m^{-1}~~	~~I, V~~	~~N~~
Meteorological Optical Range [10]	1 – 100 000 m	1 m	I, V	N
Runway visual range	1 – 4 000 m	1 m	I, V	0 20 061
Other weather type	up to 18 types	BUFR Table	I, V	0 20 023
LIGHTNING				
Lightning rates of discharge	0 – 100 000	Number h^{-1}	I, V	0 13 059
Lightning discharge type (cloud to cloud, cloud to surface)	up to 10 types	BUFR Table	I, V	N
Lightning discharge polarity	2 types	BUFR Table	I, V	N
Lightning discharge energy	Not specified yet	Not specified yet	I, V	N
Lightning - distance from station	$0 – 3{\cdot}10^{4}$ m	10^{3} m	I, V	N
Lightning - direction from station	1° – 360°	1 degree	I, V	N

VARIABLE [1)]	Maximum Effective Range [2)]	Minimum Reported Resolution [3)]	Mode of Observation [4)]	BUFR / CREX [5)]
HYDROLOGIC AND MARINE OBSERVATIONS				
Flow discharge – river	0 – 2.5·10^5 m^3 s^{-1}	0.1 m^3 s^{-1}	I, V	0 23 017
Flow discharge – well	0 – 50 m^3 s^{-1}	0.001 m^3 s^{-1}	I, V	0 23 017
Ground water level	0 – 1 800 m	0.01 m	I, V	N
Ice surface temperature	-80 °C – +0 °C	0.5 K	I, V	N
Ice thickness - river, lake	0 – 50 m	0.01 m	I, V	N
Ice thickness - glacier, sea	0 – 4 270 m	1 m	I, V	0 20 031
Water level	0 – 100 m	0.01 m	I, V	0 13 071 0 13 072
Wave height	0 – 50 m	0.1 m	V	0 22 021
Wave period	0 – 100 s	1 s	V	0 22 011
Wave direction	0 [13)]; 1 – 360 degrees	1 degrees	V	0 22 001
1D spectral wave energy density	0 – 5x10^5 m^2Hz^{-1}	10^{-3} m^2Hz^{-1}	V, T	0 22 069
2D spectral wave energy density	0 – 5x10^5 m^2Hz^{-1}	10^{-3} m^2Hz^{-1}	V, T	0 22 069
Sea salinity	0 – 40 % [12)] [0 – 400 psu]	10^{-4} % [10^{-3} psu]	I, V	0 22 059 0 22 062 0 22 064
Conductivity	0 – 600 S m^{-1}	10^{-6} S m^{-1}	I, V	0 22 066
Water pressure	0 – 11x10^7 Pa	100 Pa	I, V	0 22 065
Ice thickness	0 – 3 m	0.015 m	T	0 20 031
Ice mass	0 – 50 kg m^{-1}	0.5 kg m^{-1} (on 32 mm rod)	T	N
Snow density (liquid water content)	100 – 700 kg m^{-3}	1 kg m^{-3}	T	N
Tidal elevation with respect to local chart datum	-10 – +30 m	0.001 m	I, V	0 22 035 0 22 038
Tidal elevation with respect to national land datum	-10 – +30 m	0.001 m	I, V	0 22 037
Meteorological residual tidal elevation (surge or offset)	-10 – +16m	0.001 m	I, V	0 22 036 0 22 039 0 22 040
Ocean Current - Direction	0 [13)]; 1° – 360°	1°	I, V	0 22 004 0 22 005
Ocean Current - Speed	0 – 10 m s^{-1}	0.01 m s^{-1}	I, V	0 22 031 0 22 032
OTHER SURFACE VARIABLES				
Runway conditions	up to 10 types	BUFR Table	I, V	N
Braking action/friction coefficient	up to 7 types	BUFR Table	I, V	N
State of ground	up to 30 types	BUFR Table	I, V	0 20 062
Type of surface specified	up to 15 types	BUFR Table	I, V	0 08 010
Snow depth	0 – 25 m	0.01 m	T	0 13 013
OTHER				
Gamma radiation dose	1 – 10 nSv h^{-1}	1 nSv h^{-1}	I, T	N
Categories of stability	9 types	BUFR Table	I, V	0 13 041

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", σ, by MOR = -ln(5%)/σ.

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 Asal (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.

