

READING, UK, 4-7 SEPTEMBER 2007

**WIGOS: TOWARDS ENHANCED INTEGRATION BETWEEN  
THE WMO OBSERVING SYSTEMS**

*(Submitted by Secretariat)*

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**SUMMARY AND PURPOSE OF DOCUMENT**

This document provides a summary of the emerging concept of WIGOS as agreed by Fifteenth Congress and EC together with CBS-MG considerations.

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**ACTION PROPOSED**

Take note of the WIGOS development and address relevant support from WIS and actions from ICG-WIS.

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- References:**
1. Provisional Report with Resolutions from the Fifteenth Congress;
  2. Provisional Report with Resolutions from the Fifty-ninth Executive Council;
  3. Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session 2006 of the Commission for Basic Systems (WMO-No. 1017);
  4. Final Report of the seventh session of the CBS Management Group, Geneva, Switzerland, 18-20 June 2007.

- Appendices:**
- A. Cg-XV/PINK 7.4(3), APPENDIX A (Draft text for inclusion in the general summary of Cg-XV).
  - B. Extract from the 3<sup>rd</sup> meeting of the Expert Team on Evolution of the Global Observing System (ET-EGOS), Geneva, Switzerland, 9 - 13 July 2007.

## **DISCUSSION**

1. The present document provides a brief overview of the WIGOS concept which has been agreed during the last session of Congress, the Executive Council and the CBS Management Group (CBS-MG).

### **Fifteenth WMO Congress**

2. Cg-XV PINK 7.4(3), "Towards Enhanced Integration between the WMO Observing Systems" (Appendix A) provides a comprehensive discussion of the integrated observations initiative; it includes: a definition of integration; objectives of the integrated observations initiative; general considerations and recommendations from Cg-XV; policy and governance guidance and direction for a roadmap leading to future decisions by Congress-XVI.

3. A brief summary: Congress agreed to work towards enhanced integration between the WMO observing systems and decided to refer to it as WIGOS (WMO Integrated Observing Systems). Congress identified a number of possible projects that could be used to test concepts, identify problem areas and to help in elaborating the WIGOS over-arching Development and Implementation Plan. These include: Integration of WWW/GOS and GAW, Integration of AMDAR into the GOS, Integration of WHYCOS into WIGOS, Integration of marine meteorological and other appropriate oceanic observations into the WIGOS. (It was also suggested that a partial overlap of the session of CBS and CAS might help to address the GAW/GOS integration and should be taken into consideration in the planning of the forthcoming sessions.)

### **Fifty-ninth Executive Council**

4. The Executive Council established an "Executive Council Working Group on the WMO Integrated Global Observing System (WIGOS) and the WMO Information System (WIS)" to steer and monitor the activities and to coordinate with the planning and development of WIS. There is a tentative plan to convene the EC WG before the end of 2007; Presidents of Technical Commissions would be invited. Purpose of the first meeting would be to develop the strategies and framework for a WIGOS development and implementation plan.

### **CBS-MG-7**

5. The CBS-MG at its seventh session address the topic of WIGOS and decided that CBS through OPAG-IOS should take a leading role within CBS in the technical development and planning of integrated observing systems with a view to a cost-effective and flexible system of systems that can meet in an optimal way the requirements of all WMO Programmes.

6. The MG reviewed PINK 7.4(3) from Cg XV which gives direction to WMO to pursue the integrated observations initiative as Expected Result 4 of the WMO Strategic Plan. It was noted that this is a complex initiative. It was further noted that there is a critical link between the WIS programme, for which CBS is the lead, and the proposed WIGOS programme, which will be steered and monitored by an EC Working Group on WIS-WIGOS. In this regard, the meeting noted that the ICG-WIS will report to the EC WG- WIGOS/WIS. The MG further noted that the Congress document provides only general guidance on WIGOS "what, when and by whom".

