WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR BASIC SYSTEMS

OPAG ON INTEGRATED OBSERVING SYSTEMS

EXPERT TEAM ON EVOLUTION OF THE GLOBAL OBSERVING SYSTEM
First Session

Geneva, Switzerland, 7-9 December 2005

FINAL REPORT

WMO General Regulations 42 and 43

Regulation 42

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

Regulation 43

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

EXECUTIVE SUMMARY

The Expert Team on Evolution of the Global Observing system was held in the WMO building in Geneva from 7 to 9 December 2005. The meeting reviewed activities since its last meeting relevant to changes and additions to the evolution of the Global Observing System. The session reviewed in detail the progress achieved toward meeting the 47 recommendations in the Implementation Plan for Evolution of Space and Surface-based Sub-system of the Global Observing System. In joint session with ET-SAT, the space-based component of the GOS was reviewed.

1. ORGANIZATION OF THE SESSION

The Expert Team on Evolution of the Global Observing system was held in the WMO building in Geneva from 7 to 9 December 2005. The list of participants is given in Annex I.

1.1 Opening of the meeting

The meeting was opened at 9.30 a.m. on Wednesday 7 December 2005 by Dr A. Karpov, acting Director of the World Weather Watch. On behalf of the Secretary General of WMO, Dr Karpov welcomed the participants to Geneva on the occasion of the first session of the CBS Expert Team on Evolution on the Global Observing System (GOS). He advised the session that during 2005 the implementation of surface and upper-air observational programme in WMO regions had shown increasing stability, and that the recently established Regional Basic Climatological Network (RBCN) in all WMO regions have contributed to on-going improvement of the availability of climatological data. He also reiterated that the Global Observing System impacts on the monitoring of climate and the environment, and provides the observational basis for more accurate and reliable forecasts and warning of severe weather events. The session was advised that it was their task to help make this a reality. Thus the opportunity to update the Implementation Plan for Evolution of Space and Surface-based Sub-system of the GOS was noted as an extremely important outcome of the meeting. Dr Karpov finally wished the group a constructive and successful session

Dr Paul Menzel thanked Dr Karpov for his cogent remarks, and stated that the session would work hard to fulfill its obligations.

1.2 Chairman of the meeting

Dr Paul Menzel, as chairman of ET-EGOS, chaired the meeting.

1.3 Adoption of the agenda

The agenda was adopted by the meeting with no changes.

1.4 Working arrangements

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

2. REPORTS FROM OPAG-IOS CHAIRMAN AND ET-EGOS CHAIRMAN

2.1 The OPAG-IOS Chair provided a summary of the relevant activities within the Open Program Area Group on Integrated Observing Systems since the ICT Meeting prior to CBS 2005. He expressed his sincere appreciation for the excellent work done by the ET and passed on similar appreciation from both CBS and the WMO Executive Council. He noted that at CBS 2005, that Mr Gusev of the Russian Federation was elected President and Prof. Hoffman of Germany was elected Vice President, that he was reconfirmed by CBS as Chair, Open Program Area Group on Integrated Observing Systems, and that Dr Sue Barrell, Australia Bureau of Meteorology was confirmed as OPAG-IOS Co-Chair. The Implementation Plan for Evolution of Space and Surface-Based Sub-Systems of the GOS was endorsed by CBS and has been subsequently published as WMO/TD No. 1267 and distributed to all WMO Members. He informed the ET that a new Expert Team on Satellite Systems had been added to OPAG IOS, that ET-ODRRGOS had been reformulated as ET-EGOS, and that ET-Satellite Systems Utilization and Products had been reformulated as ET-Satellite Utilization and Products. He informed the ET-EGOS that at the CBS Management Group Meeting in late April 2005 all OPAG Implementation Coordination Teams and Expert Teams, Terms of Reference, and two year work programs were finalized. He informed the ET that the next extra-ordinary session of CBS was to be held in November 2006 and that

preparation for that meeting would be an important part of their report for the OPAG-IOS ICT meeting in September 2006. He informed the meeting that he had been named CGMS Rapporteur to the THORPEX ICSC and that he also served THORPEX as Co-Chair of their Observations Working Group. He noted that the Virtual Laboratory for Education and Training in Satellite Utilization continues to receive strong endorsement, that there would be a High Profile Training Event in late 2006 and that there was great interest in the success from the electronic notebook now used for training within the Virtual Lab.

The OPAG Chair then informed the meeting of his activities relevant to actions from the ET-EGOS. He stressed that ultimate success for portions of the ET work would require strengthening coordination through Regional Rapporteurs in consultation with the chairs of the Regional Working Group on Planning and Implementation of WWW to ensure that operators and managers of regional observing systems are made aware of evolving GOS requirements as expressed in WMO 1267. He was keenly aware of the need to maintain liaison and ensure targeting strategies developed by EUMETNET and THORPEX are made available through liaison with CAS, EUCOS and THORPEX. He noted that CGMS had named Dr Purdom as Rapporteur to the THORPEX ICSC. He expressed his appreciation for the progress being made within the AMDAR Programme and thanked Mr Stickland for his dedication to that Programme.

The OPAG Chair concluded his guidance, with respect to future activity of the ET-EGOS. He stressed the dynamic nature of the evolving GOS, the relevance of GEOSS, and the reliance on Members for important information being generated through the ET and OPAG-IOS. He pointed out the potential for the evolution of the GOS to be greatly aided by THORPEX. He closed by emphasizing that as is clearly recognized by the GEOSS 10 Year Implementation Plan: “Understanding the Earth system – its weather, climate, oceans, land, geography, natural resources, and natural and human-induced hazards – is crucial to enhancing human health, safety and welfare, alleviating human suffering including poverty, protecting the global environment, and achieving sustainable development.” The reason we want to monitor the “pulse of our planet” is not solely for economic benefit but for human health and well being while learning how to sustain humankind’s future on our evolving planet Earth.

2.2 The ET-EGOS Chairman presented his report that summarized activities since the last meeting of ET-ODRRGOS in July 2004. He noted that Statements of Guidance had been updated for Atmospheric Chemistry, Hydrology, and Agro-meteorology, that the Implementation Plan for Evolution of GOS had been finalized at the ICT in September 2004 (with additional recommendations for NWP and Education and Training) and endorsed by the CBS in February 2005; and that progress on some recommendations in the IP were recorded in October 2005. He mentioned that the agenda for this meeting included (a) hearing about the International Polar Year, Thorpex, AMDAR, and EUCOS developments that might influence the Evolution of the GOS, (b) reviewing the progress and actions on the evolution of the ground-based and space-based sub-systems of the GOS, and (c) hearing of progress in WMO Regions toward evolving the GOS, and (d) updating the implementation plan by surface and space sub-system committees.

2.3 The Terms of Reference for the ET-EGOS, as approved by CBS-XIII, were reviewed. The session agreed that the terms of reference were appropriate. The associated workplan and deliverables for 2005-2006 were presented, and were accepted by the team with no changes.

3. REVIEW OF ACTIVITIES RELATED TO ET-EGOS

3.1 The session was advised of the terms of reference of the IPY sub-committee on observing systems. In addition, the session was brought up-to-date with information on observing systems relevant to IPY, as described in the IPY Framework Document.

3.2 Recent activities within the THORPEX Program were summarized. ET-EGOS was told of the establishment of a THORPEX Observing Systems Working Group, to be co-chaired by Dr Purdom. Dr Purdom asked ET-EGOS members to provide comments on this group’s draft Terms

of Reference before the end of February 2006. He also stressed the potential importance of THORPEX to the Implementation Plan activities of the ET-EGOS.

3.3 A status report on the global AMDAR programme was provided by the AMDAR Panel Technical Coordinator, Jeff Stickland. AMDAR coverage has continued to expand in many areas by the established and newer programmes with up to 190,000 observations per day being exchanged on the GTS. It was reported that 3 new national programmes had commenced in Japan, China and Canada. Of special note was the increase in coverage over Africa with 40 sites now receiving vertical profiles of wind and temperature on a fairly regular basis. Increased coverage was also noted in higher latitudes, particularly over Canada and Scandinavia as well as Central and Eastern Europe, Asia and some of the oceanic areas. The Panel has continued to provide technical training and the AMDAR Rapporteur prepared a questionnaire for distribution to Regional Rapporteurs. Data targeting and system optimization continue to play a more significant role in gathering observations from data sparse areas and to improve programme efficiencies. Special effort is being used to support the IPY 2007-2008 with the extension of AMDAR into higher latitudes and in particular over Antarctica. The development of software for installation onboard participating AMDAR aircraft remains an important focus for AMDAR and special mention was given to the close collaboration with Airbus industries. Of special concern are the difficulties being experienced with generally much poorer quality data being obtained from existing sensing systems on smaller regional aircraft. This can be overcome by using better quality sensors including the TAMDAR sensor package but the process can be difficult and expensive. Similarly, there is now clear evidence of systematic temperature bias related to aircraft type and model on larger aircraft. The AMDAR Panel will undertake studies in collaboration with NWP centres to determine the reasons for this with the aim to improve data quality. Functionality has been provided in onboard software to improve the resolution of vertical profiles but as this will have cost implications on operational AMDAR programmes, careful consideration is required to achieve the most suitable balance in meeting user requirements. It was also reported that the current constraints imposed by the system provider that inhibit the free exchange of TAMDAR data on the GTS are of particular concern. A potential solution via purchase of sensors has been identified but it also is proving difficult to implement. Substantial progress has taken place with the development and evaluation of the WVSSII water vapour sensor. Initial trials have been completed showing that generally good quality data is obtainable in the boundary layer to the mid troposphere. Further modifications will extend this to the lower stratosphere during 2006. Further evaluation trials will follow during 2006 in the US and Europe. International collaboration will be extended through operational trials in Australia, New Zealand, and South Africa. High quality humidity/water vapour data should be routinely available in small volumes from 2007. Global implementation will be governed by the relatively high cost to purchase, install, and maintain sensors and on the willingness of airlines to participate.

