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COMMISSION FOR BASIC SYSTEMS
OPAG ON INTEGRATED OBSERVING SYSTEMS

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DRAFT IMPLEMENTATION PLAN FOR THE GOS

(Submitted by the Secretariat)

Summary and Purpose of Document

The purpose of the document is to inform the Expert Team of the status of the draft implementation plan as prepared at ODRRGOS-6

ACTION PROPOSED

The meeting is invited to use this draft, where each of the 42 recommendations of the GOS was addressed, as input into the final version of the implementation plan.

Appendix: Annex IV to the Final Report of the Expert Team on Observational Data Requirements and Redesign of the Global Observing System – Sixth Session (ET-ODRRGOS-6) - Evolution of the GOS: towards an implementation plan

DISCUSSION

1. The ET-ODRRGOS, at its previous meeting in November 2003, started the draft of an implementation plan (see Annex 1), and each of the 42 recommendations for the evolution of the GOS was addressed. The ET at that meeting also stated that many of the next actions for implementation of the recommendations for the space based component of the GOS will require the WMO Space Programme to take them up with space agencies, via CGMS and WMO consultative meetings on satellite matters.

2. For the surface-based subsystem of the GOS, the ET recommended that different strategies of implementation were required for the different surface based components of the GOS. The ET also recommended that the implementation plan will be iterated monthly, with the goal that a final version of the implementation plan can be drafted at this current ET meeting.

3. Additionally, Congress XIV, in May 2003, supported the following views and conclusions of CBS on redesign issues:

(a) The rolling requirements review was readily applied to a diversity of application areas, provided the database of user requirements and observing system capabilities was accurate;

(b) Hypothetical changes to the GOS could be explored in OSEs with NWP centre assistance, provided data assimilation procedures were well understood and impact studies were conducted in a statistically-significant way. Present weaknesses and possible future improvement of data assimilation systems and NWP should also be taken into account when assessing the results of OSEs. Furthermore it was made apparent that the OSSEs required huge human and computer resources and were beyond the available resources;

(c) The future GOS should build upon existing components, both surface and space based, and capitalize on existing and new observing technologies not presently incorporated or fully exploited; each incremental addition to the GOS would be reflected in better data, products and services from the NMHSs;

(d) The impact of the changes to the GOS in the next decades was anticipated to be so massive that new revolutionary approaches for science, data handling, product development, training and utilization would be required. There was an urgent need to study comprehensive strategies for anticipating and evaluating changes to the GOS.

4. Congress also reiterated the view of the Executive Council that the structure of the future GOS and the implementation of new technologies should be driven by Members' requirements rather than by technological opportunities. It reaffirmed that new technologies should be implemented as soon as practical to replace older, more costly observing systems with a view to reducing expenditures. Congress noted the importance for the future GOS of the organization and implementation of observing systems envisaged by THORPEX. Congress requested CBS to continue vigorously its efforts in the redesign of the GOS, as a part of overall modernization of WWW systems.

5. The ET should take the above considerations into account when it prepares the GOS implementation plan.

ANNEX IV to the Final Report of ET-ODRRGOS-6

Evolution of the GOS: towards an implementation plan

Implementing the Recommendations for Evolution of Surface-Based Component of GOS

High-Priority General Recommendations

Data distribution and coding

1. Exchange internationally observational data not yet centrally collected but potentially useful in NWP, e.g., radar measurements to provide information on precipitation and wind, surface observations, including those from local or regional mesonets, wave buoys. Encourage WMO Members in regions where these data are collected to make them available via WMO real time information systems.

Next Actions: Request Members, via letter from WWW Secretariat to Regional Rapporteurs to IOS ICT, to provide information on data potentially available in this category. [The letter should request supply; alert potential users to plans; arrange training material]. ET-ODRRGOS to review input and consider which potentially available data merit further action.

2. Observations made routinely but not distributed should be made available (for example data with high temporal frequency should be distributed at least hourly). Recent studies have shown that 4D-Var data assimilation system or analysis system with frequent update cycles can make excellent use of hourly data, e.g. from SYNOPs, buoys, profilers, aircraft (AMDAR).

Note: OSE-1 provided justification for this recommendation.

Next Actions: (for SYNOPs (land and marine), buoys, profilers): WMO Members to implement this recommendation at the earliest possible date, no later than Nov 2005. (for AMDAR): See 8-11 below. The benefit of this implementation will be more rapid development.