8. After an extended discussion, the MG agreed that CBS should move proactively to support the EC WG WIS-WIGOS with CBS input for the planned meeting, taking into consideration the existing Commission work programme. The MG decided to form a CBS Task Team composed of the CBS President, Vice President, the OPAG IOS and ISS Chairs and the Director of the World Weather Watch Department. The objective of the Task Team will be to prepare input the CBS President can submit as input to the EC WG WIS-WIGOS. The MG agreed the input would include:

- CBS assessment of the WIGOS concepts as described in the reports prepared by Dr Jim Rasmussen and B. Gen. Massimo Capaldo on this initiative; Assessment should include review of definition, such as definition of integration and potential impact of the integration on the WMO structure, particularly WWW;
- CBS recommendations drawn from existing relevant plans and documents, such as the WMO's submission to GEOSS plan and the WIS Implementation Plan;
- A proposal developed jointly with CAS for a pilot project to unify access to GOS-GAW information in a system of systems architecture – include proposed scope, levels of integration and timetable;
- A proposed outline for the WIGOS Implementation Plan;
- Following the presentation on the Flash Flood Guidance System (FFGS), the MG agreed that this could constitute a cross-cutting pilot project on WIGOS. It comprises both surface and space based GOS as well as the hydrological networks with a significant input needed from CIMO. Collaboration on this project is also expected from other WMO programmes, such as AREP, WCRP and DPFS;
- A WIS document/briefing describing WIS as the foundation for WIGOS data management, access and distribution – include key WIS milestones and resource shortfalls.

10. The ICG-WIS is invited to note the objectives of the integration process as laid down in Cg-XV/PINK 7.4(3) with a view to developing WIS support and services to meet requirements for WIGOS data management, access and distribution, and ICG-WIS contribution to the EC WG on WIGOS-WIS.

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**(Cg-XV/PINK 7.4(3), APPENDIX A)**

**DRAFT TEXT FOR INCLUSION IN THE GENERAL SUMMARY OF Cg-XV**

**7.4 EVOLUTION OF NMHSS AND WMO** (*agenda item 7.4*)

**Towards Enhanced Integration between the WMO Observing Systems**

***Introduction***

**7.4.x.1** Congress recalled that one of the objectives of the WMO Space Programme as adopted in the Sixth WMO Long-term Plan, was to review the space-based components of the various observation systems throughout WMO and WMO-supported Programmes with a view towards the development of an integrated WMO global observation system that would encompass all present WMO observation systems. Congress also recalled that the Executive Council concluded that the enhanced integration between the WMO observation systems should be pursued as a strategic objective of WMO and proposed it as one of the eleven major Expected Results for the fifteenth financial period (2008-2011) as reflected the WMO Strategic Plan, WMO Secretariat Operating Plan and the Result-Based Budget. Congress noted that by Resolution 13 (EC-LVIII) the Council had established the Executive Council Task Team on the Integration of WMO Observation Systems <sup>1/</sup> and charged it with developing a report to this session of Congress on the subject. That report should facilitate decision-making by Congress on the range and depth of the integration and how it should be pursued, and should take full account of the technical characteristics, policy and governance aspects of all relevant observation systems.

**7.4.x.2** Congress received with appreciation the report by the chairman of the Task Team, General M. Capaldo (Italy). Congress was pleased to note that the Task Team acknowledged the outstanding contributions provided by all WMO Members, operating at times under very difficult circumstances, in implementing and maintaining the many observing systems that support the WMO scientific and technical programmes and which are the fundamental backbone of the wide range of services and scientific research carried out by Members and the international community.

***Integration***

**7.4.x.3** Congress agreed that integration in the context of WMO global observing systems should be defined as establishment of a comprehensive, coordinated and sustainable system of observing systems, ensuring interoperability between its component systems, and aiming to:

- (a) Address in the most cost-effective way all of the WMO Programme requirements with a view to reducing the financial load on Members and maximizing administrative and operational efficiencies;
- (b) Ensure the availability of the required information produced within the various WMO observing systems (e.g. GOS, GAW, etc.), and the WMO components of co-sponsored systems (e.g. GCOS, GOOS etc.) with particular emphasis on information generated by satellite, radar, wind-profilers, aircraft systems, ARGO, and other new technology systems;

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<sup>1</sup> The Task Team was comprised of two members of the Executive Council and the presidents of the WMO technical commissions including JCOMM; it included also representatives from the Steering Committees for GCOS and GOOS, the JSC for WCRP, and space agencies of China and the USA, who attended as invited participants.