ET-EGOS became aware that Mr Stickland would be retiring from his role as the AMDAR Panel Technical Coordinator; the ET-EGOS chair noted the excellent coordination achieved with the AMDAR Panel through his efforts and thanked him.

4. IMPLEMENTATION PLAN FOR EVOLUTION OF SPACE AND SURFACE-BASED COMPONENTS OF THE GOS

4.1 Dr Horst Böttger summarized the progress and actions on surface-based sub-system of the GOS evolution. He noted that the recommendations drawn up by the ET at its 7th session in Geneva in July 2004 had been considered by CBS at its 13th session, St. Petersburg, 23 February to 3 March 2005. The Commission had taken note of these recommendations and agreed on a list of elements for implementation. Subsequently, Executive Council at is fifty-seventh session, Geneva, June 2005 noted the Progress/Activity Report on the implementation of the WWW and took several decisions in support of the proposed evolution of the GOS. In his review Dr Böttger stressed that much progress had been made in several areas of the evolving Global Observing System. Notable examples are the development of the AMDAR programme and the actions taken by JCOMM to improve the observations in ocean areas. In particular the expansion of the AMDAR programme led to a substantial increase in both flight level and profile wind and temperature

observations from otherwise large data void areas, such as over Africa and the Canadian Arctic. JCOMM had taken several steps to increase the observation coverage over the oceans, in particular in the tropical areas and in the southern oceans. The ET noted with appreciation that most XBT data now are distributed in near real-time. However, a particular concern expressed by the ET was the risk of a lack of sustained funding for the ARGO Programme as it moves from the developmental to operational phase.

ET-EGOS noted that the process of evolving the GOS requires a close cooperation with the Regional Associations and a constant dialogue to monitor the progress. It was noted that feedback received from the Regions reporting on the monitoring and recent enhancements of the observing system was an excellent start of establishing the dialogue with the Regions. To further improve the tracking of progress against the Implementation Plan, the Regional Rapporteurs should in future be encouraged to focus on the particular issues in the Implementation Plan relevant to their respective Regions. ET-EGOS also noted that actions which require inter-Commission coordination will need to be monitored very closely by the WMO Secretariat, special support to be given as required.

ET-EGOS reviewed the progress and next actions regarding the 22 recommendations in some detail, which can be found in Annex II.

4.2 In a joint session between ET-EGOS and ET-SAT, Dr Eyre presented a review of progress and actions on the evolution of the space-based sub-system of the GOS. Those sections of the Implementation Plan (IP) for the Evolution of the GOS concerning the space-based sub-system were discussed; additions were made to the record of recent progress, and some amendments were made to the schedule of next actions. These are recorded in Annex III of this report. In addition, two relevant areas were discussed: one concerning an optimum balance of development efforts between operational geostationary and polar satellites, and the other concerning the need to achieve polar satellite systems that operate in a complementary way to fulfill the collective user requirements to the greatest possible extent. These concerns are described in more detail in the Annex III. It was proposed that a WMO Space Programme Office workshop planned for the second quarter of 2006 would provide an opportunity to further address these issues.

Also discussed were NOAA's preliminary studies into the potential future role of mid-Earth orbit (MEO) satellites. Both ETs expressed concern that such satellites could not feasibly fulfill some of the missions undertaken by current operational polar satellites (e.g. microwave sounding and imaging) and so did not appear to offer the potential cost savings that prompted their study.

The meeting also noted potential gaps in the IP concerning atmospheric chemistry and perhaps other applications that had not yet been fully analyzed by ET-EGOS. The requirements for observations of lightning, and the plans of space agencies to implement them, were noted; in recognition of this, an additional item was added to the IP.

4.3 Several regional initiatives to evolve the GOS were presented. ET-EGOS was informed of the GCOS revitalization activities in RA I, which has provided consumables and equipment, such as hydrogen generators, to several stations, allowing them to carry out their nominated observing programmes. The RA I Rapporteur on Regional Aspects of the GOS provided a summary of the African Monsoon Multidisciplinary Analysis (AMMA) program and how this would restore or upgrade 22 RBSN radiosonde stations from late 2005 to early 2007. However a concern was expressed regarding the challenge to continue operating these stations after the AMMA project terminates.

The RA II Rapporteur on Regional Aspects of the GOS provided a progress report on GOS evolution activities in RA II. These included information on new AMDAR initiatives in the region, the installation of new Doppler radar systems in Japan, Hong Kong, China and Vietnam. It was also pointed out that the multitude of different satellite receiving equipment is causing concern

in the region, and that investigation into rationalizing satellite ground receiving equipment would be beneficial. The high costs of GPS radiosondes were also mentioned, and that systems, such as Radio Acoustic Sounding Systems (RASS) may be an alternative.

In Region III the GOS Rapporteur commented on the declining number of stations in the RBSN and the RBCN. He also advised that between 2002 and 2005 the number of GUAN stations has decreased by 10%. The rapporteur stated that a primary requirement is for the Region to have its own satellite programme. Information was also provided on the establishment of an operational AMDAR programme in South America with some regional airlines, such as LAN Chile enabling their aircraft to be AMDAR compliant.

Region IV has increased the number of CLIMAT stations in its RBCN from 242 stations in 2002 to 298 stations in 2004. However CLIMAT TEMP reports have decreased from 72 to 58 during the same period. To assist with this situation the RA IV rapporteur on Regional Aspects of the GOS suggests that it may be sensible to arrange a training workshop on CLIMAT and CLIMAT TEMP reporting in South America.

The RA VI Rapporteur provided a detailed report of the evolution of ground-based components of the GOS in RA VI. He advised that ten countries are now regularly inserting hourly synoptic data on the GTS, and that plans exist for several other countries to begin providing hourly data shortly. It was noted that several countries do not make their synoptic data available until 30-45 minutes after observation time. This is obviously unsatisfactory, and it will be monitored and corrected if possible. Regarding hourly observations from ships, it was reported that this was far from common and that only Germany operates a significant number of ships, which report every hour. A project under EUMETNET (SURFMAR) has been established, which will, as part of the project, result in a network of 50 drifting buoys being deployed in the North Atlantic from 2005. The closure of LORAN-C was mentioned as an issue in that some stations may find the high costs of GPS radiosondes too expensive, with the resultant closure of some upper-air stations being imminent. The rapporteurs advised that under the E-ASAP project it was planned to launch 5300 soundings in the North Atlantic during 2006. A project with EUMETNET (WINPROF) has been established to develop an operational wind-profiler programme. It is planned for 28 profilers to be in the network. As far as radars are concerned, 150 radars are operational in RA VI. Many of these radars have Doppler functionality and can therefore provide wind information. It is planned to include radar products on the GTS.

The Chairman thanked the Regional rapporteurs for their reports and expressed a desire for routine contact regarding progress on the IP relevant to their region.

4.4 Recent EUCOS impact studies were presented by Dr Horst Böttger. OSEs at European NWP centres and NCEP focused on the evaluation of using targeted observations generated and collected during THORPEX/ATreC. Results indicate that these additional observations have had a moderate positive impact during the ATreC campaign period. EUCOS and EUMETSAT recently commissioned a series of impact studies aiming at evaluating the balance between various components of the GOS. ET-EGOS was informed of the status of these studies and appreciated the presentation of preliminary results. These studies are still ongoing and will be conducted in various configurations with global and regional analysis and forecasting systems. Reports will become available in 2006. ET-EGOS requested EUCOS and EUMETSAT to make these results available to the ET. ET-EGOS discussed and proposed some future impact studies that would be informative regarding the evolution of the GOS.

4.5 Recent efforts in performing Observing System Simulation Experiments (OSSEs) at NCEP and JCSDA were summarized. NCEP has demonstrated reasonable agreement between OSE (real data) and OSSE (simulated data) results. More recently wind lidar OSSEs have been performed with models of different spatial resolution. NCEP is planning to conduct more OSSE with another nature run of at least one year and with special, high density observing periods. The ET-EGOS noted the OSSE progress with interest and suggested that NCEP should be asked to

consider an OSSE studying sensitivity to density (spatial and temporal) of in situ sea surface observations (pressure and wind).