3. Assure that all sources are accompanied by good documentation including metadata, careful QC, and monitoring.

Next Actions: [Actions are needed addressing problem areas for each data types. Actions should be specific and driven by user problems. What problems are preventing users from using data effectively?] (1) WMO (OPAG DPFS?) draft a letter to Members (NWP centres) requesting report of specific problems inhibiting effective use of available data. (2) ET-ODRRGOS to review responses.

4. Use coding standards that assure that the content (e.g. vertical resolution) of the original measurements, sufficient to meet the user requirements, is retained during transmission. Some current coding/formatting standards in the character codes degrade potentially useful information in meteorological reports. (Example (1) lost information at various levels in a rawinsonde sounding in the TEMP code could be retained in the BUFR code. Example (2) the vertical sounding taken over some 90 minutes and displaced from the starting position could be complemented by position and time information for each data point).

Note: The CBS decision to migrate to table driven and binary codes is relevant to this issue.

Next Actions: (1) WMO Members with the existing capability to implement this recommendation with respect to the vertical information in radiosonde measurements at the earliest possible date, but no later than Nov 2005. Other Members to develop plans to implement on an appropriate timescale. All Members to report to WMO on their plans in this area. (2) Revise appropriate Manuals to update reporting standards consistent with the above action. (3) ET-ODRRGOS to consider need for similar changes for other observation types (e.g. profilers) plans.

Broader use of ground based and in situ observations

5. Calibration of measurements from satellites depends on using ground-based and *in situ* observations, such as ozone profiles from 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. [Joint ECMWF / WMO expert team meeting on real time exchange of ground based ozone measurements, ECMWF, 17-18 October 1996]

Next Action: WMO Members making ozone profile measurements to place data on the GTS as near to real time as is feasible (but no later than 24 hours) in CREX format at the earliest possible date. Members to inform WMO of their implementation plans.

Moving towards operational use of targeted observations

6. Transfer into operations the proven methodology of observation targeting to improve the observation coverage in data sensitive areas. This concept is in operational use at the US Weather Service in the north-eastern Pacific during the winter storm period. EUCOS is planning field experiments in the Atlantic, in the context of a THORPEX study. Designated major operational centres should share the responsibility for determining the target areas. [FASTEX results and Toulouse report]

Next Actions: (1) With a strategy to learn from THORPEX, CBS representatives to request THORPEX to provide CBS with a strategy for an operational targeted observing system. CBS representative to THORPEX ICSC meeting (Dec 2003) to bring this forward [including meteorological situations in which targeting could be useful, observing systems to be activated]. (2) ET-ODRRGOS to request a study to survey and compile information on activities and results associated with use of in situ observation systems for targeting purposes that have taken place in the past.

High Priority System Specific Recommendations

Optimization of rawinsonde launches

7. 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. [EUCOS Studies, OPAG IOS Chairman]

Next Actions: ET suggestion to WMO to request a WMO funded-study, to develop guidelines of issues to be considered (e.g. local weather phenomena, local times of 0000 and 1200 UTC observations, other observations available, costs) when optimizing local/regional launch schedules for radiosondes. This should consider initiating a local study

Development of the AMDAR programme

8. AMDAR technology should provide more ascent/descent profiles, with improved vertical resolution. A good way to accomplish this is to extend the AMDAR programme to short-haul commuter flights, business aviation, and air freight. Emphasis should be to expand into areas where vertical profile data from radiosondes and pilot balloons are sparse a well as into times that are currently not well observed such as 11 pm to 5 am local times. [Toulouse report, ECMWF northern hemisphere AMDAR impact study, OSEs 4, 5, 8]

Note: The AMDAR Panel plans to (1a) continue to support the South African Weather Service to extend the Southern Africa Pilot Project to a regional programme under SADC; (1b) monitor and

provide technical support to the ASECNA programme in collaboration with the EUMETNET AMDAR; (1c) coordinate and/or implement targeted AMDAR observations programmes as opportunities arise; (1d) provide information, guidance and monitor progress on alternative AMDAR systems (e.g. TAMDAR, MDS, AFIRS, Cell phone technology). (AMDAR TC and Panel Members).

Next Actions: ET-ODRRGOS to (2a) continue to monitor progress of the AMDAR Programme in above activities; and (2b) ET-ODRRGOS recommend that several OSEs be undertaken, if possible. One OSE is required to assess (i) the potential impact on NWP predictions of a substantial increase in AMDAR data in a data sparse region; (ii) the relative impact with respect to a single conventional upper station given the availability of these AMDAR data; (iii) the study should last for a period of at least 3 months; (iv) the study should be completed by the end of 2006. Specifically, the first OSE to be undertaken should be over the South Africa region as representative of a data sparse area. Assistance could be provided by the AMDAR Panel and the South African Weather Service in providing guidance on enhancing AMDAR coverage through a data coverage and frequency analysis over the next 2 to 3 years.