- (c) Facilitate the access, in real/quasi-real time, to observations required for WMO and WMO co-sponsored programmes and relevant international conventions, but which are generated by systems implemented and managed by cooperating agencies, organizations and programmes;
- (d) Ensure required data quality standards are met and sustained for all programme requirements;
- (e) Facilitate archiving and technological innovation.

**7.4.x.4** Congress envisaged that the integration process should encompass four broad objectives:

- (a) Improving management and governance (use of resources, planning, institutional and programme structures, and monitoring);
- (b) Increasing interoperability between the various systems with particular attention given to the complementarity between the space-based and *in-situ* components of the systems;
- (c) Addressing the domains (atmospheric, oceanic and terrestrial including hydrological) as a comprehensive total system;
- (d) Ensuring that broader governance frameworks (e.g. inter-agency co-sponsorship of systems) and relationships with other international initiatives (e.g. GEO) are respected, sustained and strengthened.

#### **General considerations and recommendations**

**7.4.x.5** Congress emphasized that working towards enhancing integration between the WMO global observing systems should proceed in parallel with the planning and implementation of the WMO Information System (WIS). The combination of both efforts would allow for an integrated WMO end-to-end system of systems designed to improve Members capability to effectively provide a widening range of services and to better serve research programme requirements. Congress noted that the parallel development would have an impact on the structure and functions of WMO, including aspects of:

- (a) WMO Technical Regulations;
- (b) Data policy;
- (c) The roles, terms of reference, and working arrangements of the technical commissions;
- (d) The WMO programme structure;
- (e) The WMO Secretariat.

**7.4.x.6** Congress further noted that the networks and subsystems that comprise the WWW/GOS and that focus primarily on the observations required to support the provision of weather services will naturally be a major component of the future integration. In addition there are many observing systems that have developed over the years, often initially as research stations or arrays of sensors supporting broader environmental and/or research applications, but which have matured beyond the experimental stage and have reached a more operational status in response to a scientific or service requirement. The integration process should ensure the continued

partnership and participation of the bodies responsible for these observing systems (including the World Data Centres) as they become part of an integrated system of systems with sustained sense of ownership.

**7.4.x.7** Congress appreciated that integration would offer the opportunity for including hydrological networks in that process thus allowing WMO to more effectively respond to climatological requirements as expressed, for example, through the GCOS implementation plan, and to contribute to the broader environmental concerns regarding global fresh water resources.

**7.4.x.8** Congress emphasized that the integration should be undertaken to accommodate the diversity among Members with respect to their capabilities and needs. An objective of the integration initiative should be to plan for adequate guidance material, training programmes and focused technical assistance projects to ensure that all Members benefit from the effort.

**7.4.x.9** Congress noted that the growing multi-disciplinary applications of observations from the various individual component systems often place more stringent requirements on the accuracy and resolution of the instruments and sensors, and often require adjustments in the operation of the networks and arrays and the sharing of information. The integration process would allow these data quality issues to be addressed in a comprehensive coordinated way.

**7.4.x.10** The increasing reliance on space-based observations in virtually all application areas places a growing emphasis on the long-term quality, continuity and homogeneity of the data from multiple satellite operators. Research or experimental satellite-borne sensors often provide crucial data for applications and services; this is especially the case for ocean observations. Therefore, Congress expected that the integration of the WMO observing systems would provide a mechanism for assembling, and continually up-dating, a coherent and integrated set of requirements for the satellite operators and fostering more effective integration of satellite and *in-situ* observations.

**7.4.x.11** Congress emphasized the crucially important role played by the WMO regional associations in the implementation of observing systems. While the integration may have a positive impact on them through the consolidation of individual systems into a single observational focus, thereby reducing the complexity of global programme support structures and activities, the important regional implementation role of the regional associations will be mandated and strengthened.

### ***Benefits and challenges***

**7.4.x.12** Congress noted that potential benefits of the integration to the Organization and to Members themselves would fall into four categories:

- (a) Improved services;
- (b) Increased quality and access to observations;
- (c) More efficient use of resources;
- (d) Better preparedness to incorporate new observing systems and to interface with non-WMO systems.