5. OTHER BUSINESS

5.1 WMO recalled the concept of Regional ATOVS Retransmission Services (RARS), which provide an innovative way to access ATOVS sounding data from polar orbiting satellites with an efficient trade-off between timeliness of direct broadcast and global coverage of on-board recorded data. Following a first WMO-CGMS workshop in December 2004 and regional discussions with Asian-Pacific and South-American NMHS, the WMO Space Programme held a second RARS workshop in WMO headquarters the week before ET-EGOS meeting. The session reviewed the current RARS requirements for ATOVS data in terms of timeliness, data level, data format and transmission means. As concerns timeliness, the expert team considered 30 minutes as a breakthrough value, but noted that any effort to improve timeliness below 30 minutes is valuable for NWP and should be encouraged. The session confirmed the requirement of NWP centers to receive ATOVS data from RARS at level 1c (relocated, calibration applied) in BUFR format via GTS. However attention of RARS operators should be raised to the critical importance of consistency of data calibration between regional (RARS) data and global data delivered by NOAA. New RARS operators are therefore encouraged to collaborate with EUMETSAT NWP SAF, led by the Met Office (UK), in order to exchange information and methods for data pre-processing and monitoring, with a view to ensuring common and consistent practices across WMO regions. ET-EGOS considered the current RARS baseline as sound and looked forward to the implementation of these projects. This will be taken into account when reviewing the Database for NWP requirements and capabilities.

6. CLOSURE OF THE SESSION

Eleven new actions were formulated based on discussion during the meeting (see Annex IV). In closing Dr Menzel thanked the team for their hard work and announced that he was stepping down as chair of ET-EGOS effective February 2006. Dr. John Eyre agreed to act as interim chair until the post is filled officially. The session concluded at 3.00 p.m. on Friday 9 December 2005.

ANNEX I

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ANNEX II

REVIEW OF PROGRESS AND ACTIONS ON EVOLUTION OF THE SURFACE-BASED SUB-SYSTEM OF THE GLOBAL OBSERVING SYSTEM (GOS)

This annex provides a summary of progress and actions concerning the evolution of the surface-based sub-system of the GOS, through an update of relevant sections of the Implementation Plan (IP) for the Evolution of the GOS.

The IP was updated by ET-ODRRGOS at its meeting 12-16 July 2004 and, following minor revision by ICT at its meeting 6-10 September 2004, was endorsed by CBS-XIII in February 2005. The section of the IP covering the surface-based sub-system of the GOS was reviewed in November 2005 by Dr Horst Böttger (ECMWF), with input from Mr Jeff Stickland and Mr Etienne Charpentier. Thereupon the ET-EGOS drafted the following update to the relevant parts of the IP (updates are in *blue italic*).

RECOMMENDATIONS FOR THE EVOLUTION OF SURFACE-BASED SUB-SYSTEM OF GOS

(updated ET-EGOS on 8 December 2005)

Data coverage, distribution and coding

G1. Distribution - Some observations made routinely are not distributed in near real-time but are of interest for use in meteorological applications.

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

Comment: Recent studies have shown that 4D-Var data assimilation systems or analysis systems with frequent update cycles can make excellent use of hourly data, e.g. from SYNOPs, buoys, profilers, and other automated systems, in particular AWS.

Next Actions: CBS to urge WMO Members to implement this recommendation at the earliest possible date.

Update: Done (ref CBS-XIII Report)

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

Next Actions: Regional Rapporteurs, via letter from Secretariat, are requested to provide information on data potentially available in this category. [The letter should request supply and alert potential users to plans]. IOS ICT in September 2004 meeting and ET-ODRRGOS in 2005 should review input and consider which potentially available data merit further action.

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

The Secretariat is in regular contact with Regional Rapporteurs and also the National Focal Points on all issues related to the observing programmes. To track progress against the Implementation Plan, the Regional Rapporteurs should be encouraged to focus on the issues relevant to their respective Regions

New action: Add lake temperature data to the requirements .

G2. Documentation - All observational data sources should be accompanied by good documentation including metadata, careful QC, and monitoring.

Next Actions: (1) WMO Secretariat to draft a letter to Members (NWP centres) requesting report of specific problems inhibiting effective use of available data. [In their responses Members need to address problem areas for each data type. Reports should be specific and indicate what problems are preventing users from using data effectively.] (2) ET-ODRRGOS to review responses. (3) Based on the analysis of 1 and 2 above, such information should become accessible through a centralized WMO web portal (late 2005).

Update: The Implementation Plan was sent to Members, initial useful feedback was received from Regional Rapporteurs.

G3. Timeliness and Completeness - There should be a timely distribution of radiosonde observations with all observation points included in the message (together with the time and the position of each data point; information on instrument calibration prior to launch, and information on sensor type and sub-sensor type). Appropriate coding standards should be used to assure that the content (e.g. vertical resolution) of the original measurements, sufficient to meet the user requirements, is retained during transmission.

Comment: NWP OSEs have demonstrated the usefulness of full resolution data for NWP. The NWP OSE Workshop (Alpbach, 2004) reiterated the need for near real time distribution of full resolution RAOB data.

Next Actions: CBS to urge all Members with the existing capability of producing full vertical resolution sounding data to implement the transmission as soon as possible, starting in November 2005. Further CBS to ask all Members to generate, as soon as possible, sounding data in Table Driven Code Forms (BUFR or CREX), following the technical specifications defined by CBS in the Guidance for Migration (See http://www.wmo.ch/web/www/documents.html#CodeTables). In the interest of timely data delivery, the first BUFR message should be sent when level 100 hPa is reached and the second message should be sent when the whole sounding is completed (containing all observation points). The delivery of the profile data in several stages may be necessary to accommodate the interests of other application areas, such as Nowcasting and aeronautical meteorology.

Update: CBS encouraged Members with existing observing capabilities and networks to distribute their full information content as quickly as possible (CBS XIII Report).

EUCOS has taken an initiative to encourage operators of radiosonde stations to generate and transmit their data in BUFR, in addition to the TEMP message. First such data to become available by late 2006..

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

Comment: Regional forecasting systems continue to show benefit from a comprehensive and uniform coverage with at least 12-hour frequency of temperature, wind, and moisture profiles over

mid-latitude continental areas and coastal regions. In tropical regions the wind profile information is considered to be of particular importance. At this stage the radiosonde and PILOT network still plays an important role in meeting these requirements (NWP OSE Workshop, Alpbach 2004). Profile data are now and will in future, to an increasing extent, be provided from a mix of observing system components and will be complemented by the utilization of satellite data over land. In polar regions, this need has not been addressed, however the linkage between CBS, CAS's THORPEX, and IPY should give guidance for that data sparse region.

Next Action: OPAG-IOS chair in consultation with the chairs of the Regional Working Group on Planning and Implementation of WWW to ensure that operators and managers of regional observing systems are made aware of these requirements (CBS in 2005).

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

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

Comment: NWP OSE Workshop, Alpbach 2004, suggested that OSE results on the usefulness of stratospheric observations should be consolidated. It also noted that the COSMIC mission likely will provide a substantial enhancement to the stratospheric observing system. Further, AOPC has noted that current in situ measurement capabilities for UT and LS water vapour are not meeting climate requirements and stressed need for further development.

Next Action: ET to initiate further OSEs to include the use of COSMIC data when available. Results of OSEs to be reviewed and consolidated at that stage (2008).

Update: CBS reiterated the great value of experiments in the redesign process and encouraged leading NWP centres and relevant scientific groups to continue their efforts in that area. A review of EUCOS impact studies was presented at the ET-EGOS session (December 2005).

Broader use of ground based and in situ observations

G6. Ozone Sondes - Near real-time distribution of ozone sonde data is required for calibration and validation of newly launched instruments and for potential use in NWP. [recommendation is supported by information from the Joint ECMWF / WMO expert team meeting on real time exchange of ground based ozone measurements, ECMWF, 17-18 October 1996, WMO NWP OSE Workshop, Alpbach, 2004]

Next Action: CBS and CAS to request WMO Members making ozone profile measurements to place data on the GTS in near real time in BUFR/CREX format at the earliest possible date. Secretariat to inform Members of this requirement and request Members to inform WMO of their implementation plans (November 2005).

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

Moving towards operational use of targeted observations

G7. Targeted Observations - Observation targeting to improve the observation coverage in data sensitive areas for NWP should be transferred into operations once the methodology has

matured. Non-linear methods in targeting have been studied and should also be considered. The operational framework for providing information on the sensitive areas and responding to such information needs to be developed.

Comment: The proof of the observation targeting concept was given by US Weather Service in the northeastern Pacific for winter storms. THORPEX has declared observation targeting a core research activity in its implementation plan (2.3 ii), has successfully carried out jointly with EUCOS the NA-TreC campaign, and has benefited from the lessons learned from FASTEX.