DRAFT RECOMMENDATION

Rec. 6.1/5 (CBS-XIV) – BASIC SET OF VARIABLES FOR A STANDARD AUTOMATIC WEATHER STATION FOR MULTIPLE USERS

THE COMMISSION FOR BASIC SYSTEMS,

Noting:

(1) The request of CBS-Ext.(06) to revise the basic set of variables to be reported by a standard AWS,

(2) ET-AWS Work Plan 2007 to 2008 to revise the list of the basic set of variables to be reported by a standard AWS for multiple users,

Considering that:

(1) The Manual on the GOS prescribes the variables to be measured by the various types of weather observing stations,

(2) Differences exist between the set of variables measured by synoptic, ocean weather stations, aeronautical, hydrological, agrometeorological and climatological stations, which result in ambiguities when exchanged between disciplines,

(3) The need for the standardization of observations,

(4) A standard set of variables shall be measured for all these disciplines, whereas other variables should be measured as recommended by technical commissions or regional associations,

(5) The basic set of variables to be reported by a standard AWS has been reviewed and updated based on the proposals received from other technical commissions,

Recommends that the revised basic set of variables to be reported by a standard AWS (see Annex) is approved for inclusion in the *Manual on the GOS* (WMO-No. 544).

Requests that the Secretary-General make arrangements for publishing the updated Manual on the GOS.

Annex: 1

Annex to draft Recommendation 6.1/5 (CBS-XIV)

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

Variables	*SYNOP Land Stations[14)]*	*[Fixed] Ocean Weather Stations[14)]*	*Ocean observing platforms[9)]*	*Aeronautical meteorological station[14)]*	*Principle climatological station[14)]*	***STANDARD AWS***
Atmospheric Pressure	M A	M A	M A	X [1)]	X	**A**
Pressure tendency & characteristics	[M]	M	[M] [A]			**[A]**
Air temperature	M[2)] A	M A	M [A]	X	X[3)]	**A**
Humidity[5)]	M A	M	[M] [A]	X[4)]	X	**A**
Surface wind[6)]	M A	M A	M [A]	X	X	**A**
Cloud Amount and Type	M	M	[M]	X[11)]	X	**A[11)]**
Extinction profile/Cloud-base	M [A]	M		X	X	**A[12)]**
Direction of Cloud movement	[M]					
Weather, Present & Past	M	M	M	X	X	**A[12)]**
State of the Ground	[M]	n/a	n/a		X[7)]	**[A]**
Special Phenomena	[M] [A]	M	[M]			
Visibility	M [A]	M	M	X	X	**A**
Amount of Precipitation	[M] [A]	[A]	[A]		X	**A**
Precipitation Yes/No	A	[A]	[A]		X	**A**
Intensity of precipitation	[A]		[A]			
Soil temperature		n/a	n/a		X	**A**
Sunshine and/or Solar radiation			[A]		X	**A**
Waves		M [A]	[M] [A]			**A[8)]**
Sea temperature		M A	[M] A			**A[8)]**
Sea ice and/or icing	n/a	M	M			
Ship's course and speed	n/a		[M] [A]	13)		**[A] [8)]**
Sea level		10)	[M] [A]	n/a		**[A] [8)]**

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

DRAFT RECOMMENDATION

Rec. 6.1/6 (CBS-XIV) – REVISED LIST OF CBS LEAD CENTRES FOR THE GOS INCLUDING THEIR AREAS OF RESPONSIBILITY AND THEIR TERMS OF REFERENCE

THE COMMISSION FOR BASIC SYSTEMS,

Noting:

(1) The establishment by CBS-XIII of CBS Lead Centres for the GOS,

(2) The first Coordination Meeting of the CBS Lead Centres for GCOS, Teheran, Iran, November 2007,

Considering that:

(1) The Coordination Meeting updated the list of CBS Lead Centres for GCOS and their areas of responsibility,

(2) The Coordination Meeting provided revised Terms of Reference for the CBS Lead Centres for the GOS,

Recommends that:

(1) The revised list of CBS Lead Centres for the GOS and their areas of responsibility be adopted as in Annex 1 to this recommendation;

(2) The revised Terms of Reference of the CBS Lead Centres for the GOS be adopted as in Annex 2 to this recommendation.

Annexes: 2

Annex 1 to draft Recommendation 6.1/6 (CBS-XIV)

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, Thailand, 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.

Annex 2 to draft Recommendation 6.1/6 (CBS-XIV)

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. Coordinate 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.