**7.4.x.13** Congress also identified potential risks and challenges associated with embarking upon enhancing the integration between the WMO observing systems, which include:

- (a) The cross cutting nature of the overall project will require unprecedented cooperation and coordination efforts by all concerned;

- (b) Time will be a critical risk factor. The development of a detailed, comprehensive Implementation Plan and the elaboration of meaningful Pilot Projects need to be addressed early in the period;
- (c) Effective and constructive coordination and collaboration with co-sponsoring and cooperating Organizations is a sensitive issue that must be carefully undertaken to avoid misunderstandings.

### ***Policy and governance***

**7.4.x.14** Congress joined the view of the Council in assessing the integration as a complex undertaking, which would comprise policy as well as technical issues, stretch over several years, and would require the full support of all Members to be successful. The integration would actively involve and eventually depend on the consensus inputs from the technical commissions, regional associations and the Steering Committees of GCOS, GOOS, GTOS and WCRP. It would require the approval of the Council, and eventually of Congress, for major phases.

**7.4.x.15** Congress agreed to invite the Council to establish an overview mechanism to steer and monitor the activity and to achieve the broadest possible collaboration and cooperation. It proposed the establishment of an EC working group or similar body with membership comprising representatives of the principal bodies concerned and also the participation, as appropriate, of technical experts and representatives of agencies undertaking co-sponsored observing initiatives. That body should ensure that the planning for this complex undertaking is meeting its objectives and stays on target. This mechanism should be closely coupled with the institutional arrangements for planning and overseeing WIS.

**7.4.x.16** Congress stressed the significance of cross-cutting coordination and collaboration among the technical commissions and regional associations, and agreed that steps be taken to ensure the programme-wide nature of integration initiative would be accommodated in the in work programmes.

### ***Roadmap***

**7.4.x.17** Congress agreed that planning and implementation of the integration process should proceed in phases defined by the annual meetings of the Council in order to assure oversight, review and direction. The process foreseen is one where planning and implementation of an integrated WMO observing system and of the WIS would culminate with Cg-XVI (2011) adopting improvements towards strengthening the WMO programme structure and the system of technical commissions, which would be positioned to extend the benefits of the integration into the service and application components of the overall WMO Programmes at both the national and international levels.

**7.4.x.18** Congress agreed further that the integration process would centre initially upon the preparation of an over-arching Development and Implementation Plan. The plan should be kept up-to-date through a "rolling review" mechanism. It should also serve as the source of information on the integration initiative for all Members and in particular the developing countries. Several "Pilot Projects", as proposed by the EC Task Team, should be designed to test concepts, identify problem areas, and to help in elaborating the Plan. Possible candidate Pilot Projects include:

- (a) Integration of WWW/GOS and GAW;
- (b) Initiation of a Global Hydrologic network addressing a GCOS requirement;
- (c) Elaborating the underpinning/crosscutting role and responsibilities of the Instruments and Methods of Observation Programme;

- (d) Integration of AMDAR into the WMO global observing systems;
- (e) Integration of marine meteorological and other appropriate oceanic observations into the WMO global observing systems.

**7.4.x.19** In conclusion, Congress stressed that enhanced integration between the WMO observing systems was expected to generate important benefits for Members, their NMHSs and for the Organization as a whole. It would also be an important element in the efforts towards a crosscutting approach on topics of interest to the Organization. With reference to Expected Results 4 (Integration of WMO observing systems) and 5 (Development and implementation of the WMO Information System (WIS) given in the WMO Strategic Plan, Congress agreed to refer to this initiative by the acronym WIGOS (WMO Integrated Global Observing Systems). It placed a high priority on this endeavour and adopted Resolution 7.4/1.