Next Action: The OPAG-IOS Chair to maintain liaison and ensure targeting strategies developed by THORPEX are made available to the CBS.

Update: CBS XIII requested the OPAG-IOS to maintain liaison and to ensure that targeting strategies developed by programmes such as EUMETNET and THORPEX were carried through to operational implementation. No new field campaigns with observation targeting were carried out in 2005, nor are there any concrete plans to this extent for 2006/2007 at this stage. A joint CAS/CBS workshop on targeted and optimised observation is being planned for the second half of 2006.

Optimization of rawinsonde distribution and launches

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

Comment: Observation targeting requires a flexible observing practice. THORPEX has included this concept in their considerations.

Next Actions: ET to follow the THORPEX Implementation Plan and to learn from the THORPEX experience. When appropriate ET to request Secretariat to inform Regional Rapporteurs and managers of observing systems of the requirements for adapting to flexible observing practices including taking observations on demand, while safe-guarding the integrity of the baseline observing system.

Update: The THORPEX Implementation Plan stipulates that the concept of interactivity will be tested in the TIGGE (THORPEX Interactive Grand Global Ensemble) framework. Observation targeting is expected to benefit from the large ensemble size available in TIGGE, from which some methods of sensitive area prediction may benefit. The exploration of innovative uses (e.g. targeting) of operational observing systems is part of the planned THORPEX observing system tests. DSG, in letter dated 19 July 2005, to President CBS advised him of the EC recommendation to organize a joint workshop between CBS and CAS to investigate the concept of targeted (adaptive) observing systems.

Development of the AMDAR Programme

G9. AMDAR - AMDAR technology should provide more ascent/descent profiles, with improved vertical resolution, where vertical profile data from radiosondes and pilot balloons are sparse as well as into times that are currently not well observed such as 2300 to 0500 local times. [recommendation is supported by information from the Toulouse report, ECMWF northern hemisphere AMDAR impact study, OSEs 4, 5, 8]

Progress: The AMDAR Panel plans to coordinate homogeneous coverage of AMDAR data over 24 hours over as many regions as possible and to improve the value of upper air data through a combination of:

Update: Onboard software permits operators to select the vertical resolution update rate. Increasing the sampling rate in the vertical will lead to increased cost implications. However user requirements can be met by improving the sampling rate within the constraints of communication costs. NWP users need to consider the optimum sampling rate or possible time averages.

- Expanding the number of operational national and regional programmes;

Update: Existing programs in Australia, the US and Europe have expanded coverage both domestically and internationally providing more profiles in data sparse regions of Africa, Eastern Europe, parts of Russia, the Middle East, South and East Asia and South America. South Africa has expanded its international coverage to include more African, South American and Asian destinations and is well underway with expanding its domestic and regional program in Southern Africa.

New operational programs have commenced in Hong Kong China, Saudi Arabia, Japan, China and Canada. Finland is completing testing and will become part of the E-AMDAR program. New programs that are under development in Repub. of Korea and Chile should become operational by mid 2006.

As a result of AMDAR technical workshops in Bucharest and Budapest in December 2004, programs are in the early development stage in Romania, Slovenia and Austria. Other programs are being planned or considered in Argentina, Brazil, French Polynesia, United Arab Emirates, Mauritius, Malaysia, India, Pakistan, Kenya, Iceland, Ireland, Italy, Portugal, Spain, Morocco, Russian Federation, Hungary, Poland, Czech Republic, Bulgaria, Croatia and the Ukraine.

- Development and use of new onboard software and alternative AMDAR technologies;

Update: Significant progress has been achieved in the development of alternative AMDAR systems. The TAMDAR system is nearing completion of a 12-month trial in the US on 64 regional aircraft. However there are still issues with reaching agreement with the manufacturer on free exchange of the data on the GTS to Members. To overcome this issue the problem is being addressed by Members procuring a combination of the TAMDAR sensor package and an alternative communications system.

Australia will install an AFIRS (Aircraft Flight Information Reporting System) system in 2006 and is planning to evaluate a very inexpensive and broadly based ADS-B system. The ICAO ADS-C system operates over the North Atlantic and SW Pacific Ocean areas.

- Selective deployment of humidity/water vapour sensors;

Update:US WVSSII water vapour sensors have been installed on 25 UPS B757 freighter aircraft and are undergoing operational evaluation. Initial results are very encouraging but some additional modification work needs to be completed. A short intercomparison trial over the US Great Lakes region against radiosondes and other upper air systems was conducted in mid 2005 that resulted in a small number of items requiring attention. Data are being exchanged on the GTS. E-AMDAR has commenced a substantial WVSSII evaluation program. Laboratory testing by the German Juelich Research Centre has been completed and following the certification process, operational trials on Lufthansa A320 aircraft and possibly one MOZAIC A340 aircraft will commence in the second quarter of 2006. Other international purchase and evaluation collaboration has been

organized by the AMDAR Panel with Australia, New Zealand and South Africa who will install a small number of sensors for operational testing.

Another major step forward has been the interest and involvement of Airbus Industries who in collaboration with the AMDAR community, are planning to complete the certification process on the entire A320 family and extend this to all other Airbus models. They plan to offer the sensor as a routine optional component to all Airbus customers.

- Provision of targeted observations into data sparse areas and special weather situations;

Update: Formal arrangements have been completed for E-AMDAR to provide targeted data for Southern Africa. Work continues on the establishment of substantial targeted program over Central and West Africa and Madagascar through arrangements between E-AMDAR and ASECNA.

AMDAR support for the IPY2007-2008 is being undertaken by Canada as it extends operations into arctic Canada; by Germany through activating additional over-flights; and by Sweden as it expands its national program into high latitudes. The US, Australia and Chile are actively planning to introduce first AMDAR operations into Antarctica in time for the IPY. The AMDAR Panel Technical Coordinator is a member of the WMO Intercommission Task Team on the IPY 2007-2008.

As mentioned above, many of the existing operational programs (US, Australia, South Africa and E-AMDAR) are providing targeted data into many data sparse regions as part of their contribution to the WMO WWW program. The US is particularly interested in developing targeted programs for regions in the Caribbean, Central and South America.

E-AMDAR in collaboration with ECMWF conducted an investigation into the impact of high frequency data on NWP forecasts over Europe (see more below).

Some national studies have assessed the potential impact of targeted AMDAR data on the ability to forecast special weather situations. The work of ECMWF using the GADS database has highlighted a number of events to show the benefits of AMDAR data fore this purpose. E-AMDAR has developed most of the tools to accomplish this but it is very difficult to obtain profiles in the required locations upstream of most of Europe. Enroute data and some profiles in Iceland and some of the Atlantic islands off Africa are all that are currently possible.

- Use of optimization systems to improve cost effectiveness;

Update: E-AMDAR continues to develop and refine its optimization schemes. The benefit has been shown to be very positive. This will become even more useful as the E-AMDAR program begins to incorporate additional airlines and extend the program through the participation of programs in Central and Eastern Europe.

E-AMDAR undertook a 2-phased high frequency trial in 2003 to evaluate the impact of obtaining high frequency E-AMDAR data over Europe. ECMWF produced the final report in February: TechMemo 45 by Andersson, E., C. Cardinali, B. Truscott and T. Hovberg titled High-frequency AMDAR data - a European aircraft data collection trial and impact assessment.

Canada has also established an operational optimization scheme. The US and Australia are planning to develop appropriate systems in the near future as both countries see this as an essential component of major operational programs.

- Improvements in the monitoring, quality control;

Update: Substantial progress has been made in the area of data monitoring and quality control. All monitoring centres have made substantial improvements to their AMDAR data quality monitoring systems. Particular attention has been given to presenting the results so that they are more useful to program operators. The commencement of 5 new operational programs has presented some interesting challenges over the past 18 months. A series of studies have shown that temperature data quality is very clearly linked to individual aircraft types and models Additionally, clear differences in bias are seen between ascent and descent profiles on many aircraft. The AMDAR Panel Science Sub Group is committed to investigate the causes of both problems but it is likely to be a very difficult task, which will also require the involvement of NWP centres. Similarly wind data is proving to be a problem on some aircraft, particularly the smaller regional aircraft. This has become increasingly obvious over the past 12 months as the first fleets of regional jets and turbo props in Europe, Canada and the US become operational. Another major problem is the very poor wind quality derived from aircraft in high latitudes. This is a direct result of the problems associated with the use of magnetic heading, which is completely unusable at these latitudes. Much work is needed on data quality.

- Efforts to encourage and pursue the free exchange of data

Update: Changes to FM94 BUFR code to improve the exchange of AMDAR data have become operational. A trial is being planned by Australia and the UK to test the new CREX encoding of AMDAR data. Most of these changes and new codes are designed to make it easier for developing countries to receive and use the data. Discussions continue with the provider of the TAMDAR system to allow for the free exchange on the GTS of TAMDAR data.