9. 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. Moreover, the timing and location of reports, whose number is potentially very large, can be optimized while controlling communications costs. The recommendation is to 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. [Toulouse report, ECMWF northern hemisphere AMDAR impact study]

Note: The AMDAR panel is planning to assist more countries to become involved in AMDAR programmes by (1a) initiating new developing programmes in Saudi Arabia, Canada, Chile, China, Hong Kong China, Japan, and the Republic of Korea, and (1b) planning programmes in Argentina, Finland, Morocco, Russian Federation, United Arab Emirates and a group of Central and Eastern European countries. Further the AMDAR panel is planning to improve the effectiveness of existing programmes by assisting in (2a) development of data optimization systems to improve cost effectiveness and coverage; (2b) data targeting in data sparse areas, (2c) further developments in quality monitoring and control of data exchanged on the GTS; (2d) development of new AMDAR systems based on alternative technologies including TAMDAR; (2e) improvements to onboard software and the development of new international standard software specifications.

Next Action: ET-ODRRGOS to review progress of the AMDAR programme.

10. Lower-tropospheric water vapour measurements are vital in many forecast applications. To supplement the temperature and wind reports from AMDAR, the further development and testing of water vapour sensing systems is strongly encouraged. Example: WVSS-2 employs a laser diode to measure the absorption by water vapour of energy in the laser beam over a short path length. This is an absolute measurement of water vapour content that is expected to be accurate from the ground to flight altitudes. [Toulouse report]

Note: AMDAR Panel is planning to continue to monitor and support development of new measurements and sensors including humidity. Examples include providing assistance to: (i) evaluation of the most recent US WVSSII sensor by NCAR and NWS; (ii) operational evaluation trials of the TAMDAR humidity sensor in the US, France and Canada; (iii) evaluation trials of the UK humidity sensor in collaboration between Cambridge University and the Met Office; (iv) evaluation trials of the MOZAIC humidity sensor in collaboration between DWD and DLR]

Next Action: ET-ODRRGOS to monitor progress associated with development of new sensors and technology particularly in relation to water vapour measurement.

Tropospheric Aircraft Meteorological Data Reporting (TAMDAR)

11. TAMDAR could potentially supplement 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. The development of the TAMDAR system should be monitored with a view towards operational use.

Note: EUCOS Programme Plans are very relevant here.

Next Action: ET-ODRRGOS to review progress under AMDAR and EUCOS Programmes.

Ground based GPS

12. Develop further the capability of ground-based GPS systems for the inference of vertically integrated moisture with an eye toward operational implementation. Distribute globally the measurements of total column water vapour from available and emerging ground based GPS systems for use in NWP. Such observations are currently made in Europe, North America and Asia. I t is expected that the global coverage will expand over the coming years.

Note: The COSNA/SEG, NAOS, JMA reports provide useful background information.

Next Actions: (1) WMO Members with the existing capability to implement this recommendation with respect to the vertical information in measurements at the earliest possible date, but no later than Nov 2005. Other Members to develop plans to implement on an appropriate timescale. All Members to report to WMO on their plans in this area. (2) Revise appropriate Manuals to update reporting standards consistent with the above action. (3) ET-ODRRGOS to consider need for similar changes for other observation types (e.g. profilers)

Regarding improved observations in ocean areas

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

Note: The EUCOS programme plan provides background for actions in this area.

Next Action: ET-ODRRGOS request a review from JCOMM on the current status and plans of ASAP in next 6 months. Follow AMDAR philosophy in making these sort of data available.

14. Considering the envisaged increase in spatial and temporal resolution of *in situ* marine observing platforms and the need for network management, either increase the bandwidth of existing telecommunication systems (in both directions) or establish new relevant satellite telecommunications facilities for timely collection and distribution. Examples include drifting buoys, profiling floats, XBTs.

Note: 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.

15. For both NWP (wind) and climate variability/climate change (sub-surface temperature profiles), it is recommended to extend the tropical mooring array into the tropical Indian Ocean at resolution consistent with what is presently achieved in the tropical Pacific and Atlantic Oceans.

Note: 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

16. Ensure adequate coverage of wind and surface pressure observations from drifting buoys in the Southern Ocean in areas between 40S and the Antarctic circle based upon 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.

Note: The Toulouse report and the ET-ODRRGOS OSE study provide background for actions in this area. 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)

17. 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.