- Improvements in user awareness & training plus operational forecasting tools & systems

Update: Dr. Jochen Dibbern (Germany) was appointed as the CBS AMDAR Rapporteur with particular responsibilities in awareness and operational training. CBS XIII and EC LVII approved recommendations to develop a training concept for the use of AMDAR data including an implementation plan. EC decided that a CAeM/CBS task team should be established to evaluate current training activities and requested Regional Rapporteurs in consultation with the OPAG IOS Rapporteur on AMDAR to develop a questionnaire on AMDAR training requirements. The AMDAR Panel formed a training sub-group at its Seventh meeting in Oct. 2004. The group has completed the training questionnaire that has been passed to the WMO Secretariat for distribution to Regional Associations and other relevant groups. Several familiarization seminars were also held during 2005.

Major technical training events took place in December 2004. 2 technical seminars were held in Bucharest and a large 3-day workshop was held in Budapest with 13 participating countries from Central and Eastern Europe. Workshops have been formally requested by the Russian Federation, Morocco, Brazil and Kenya and informally by India, Bulgaria and Croatia. A workshop on the Great Lakes Field Experiment on TAMDAR (GLFE) was held in August 2005 where internal US user information was provided.

The following table needs to be made a living document for periodical updating but as it stands, it is the table used at CBS XIII. Some proposed changes are included.

Table 1: The AMDAR Programme Implementation Plan presented at 8th AMDAR Panel

Programme Items	2005-2006	2008	2010
Operational programmes (Australia, E-AMDAR*, New Zealand, USA, South Africa, Hong Kong China, Saudi Arabia, Japan, China, Canada)	Expanding	stable	stable
Emerging programmes (Central-western Africa)	Expanding	expanding/ stable	stable
Developing programmes (Chile, Argentina, Rep. of Korea)	first data	expanding	stable
Planned programmes (Eastern-central Europe#, Russian Federation, Oman, Egypt, Morocco, Kenya, Pakistan, Malaysia, Mauritius, Singapore, India, UAE, French Polynesia)		first data	expanding
Development software and technologies	work in progress	operational	stable
Humidity/water vapour sensors	operational trials	expanding	operational
Targeted data	partly operational	expanding	expanding
Optimization systems	Partly operational	expanding	expanding
Data monitoring, QC and data exchange	Ongoing	ongoing	ongoing
Awareness and training	Ongoing	ongoing	stable
Development of operational forecasting tools	in progress	operational	operational

* E-AMDAR currently: UK, France, Netherlands, Germany, Sweden
E-AMDAR emerging: Finland
E-AMDAR planned: Portugal, Spain, Iceland, Italy, Switzerland, Ireland, and Belgium
Eastern-central Europe: Austria, Poland, Hungary, Rumania, Slovenia, Ukraine, Czech Republic, Bulgaria, Croatia.

Next Actions: ET-ODRRGOS to continue to monitor progress of the AMDAR Programme in the above activities.

G10. Transmission of AMDAR reports - Optimize the transmission of AMDAR reports taking into account, en route coverage in data-sparse regions, vertical resolution of ascent/descent reports, and targeting related to the weather situation. [Recommendation is supported by information from the Toulouse and Alpbach NWP OSE Workshop reports, ECMWF northern hemisphere AMDAR impact study].

Comment: AMDAR coverage is both possible and sorely needed in several currently data-sparse regions, especially Africa and South America, Canadian arctic, northern Asia and most of the world's oceans. More T, U/V, Q profiles, but especially winds, are needed in the tropics. Moreover, the timing and location of reports, whose number is potentially very large, can be optimized while controlling communications costs.

Next Action: AMDAR Rapporteur to report progress to ET. Members in the Regions must assume responsibility of implementation.

Update: In addition to the detailed information provided under G9, i.e. new programs, developments in data sparse regions, targeting, etc., additional targeted data is being provided over the Southern and South East Asia, Central America and the Middle East by current operational programs. Australia is planning to help develop a regional program of targeted observations in the South West Pacific that will hopefully grow into a small local operational program. Preliminary discussions have been held with New Zealand to assist and with France to collaborate with developments in French Polynesia.

G11. Humidity sensors on AMDAR - Further development and testing of water vapour sensing systems is strongly encouraged to supplement the temperature and wind reports from AMDAR. [Recommendation is supported by information from the Toulouse and Alpbach NWP OSE Workshop reports]

Progress: Demonstration of WVSS-2 is expected in 2004-05. This system employs an absolute measurement of water vapour content that is expected to be accurate from the ground to flight altitudes.

Next Action: AMDAR Rapporteur to report progress of the AMDAR programme to ET.

Update: See Item G9

Alternative AMDAR systems

G12. TAMDAR & AFIRS - To expand ascent/descent profile coverage to regional airports, the development of TAMDAR and use of AFIRS should be monitored with a view towards operational use.

Comment: A range of alternative AMDAR systems including TAMDAR, AFIRS and MDS could supplement conventional AMDAR and radiosonde data by providing lower level en route observations and profiles over additional, regional airports not served by larger AMDAR compatible aircraft. Instrumentation would not necessarily be designed to function in the high troposphere and would therefore be less expensive.

Next Action: ET-ODRRGOS to review progress under AMDAR and EUCOS Programmes. First data from TAMDAR and AFIRS are expected in late 2004.

Update: In addition to the information provided in G9, it is emphasised that progress in this area is severely limited because of the much poorer quality data produced by avionics systems on the smaller regional aircraft. Much effort and expenditure is going into overcoming this problem.

Atmospheric moisture measurements

G13. Ground GPS - Develop further the capability of ground-based GPS systems for the inference of vertically integrated moisture with an eye toward operational implementation. Ground based GPS processing (ZTD and PW, priority for ZTD) should be standardized to provide more consistent data sets. Data should be exchanged globally. [Recommendation is supported by information from the NWP OSE Workshop in Alpbach.]

Comment: Such observations are currently made in Europe, North America and Asia. It is expected that the global coverage will expand over the coming years. The COSNA/SEG, NAOS, JMA reports provide useful background information.

Next Actions: CBS to urge Members to collect and exchange the ground-based GPS data. Members should take the appropriate action to ensure that the data processing be standardized by November 2005.

Update: No action has been implemented. Cost Action 716 Final Report on "Exploitation of Ground-based GPS"provides background. GPS data message type in BUFR has been developed and appro*ved. EUMETNET E-GVAP Programme is taking the results of the Cost Action 716 into an operational implementation phase.

Regarding improved observations in ocean areas

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

Next Action: ET-ODRRGOS request a review from JCOMM on the current status and plans of ASAP by end of 2004.

Update: SOT/ASAPP is attempting to increase the number of ships, however it has had difficulty doing so. The North Atlantic is better covered thanks to continuing efforts of the E-ASAP Programme, which is also targeting routes in sensitive areas. Target: 18 ships producing 5800 soundings in 2006. ASAP monitoring is routinely made by ECMWF and Météo-France. Results of the E-ASAP OSE on the impact of ASAPs in the Atlantic will be available in 2006.

WRAP (World Re-occurring ASAP Programme) was officially terminated in April 2005 because of the difficulties in maintaining a viable and cost effective service.

G15. Telecommunications - Considering the expected increase in spatial and temporal resolution of *in situ* marine observing platforms (from include drifting buoys, profiling floats, XBTs for example) and the need for network management, the bandwidth of existing telecommunication systems should be increased (in both directions) or new relevant satellite telecommunications facilities should be established for timely collection and distribution.

Comment: The JCOMM Operations Plan provides background for actions in this area.

Next Action: ET-ODRRGOS request information on progress regarding distribution of increased temporal and spatial resolution in situ marine observations from JCOMM.

Update: Iridium provides for high resolution data transmission and is global. Experiments being conducted with small number of Argo profiling floats and drifting buoys (Arctic). Argos 3 generation will be onboard METOP, mid 2006, and will provide higher bandwidth and downlink capability. High resolution XBT data collected via Inmarsat are made available through Global Temperature and Salinity Profile Programme (GTSPP). BUFR distribution of high resolution XBT data is under investigation.

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

Next Action: ET-ODRRGOS request information on progress in extending the tropical mooring array from JCOMM.

Update: Progress towards the establishment of an Indian Ocean moored buoy array was made with the deployment of an initial 4 surface ATLAS moorings and one subsurface ADCP mooring in October/November 2004. These moorings complement previously established JAMSTEC TRITON moorings and a subsurface ADCP mooring. An additional ATLAS mooring deployment is planned for late 2005. In addition to traditional wind and sub-surface temperature profiles, all have near-

surface (10 m) current meters, plus one has OceanSites flux enhancements, which include long-wave radiation, barometric pressure, and additional subsurface current meters. Vandalism remains a concern. Several enhancements to the submission of TAO, PIRATA, and Indian Ocean ATLAS data onto the GTS were made in 2005. First was the addition of daily mean salinity data. The second enhancement to the GTS data stream was that as of Feb 1, 2005, all ATLAS systems were switched to multi-satellite status by Service Argos. As a result, the volume of hourly surface met data (winds, air temperature, relative humidity and SST) on the GTS each increased from about 4000 observations per month to about 8000 observations per month. A third enhancement was that all ATLAS moorings deployed in 2005 and after will be programmed to transmit 16-hours per day. Previously, transmissions had been limited to 8 daytime hours due to budgetary constraints. As of July 2005, the number of hourly surface met data on the GTS has increased to about 15000 observations per month. The volume of hourly met data on the GTS will continue to increase throughout 2005 as new moorings replace those transmitting 8 hours per day.

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

Comment: Plans from agencies other than JCOMM need to be considered.

Next Actions: (1) ET-ODRRGOS to request information from JCOMM on plans for preserving/enhancing the network. (2) ET-ODRRGOS to review requirement for surface pressure observations in ocean areas based in results of OSE studies (EUCOS)

Update: DBCP presently maintains 80 barometer drifters South of 40S. JCOMM/OCG and DBCP have plans to eventually maintain a network of about 300 barometer drifters South of 40S (700 globally). Following results from impact studies, DBCP had recommended to transmit as much hourly data as possible. This led to substantial increase in the number of air pressure reports per day per buoy distributed on GTS (now about 14/day in average). Wind drifters with WOTAN technology are deployed in small quantities and in conjunction with hurricanes. There are no plans to increase substantially the number of such drifters.

G18. XBT and Argo - For Ocean Weather Forecasting purposes, improve timely delivery and distribute high vertical resolution data for sub-surface temperature/salinity profile data from XBTs and Argo floats.

Note: The JCOMM Operations Plan provides background for actions in this area.

Next Actions: (1) ET-ODDRGOS to request information on progress from JCOMM for the next ET-ODRRGOS meeting. (2) ET-ODRRGOS to review adequacy for WMO requirements.

Update: Most XBT data now distributed in real-time within a few hours (low resolution in BATHY). BUFR distribution of high resolution XBT data under investigation by SOT/SOOPIP. Argo data in high resolution distributed in NetCDF format through GDACs within 24H

Resources for sustaining the Argo Programme into its operational phase are causing concern. (Secretariat to investigate and provide information).

G19. Ice buoys - For NWP purposes, coverage of ice buoys should be increased (500 km horizontal resolution recommended) to provide surface air pressure and surface wind data.

Note: The JCOMM Operations Plan provides background for actions in this area.

Action: ET-ODRRGOS to request information on progress regarding ice buoys from JCOMM.

*Update: At its last meeting, Seattle, June 2005, the International Arctic Buoy Programme decided to change its operating principles and to change recommended average spacing: Horizontal resolution targeted was changed from 500km*500km to 250km*250km. In June 2005, with 33 operational buoys, it was close to the 500km*500 km resolution; 47 buoys are needed to achieve the 500kmx500km.*

*On the other hand, the WCRP-SCAP International Programme for Antarctic Buoys (IPAB) is still targeting 500km*500km while actual resolution is actually substantially lower. IPAB will meet in New Zealand next month and there might be more up to date information by then.*

Improved observations over tropical land areas

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

Comment: There is evidence from recent impact studies with the radiosonde / PILOT balloon network over the Indonesian / Australian region that such data give a better depiction of winds in the tropics and occasionally strongly influence the adjacent mid-latitude regions.

Action: AMDAR Rapporteur to report to ET. CBS to urge Members to consider activation of silent stations through a shared funding programme.

Update: Information on the collection of additional profile data from aircraft is provided und G9. In addition, the AMMA (African Monsoon Multidisciplinary Analysis) project in West Africa is expected to operate at various stages and during field phases a number of additional TEMP and PILOT stations. The AMMA Programme provides an opportunity for impact studies and subsequent network design. Sustaining an operational network in the region will be a challenging task.

New Observing Technologies

G21. AWS - Noting the widespread adoption of AWS, (a) there should be coordinated planning that includes

- appropriate codes and reporting standards,
- global standard for quality management and the collection / sharing of metadata, and
- expanded range of measured parameters;

Next action: ET-AWS to be asked to review advances in technology and to summarize for ET-ODRRGOS.

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

Next action: Reporting formats should be reviewed to include the details of observation times, OPAG_IOS Chair to bring this to the attention of the OPAG ISS ET on Data representation and codes (at CBS in 2005).

Update: No meeting of ET-AWS has been held yet to discuss and review advances in technology. Next ET-AWS should be tasked to do this (fourth session of ET-AWS planned for mid-2006).

New Issue: The evolution of the AWS network needs to be addressed and ET-AWS is not the right ET to carry this forward.

G22. New systems - In the context of THORPEX, the feasibility of new systems should be demonstrated as much as possible. These possible operational sub-systems include but are not limited to

- ground based interferometers and radiometers (e.g. microwave) that could provide continuous vertical profiles of temperature and humidity in selected areas;
- Unmanned Aeronautical Vehicles (UAVs);
- high altitude balloons.

Action: OPAG IOS Chair to liaise with the THORPEX ICSC and keep the relevant ETs informed.

Update: This will be addressed by the THORPEX observations group in March 2006 in Reading, UK.

ANNEX III

REVIEW OF PROGRESS AND ACTIONS ON EVOLUTION OF THE SPACE-BASED SUB-SYSTEM OF THE GLOBAL OBSERVING SYSTEM (GOS)

This annex provides a summary of progress and actions concerning the evolution of the space-based sub-system of the GOS, through an update of relevant sections of the Implementation Plan (IP) for the Evolution of the GOS.

The IP was updated by ET-ODRRGOS at its meeting 12-16 July 2004 and, following minor revision by ICT at its meeting 6-10 September 2004, was endorsed by CBS-XIII in February 2005. The 21 recommendations in the IP covering the space-based sub-system of the GOS were reviewed in October 2005 in discussions involving Dr P Menzel, Dr J Eyre and the WMO Space Programme Office. This version of the updated IP for the space-based component of the GOS was reviewed by the ET-EGOS and ET-SAT in joint session on 7 December 2005. The relevant portions of the IP were edited and are presented below. An additional recommendation regarding formation flying was added.

RECOMMENDATIONS FOR THE EVOLUTION OF SPACE-BASED SUB-SYSTEM OF THE GOS

(Updated by ET-EGOS and ET-SAT on 7 December 2005)

A balanced GOS

Concern 1 – Leo/Geo Balance

There has been commendable progress in planning for future operational geostationary satellites. In addition to the plans of China, EUMETSAT, India, Japan, Russian Federation and USA, WMO has been informed of the plans of the Republic of Korea to provide geostationary satellites. The Republic of Korea has made a formal declaration to WMO and is now considered part of the space-based component of the GOS. These developments increase the probability of good coverage of imagery and sounding data from this orbit, together with options for adequate back-up in case of failure. They also raise questions concerning how to meet user requirements with the best balance between polar and geostationary systems. It would be timely for the WMO Space Programme and/or CGMS to initiate studies of the relative extent to which plans for future polar and geostationary systems contribute to meeting the collective user requirements for observations, and to advise if the balance between the two systems would benefit from some adjustment. Additionally, it would be appropriate to have regional discussions for optimized operations of geostationary and polar-orbiting satellites comprising the operational space-based component of the GOS including close cooperation on instruments for future satellite missions.

Concern 2 – Achieving Complementary Polar Satellite Systems

EUMETSAT has recently initiated planning for the post-EPS era (i.e., first element in orbit in ~2019) through a thorough assessment of the user requirements for all observations that might usefully be made from low earth orbit. This is to be complemented with a remote sensing assessment of the missions needed to meet these requirements. It is expected that some of these missions will be implemented through satellite missions/systems provided by EUMETSAT, whilst other “missions” may be achieved by cooperation with other partners (e.g., NOAA/EUMETSAT Joint Polar System, complementary with GMES requirements, or acquisition of data in partnership with other space agencies). Through this process, the goals of GEOSS could be greatly advanced. WMO Space Programme Office is encouraged to consider how this process might best be facilitated, to discuss any obstacles to progress, and to identify short-term opportunities for engagement with this process. In addition, noting the polar plans of China and Russia, WMO SPO should also extend coordination efforts to include these agencies.

Calibration

S1. Calibration - There should be more common spectral bands on GEO and LEO sensors to facilitate inter-comparison and calibration adjustments; globally distributed GEO sensors should be routinely inter-calibrated using a given LEO sensor and a succession of LEO sensors in a given orbit (even with out the benefit of overlap) should be routinely inter-calibrated with a given GEO sensor.

Comment: A major issue for effective use of satellite data, especially for climate applications, is calibration. The advent of high spectral resolution infrared sensors (AIRS, IASI, CrIS) will enhance accurate intercalibration. Also regarding visible intercalibration, MODIS offers very comprehensive onboard shortwave solar diffuser, solar diffuser stability monitor, spectral radiometric calibration facility that can be considered for inter-comparison with geosynchronous satellite data at visible wavelengths. MERIS appears to have merit in this area due to its programmable spectral capability, if implemented. GOES-R selected ABI channels have been selected to be compatible with VIIRS on NPOESS. This only deals with optical sensors, and other sensor types (e.g., active, passive, MW) should be considered.