18. For NWP purposes, increase coverage of ice buoys (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.

Improved observations over tropical land areas

19. Enhance the temperature, wind and if possible the humidity profile measurements (from radiosondes, pilots and aircraft) in the tropical belt, in particular over Africa and tropical America. 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. [OSE-5]

Action: (see AMDAR plans)

New Observing Technologies

20. Demonstrate the feasibility of ground based interferometers and radiometers (e.g. microwave) to be an operational sub-system providing continuous vertical profiles of temperature and humidity in selected areas.

Action: ET-ODRRGOS to review advances in technology and user requirements. [Update of TD 1040]

21. Demonstrate the feasibility of Unmanned Aeronautical Vehicles (UAVs) to be an operational sub-system.

Action: ET-ODRRGOS to review advances in technology and user requirements. [Update of TD 1040]

22. Demonstrate the feasibility of high altitude balloons to be an operational sub-system

Action: ET-ODRRGOS to review advances in technology and user requirements. [Update of TD 1040]

Additional Recommendation for Evolution of the GOS

1. Support well-resourced studies of re-designed observing systems.

Next Actions: ET-ODRRGOS indicate support EUCOS plans (how?) and monitor similar activities elsewhere.

Implementing the Recommendations for Evolution of Space-Based Component of GOS

Calibration

1 Recommendation: "A major issue for effective use of satellite data, especially for climate applications, is calibration. There should be more common spectral bands on GEO and LEO sensors to facilitate intercomparison and calibration adjustments; globally distributed GEO sensors can be intercalibrated using a given LEO sensor and a succession of LEO sensors in a given orbit (even with out the benefit of overlap) can be intercalibrated with a given GEO sensor. The advent of high spectral resolution infrared sensors will enhance accurate intercalibration."

Next Action: OPAG IOS ask CGMS to recognize this activity as the heart of the GCOS monitoring principles and request initiation of routine intercalibration of all GEO infrared sensors (both operational and R&D) as well as evolved microwave sensors (MSU transitioned to AMSU).

GEO satellites

2 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.

Next Action: WMO Space Programme to discuss with space agencies, via CGMS and WMO consultative meetings on high-level policy on satellite matters.

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

Next Action: WMO Space Programme to discuss with space agencies, via CGMS and WMO consultative meetings on high-level policy on satellite matters.

4 GEO Imagers and Sounders - 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.

Next Action: WMO Space Programme to discuss with space agencies, via CGMS and WMO consultative meetings on high-level policy on satellite matters

LEO satellites

5 LEO data timeliness - More timely data are needed. Improved communication and processing systems are required to meet the timeliness requirements in some applications areas (e.g. Regional NWP).

Next Actions: (1) WMO Space Programme to request space agencies, via CGMS, to improve current processing and data systems in line with updated user requirements; (2) ET-SSUP, in consultation with ET-ODRRGOS, to review progress and plans for EUMETSAT ATOVS Retransmission System, and to consider whether it should be extended to other parts of world and to other satellite instruments/systems and to alternative data transmission systems.

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

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

7 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. 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.

Next Action: WMO Space Programme, via CGMS and the WMO consultative meetings on high-level policy on satellite matters, to request assessment of Windsat performance

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

Next Action: WMO Space Programme to discuss with space agencies, via CGMS and WMO consultative meetings on high-level policy on satellite matters

9 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.

Next Action: WMO Space Programme to discuss with space agencies, via CGMS and WMO consultative meetings on high-level policy on satellite matter.

R&D satellites

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

Next Action: WMO Space Programme to discuss with space agencies, via CGMS and WMO consultative meetings on high-level policy on satellite matters

11 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.

Next Action: WMO Space Programme discuss with space agencies, via CGMS and WMO consultative meetings on high-level policy on satellite matters

12 RO-Sounders - To complement the METOP and NPOESS radio-occultation sounders, the opportunities for a larger constellation should be explored and expanded operational implementation planned. International sharing of ground network systems (necessary for

accurate positioning in real time) should be achieved to minimize development and running costs.

Next Action: WMO Space Programme to discuss with space agencies, via CGMS and WMO consultative meetings on high-level policy on satellite matters

13 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.

14 LEO MW - The capability to observe ocean salinity and soil moisture for weather and climate applications (possibly with only limited horizontal resolution) should be demonstrated in a research mode (as with ESA's SMOS and NASA's OCE) 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.

15 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, land surface cover.

16 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.

17 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.

18 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.

19 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.

20 Active Water Vapor 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 Action: (Recommendations 13-20): WMO Space Programme to discuss with space agencies, via CGMS and WMO consultative meetings on high-level policy on satellite matters

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