Progress: CGMS-XXXI (2003) discussed GCOS Climate Monitoring Principles, inter-calibration of visible sensors, and inter-calibration of IR sensors on all GEOs with HIRS and AVHRR (reporting on the last item remains as a permanent action of CGMS). CGMS-XXXII (2004) considered improved infrared inter-calibration capabilities using AIRS data; the implications for GCOS Climate Monitoring Principles were discussed. The WMO Space Programme hosted a workshop in July 2005 in Darmstadt, Germany where a strategy for a global space-based inter-calibration system was drafted; it will be presented to space agencies for consideration, endorsement, and possible implementation. It was noted that the building blocks for a calibration / validation system include (1) on-board calibration devices (e.g., black bodies, solar diffusers), (2) in situ measurements of the state of the surface and atmosphere (e.g. the Cloud and Radiation Testbed (CART) site, aircraft instruments with NIST calibrations), (3) radiative transfer models that enable comparison of calculated and observed radiances, and (4) assimilation systems that merge all measurements into a cohesive consistent depiction of the earth-atmosphere system. A strategy was drafted. The WMO Space Programme presented at CGMS in November 2005 a strategy for achieving operational intercalibration of the space component of the global observing system that addresses the climate and weather forecasting needs.

Next Actions: Discussion and planning with space agencies will be continued via CGMS. CGMS will continue inter-calibration activities with current sensors (e.g. AVHRR, HIRS, MODIS, AIRS) and expand to IASI in 2006.

GEO satellites

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

Progress: The following geostationary satellite operators have reported at CGMS that they will have at least SEVIRI-like capability by 2015: NOAA (2012), EUMETSAT (present), Russian Federation (2007), and CMA (2012).

Next Actions: WMO Space Programme will continue discussions with space agencies, via CGMS, especially with IMD and JMA.

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

Comment: This was to be demonstrated by GIFTS. However, for budgetary reasons, NASA has recently curtailed the GIFTS mission to assemble and vacuum test an Engineering Design Unit; realization of a GIFTS demonstration in geostationary orbit is a task to be undertaken by the international community, possibly within the International Geostationary Laboratory (IGeoLab).

Progress: All operators reported plans at CGMS in 2004: NOAA has firm plans including this capability for the GOES-R series; EUMETSAT has it under consideration for the MTG series; China and India have plans for capability similar to current GOES sounder before 2010. CGMS endorsed the concept of the International Geostationary Laboratory (IGeoLab) that would be a joint undertaking to provide a platform for demonstrations from geostationary orbit of new sensors and capabilities. GIFTS is one of two systems being considered for IGeoLab. Roshydromet and Roskosmos are negotiating with the USA regarding the possibility to install GIFTS on board of the subsequent geostationary satellite "ELEKTRO". A task team evaluating two test instrument proposals for IGeoLab met in early June 2005 in Silver Spring, MD. This meeting was the outgrowth of an action from the Consultative Meetings on High-level Policy on Satellite Matters (CM) hosted by WMO in January 2005, where the Space Agencies endorsed the concept of IGeoLab and requested that the two proposals (the Geostationary Imaging Fourier Transform Spectrometer – GIFTS and the Geostationary Observatory for Microwave Atmospheric Sounding - GOMAS) be further explored. Instruments of this type in geosynchronous orbit are high priority enhancements to the Global Observing System (GOS) for meeting existing user requirements in numerical weather prediction (NWP), nowcasting, hydrology and other applications areas. In September 2005 thermal vacuum testing of the GIFTS Engineering Design Unit (EDU) was started in Logan, Utah. This will demonstrate several key technologies working together (active cooling, Focal Plane Array detectors (FPA), Fourier Transform Systems (FTS), high speed Analog to Digital converters (A/D), lightweight optics, operation at cryogenic temperatures). Information from the GIFTS TV will be shared with international community to help with instrument performance specifications.

Next Actions: WMO Space Programme is continuing pursuit of a GIFTS demonstration on IGeoLab with space agencies. See note in Next Action for S-13. Additionally, plans from all space agencies for hyperspectral geostationary sounding should be in place by CGMS 2006.

S4. GEO System Orbital Spacing - To maximize the information available from the geostationary satellite systems, they should be placed "nominally" at a 60-degree sub-point separation across the equatorial belt. This will provide global coverage without serious loss of spatial resolution (with the exception of Polar Regions). In addition this provides for a more substantial backup capability should one satellite fail. In particular, continuity of coverage over the Indian Ocean region is of concern.

Comment: In recent years, contingency planning has maintained a 5-satellite system, but this is not a desirable long-term solution.

Progress: WMO Space Programme continues to discuss with space agencies, via CGMS and WMO Consultative Meetings on High-level Policy on Satellite Matters, the strategy for implementation towards a nominal configuration with attention to the problems of achieving required system reliability and product accuracy.

Next Actions: This issue will be addressed at a two-day optimization workshop to be held at WMO in second quarter of 2006

LEO satellites

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

Progress: The successful EUMETSAT ATOVS Retransmission Service (EARS) has been renamed the EUMETSAT Advanced Retransmission Service and will carry AVHRR and ASCAT products in addition to ATOVS. EARS ATOVS data are now available with a delay of less than 30 minutes; the data are used operationally at some NWP centres and planned at others. Planning has begun for other Regional ATOVS Retransmission Systems (RARS) in Asia, Australia, and South America with a goal for an Integrated Global Data Dissemination Service (IGDDS). WMO hosted a global RARS Workshop in 1-2 December 2005 with participation by Europe, Canada, Americas and Asia-Pacific. WMO Space Programme is planning, with Members and CGMS, the development of Advanced Dissemination Methods (ADMs) and an Integrated Global Data Dissemination Service (IGDDS), to include: (1) the extension and enhancement of EARS; (2) the implementation of similar systems, with a goal of achieving timely retransmission of local data sets covering the globe; (3) an equivalent system for NPP data; (4) expansion of EARS and equivalent systems to include IASI data; and (5) establishment of equivalent systems for the LEO data from satellites of other agencies.

NPOESS plans are for data delivery in less than 30 min and are thus consistent with the stated timeliness requirements for NWP.

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

Next Actions: WMO SPO to pursue further actions to implement IGDDS and RARS.

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

Progress: This is now the subject of a permanent action of CGMS. WMO Space Programme will collaborate with space agencies, via CGMS, on a target system that will be implemented and to take steps towards achieving it. Matters related for contingency planning in the AM and PM polar-orbits will be included.

Next Actions: Target system agreed upon by CGMS in 2006.

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

Comment: QuikScat scatterometer data have been available to the NWP community since 1999, and will continue through the life of QuikScat (NASA has no current plans for a

successor SeaWinds scatterometer). ERS-2 scatterometer will be followed by ASCAT on METOP. Oceansat-2 has scatterometer capability that may be made available to the world community (this availability needs to be confirmed).

In the NPOESS and METOP era, sea surface wind should be observed in a fully operational framework. Therefore it is urgent to assess whether the multi-polarisation passive MW radiometry is competitive with scatterometry.

Progress: 3 months of data has been made available to Windsat science team. Windsat data have been distributed to several NWP centres in 2005. Early assessments of its polarimetric capabilities to provide information on sea surface wind direction suggest that, while good information is available at high wind speed, this technology will not be competitive with scatterometry at low wind speed.

Next Actions: WMO Space Programme to take note of recent WindSat performance studies to assess implications to the GOS and provide feedback to NOAA by February 2006.

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

Progress: Agreement has been reached to proceed with Jason-2 (2008). TOPEX/Poseidon and Jason-1 continue to provide global ocean topography data to the NWP community. ESA has plans for a Sentinel-3 ocean mission that will include an altimeter.

Next Actions: WMO Space Programme to discuss with space agencies, via CGMS and WMO Consultative Meetings on High-level Policy on Satellite Matters, the continuity of operational provision after Jason-2. Plans for operational follow-on should be reported at CGMS in 2006.

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

Comment: Plans for ERB-like measurements after Aqua remain uncertain. There are also concerns about the continuity of absolute measurements of incoming solar radiation. This is a high priority item in the GCOS implementation plan.

Progress: WMO Space Programme to discuss with space agencies, via CGMS. The second NPOESS satellite is scheduled to carry the CERES instrument (likely launch in 2013), but NPOESS program is currently under review and likely to be re-configured. FY-3A will have a proto-type Earth radiation budget instrument in 2007.

Next Actions: WMO Space Programme should advise CGMS of these developments and lead a discussion of possible gaps in coverage at CGMS in 2006.

R&D satellites

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

Comment: Plans for Aeolus demonstration are proceeding on schedule, but there are no plans for operational follow on.

Progress: EUMETSAT is considering the requirements for observations of the 3D wind field as part of their planning for post-EPS missions. ESA plans to work with ECMWF to prepare for the assimilation of Doppler winds into NWP model and to give feedback as to their impact.

Next Actions: WMO Space Programme will discuss with space agencies, via CGMS and WMO Consultative Meetings on High-level Policy on Satellite Matters, to assure demonstration with Aeolus and initiation of operational systems for wind profile measurement. Plans for continuity of a Doppler Winds capability following Aeolus should be discussed by CGMS satellite operators in 2006.

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

Progress: TRMM continues to provide valuable data for operational use. Early termination of TRMM after 2004 was averted after user community appeals for its continuation. NASA has assured continued operation into 2009. At CGMS-XXXII, NASA, ESA and JAXA reported plans for a GPM mission in 2008 (now 2010). In 2005, ESA's European GPM was not selected as the next Earth Explorer Mission. At the fifth International planning workshop WMO expressed it support and its readiness to facilitate partnerships to expand the GPM constellation. It was recognized that ISRO's Megha-tropique has a passive microwave capability that is not yet part of the GOS but could be useful in the GPM constellation (availability needs to be confirmed). Other R&D and operational satellites in polar orbit may contribute to the constellation with their microwave radiometers.

Next Actions: WMO Space Programme is continuing discussions with space agencies, via CGMS and at CM, regarding plans for GPM.

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

Progress: CHAMP and SAC-C data have been available to some centres but not in near real time (NRT). NWP OSE has shown positive impact with small number of occultations. Climate applications are being explored. Near real time dissemination of CHAMP data is planned for 2006. Plans for near real time distribution of METOP/GRAS and COSMIC data are also in place.

Next Actions: Plan for operational follow-on to COSMIC should be drafted by CGMS in 2006. Plans for a shared ground support network should also be drafted by CGMS in 2006

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

Progress: EUMETSAT, NESDIS and WMO prepared a paper for CGMS on the International Geostationary Laboratory (IGeoLab) that would be a joint undertaking to provide a platform for demonstrations from geostationary orbit of new sensors and capabilities. Geo sub-mm is one of two systems being considered for IGeoLab. A task team evaluated the IGeoLab possibilities for a Geostationary Observatory for Microwave Atmospheric Sounding (GOMAS) as well as other possible instruments. This type of instrument in geosynchronous orbit is high priority for meeting existing user requirements in numerical weather prediction (NWP), nowcasting, hydrology and other applications areas. The task team is pursuing definition of feasible options for a geo sub mm instrument; the WMO Space Programme will seek partners for development of the recommended Geo sub mm instrument with space agencies and will report progress at CGMS. An IGeoLab Focus Group meeting was held on 24 October 2005 and the results were reported to CGMS XXXIII where the concept was endorsed.

GOMAS is a candidate for an ESA Explorer core mission, to be determined in mid-2006.

Next Actions: WMO Space Programme will continue dialogue with space agencies, via CGMS. .

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

Progress: ERS scatterometer data sets have provided monthly global soil moisture maps since 1991 at 50 km resolution. WindSat and AMSR-E are being studied for possible utility of 6 and 10 GHz measurements for soil moisture for sparsely vegetated surfaces. SMOS is scheduled for launch in late 2007. Aquarius is scheduled for launch in 2008 and Hydros in 2009.

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

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

Progress: The wave spectra from ENVISAT are available in near real time from an ESA ftp server. CSA's RADARSAT data are used in deriving ice products by the National Ice Center.

Next Actions: WMO Space Programme to discuss with space agencies, via CGMS, (1) broader access by WMO Members to ENVISAT SAR data, (2) availability of SAR data from other agencies, and (3) continuity of such missions. Assessment of status and plans should completed by CGMS in 2006.

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

Comment: Terra and Aqua carry the MODIS sensor that is providing global aerosol products over ocean and most land regions of the world at 10 km spatial resolution.

Additional R&D satellites currently providing aerosol optical thickness and optical properties include Terra/MISR, PARASOL, EP-TOMS, and Aura/OMI, CALIPSO will carry an R&D lidar for monitoring the vertical distribution of aerosols along the orbital ground track of the spacecraft, which is in the A-train orbit along with Aqua, PARASOL, CloudSat, and Aura. NASA's Glory mission (2008) as well as NPOESS has added APS, an aerosol polarimetry sensor. ESA and JAXA are preparing the Earthcare (cloud/aerosol mission) for launch in 2012.

Next Actions WMO Space Programme will continue discussions with space agencies, via CGMS and at CM, regarding availability of these data for operational use.

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

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

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

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

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

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

Progress: MIPAS and SCIAMACHY data are available in near real time from the ESA ftp server. NPP is scheduled to carry OMPS with ozone limb sounding in 2009.

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

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

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

S21. Lightning Observation – There is a requirement for space borne lightning observations. Several initiatives for operational implementation exist. These should be encouraged to fruition.

Comment: NASA's observations of lightning from OrbView-1/OTD and TRMM/LIS has demonstrated that 90% of lightning occurs over land, and that it is heavily tied to deep convection. In addition to its importance in severe storms and warnings for safety, lightning is an importance source of NO_X and thus contributes to elevated levels of tropospheric

ozone. The vision for the space-based component of the GOS approved by the Extraordinary session of CBS in 2002 included GEO lightning under the need for "Several R&D satellites serving WMO Members".

Progress: The dynamics of lightning occurrence and its importance for nowcasting has been recognized by NOAA that plans to include a lightning sensor on GOES-R in the future.

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

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

Comment: NASA has already demonstrated both a morning constellation (involving Landsat 7, EO-1, SAC-C, and Terra) and an afternoon constellation (Aqua, PARASOL, and Aura, soon to be joined by CloudSat (2006), CALIPSO (2006), and OCO (2008)). These multi-agency and multi-country constellations demonstrate the added value of coordination of Earth observations to make a polar orbiting system greater than the sum of the parts, but able to launch when sensors and spacecraft are ready and available.

Next Actions: The utility of data from sensors flying in formation need to be assessed.

ANNEX IV

Actions

1a. Secretariat to facilitate quarterly contact within ET-EGOS to check progress on workplan and IP next actions (March 2006 and thereafter).

1b. WWW Director to be requested to increase resources for the Secretariat to enable pursuit of IP actions regarding ground based sub-component of GOS in similar fashion to WMO SP pursuit of IP recommendations regarding space based sub-component of GOS. (ET-EGOS chair P. Menzel, Feb. 2006)

1c. Secretariat to provide acronym list for IP (Feb. 2006).

2. Obtain update from CIMO on in situ observation capabilities for characterizing UT and LS temperature and moisture. (R. Stringer, April 2006)

3. Request response from regional rapporteurs on progress with regard to the recommendations in the IP concerning ground based sub component of the GOS as appropriate to their region. Secretariat will approach the rapporteurs routinely to receive updates. (Secretariat, Jan. 2006)

4. Review and update CEOS/WMO database of ground based component observing system capabilities to assure consistency with recent CBS monitoring statistics (R. Stringer, Jun 2006)

5. Study the impact of all AMDAR data over southern and central Africa in Global NWP. (ET-EGOS chair P. Menzel request NWP centers, Feb. 2006). Get feedback from Met Office regarding requirements for vertical resolution in AMDAR observations and in particular layer averaging for humidity (S. Goldstraw, May 2006). Study the sensitivity to density (spatial and temporal) of in situ sea surface observations (pressure and wind) in an OSSE (ET-EGOS chair P. Menzel request NCEP, Jan. 2006).

6. Complete planning for a CBS/CAS expert meeting on optimized and targeted observations as requested by EC. Report to OPAG-IOS chair on progress. (S. Goldstraw, Feb. 2006).

7. Provide a draft letter for Chair OPAG IOS to contact the appropriate commission (that owns the user requirements) for each application area to request that they assume responsibility for the RRR process, confirm or nominate a PoC that will update the user requirements as appropriate, and maintain the SoG for that application area (Secretariat, Jan. 2006).

Global NWP	CBS / J. Eyre
Regional NWP	CBS / F. Rabier
Synoptic Met	CBS / E. Legrand
Nowcasting and VSRF	CBS / (PoC TBD via J. Schmetz)
Atmospheric Chem.	CAS / L. Barrie
Aeronautical Met	CAeM / H. Puempel
SIA Forecast	CBS / (PoC TBD via B. Strauss, chair OPAG DPFS)
Climate Variability	CCl / R. Heino
Climate Change	CCl / R. Heino
Ocean	JCOMM / H. Kawamura
Hydrology	CHy / W. Grabs
Agro Met	CAgM / M. Sivakumar

8. Establish contact with Chair of IPY Observing Working Group and establish information flow. (P. Menzel, Jan. 2006)

9. Contact OSE rapporteurs to start planning next NWP OSE Workshop for 2007 (ET-EGOS chair, Jan. 2006)

10. Request CAS to look into options for sustaining the AMMA network (J. Eyre, Jan. 2006).

11. In view of the report that there is a risk of a lack of sustained funding for the ARGO Programme as it moves from the developmental to operational phase, Secretariat to contact JCOMM regarding issues to sustain Argo network (Secretariat, June 2006)

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