**DRAFT RESOLUTION**

**Res. 7.4/1 (Cg-XV) - TOWARDS ENHANCED INTEGRATION BETWEEN WMO OBSERVING SYSTEMS**

**THE CONGRESS,**

**Noting:**

- (1) Article 2 of the *WMO Convention* (WMO-No. 15),
- (2) *Sixth WMO Long-Term Plan 2004-2011* (WMO-No. 962),
- (3) WMO Strategic Plan 2008-2011 and Beyond,
- (4) *Abridged Final Reports with Resolutions of the Fourteenth World Meteorological Congress, and the Fifty-sixth, Fifty-seventh and Fifty-eighth Sessions of the Executive Council* (WMO No. 960, WMO-No. 977, WMO-No. 988, and WMO-No. 1007, respectively),
- (5) Report of the EC Task Team on WMO Integrated Observing Systems (Geneva, 31 January –2 February 2007),

**Considering:**

- (1) That all WMO constituent bodies, international Steering Committees and numerous subsidiary expert-level groups provide a complex framework for coordination and collaboration in which a large number of decision makers and experts from virtually all countries and partner organizations address matters related to the observation systems,
- (2) That an enhanced integration between the WMO observing systems could have the potential to lead to important benefits for Members and their National Meteorological and Hydrological Services and the Organization as a whole.

**Appreciating** the important contributions international partner organizations and programmes make towards observing the Planet Earth.

**Recognizing:**

- (1) That working towards enhancing integration between the WMO observing systems will be a major effort of the Organization and should proceed in parallel with the planning and implementation of the WMO Information System (WIS) to allow for an integrated WMO end-to-end system of systems designed to improve Members capability to effectively provide the widening range of services and to better serve research program requirements,
- (2) That this endeavor would have an impact on the structure and functions of WMO, including aspects of the WMO Technical Regulations, data policy, roles, terms of reference, and working arrangements of the technical commissions, the WMO Programme structure, the WMO Secretariat,
- (3) That the integration process would be a complex undertaking that would not be free of risks, stretch over several years and require the full support of all Members to be successful,

**Decides** to embark on enhancing the integration between the WMO observing systems;

**Urges** Members and **Invites** international partner organizations and programmes to collaborate actively in, and give all possible support to, development and implementation of this initiative;

**Requests:**

- (1) The Executive Council to:
    - (a) Establish a mechanism to steer and monitor the activity and to achieve the broadest possible collaboration and cooperation;
    - (b) Ensure the active participation and representation of the principal bodies concerned and also the participation, as appropriate, of technical experts and representatives of agencies undertaking co-sponsored observing initiatives;
    - (c) Ensure that this mechanism is closely coordinated with the institutional arrangements for planning and overseeing WIS;
    - (d) Submit a comprehensive report on the integration between the WMO observing systems to the Sixteenth WMO Congress;
  - (2) The regional associations and technical commissions to include this activity in their work programmes in order to fully accommodate the cross-programme nature of the integration initiative;
  - (3) The Secretary General to:
    - (a) Strengthen coordination and collaborate closely with relevant international partner organizations and programmes in pursuing this endeavour;
    - (b) Arrange for adequate resources to support the integration initiative;
    - (c) Adapt the structure of the Secretariat as and when appropriate, so as to ensure optimal management of and support to the initiative.
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## **WMO Integrated Global Observing System (WIGOS)**

### **1. Introduction**

The ET-EGOS was invited to address the objectives of the process for developing WIGOS as set out in Cg-XV/PINK 7.4(3), with a view to:

- Assessment of the WIGOS concepts;
- Further specification of the proposed roadmap;
- Providing guidance for the development of concepts and plans for pilot projects;
- Starting the preparation for the WIGOS Implementation Plan.

ET-EGOS discussed its role within the WIGOS development process. It stressed the importance of ensuring that initial projects have easily understandable benefits for WMO Members, and hence the advantage in focusing the projects on specific improvements in the availability of observations in response to identified user requirements. ET-EGOS appreciated that many of the long-term benefits of WIGOS would come from improvements in high-level system architecture and data management. The proposals for initial projects do not focus on these aspects. However, ET-EGOS expects the proposed pilot projects to be good vehicles for developments in improved architectures and procedures, in concert with WIS developments.

It is proposed to initiate pilot projects under four headings:

- Improved access to observations of atmospheric composition
- Improved access to marine observations
- Improved access to aircraft observations
- Improved access to observations for the hydrological user community

### **2. Improved access to observations of atmospheric composition**

The emphasis currently of GAW is mainly on surface monitoring of the atmospheric composition. However, the mandate of GAW includes the integration of satellite and aircraft observations with surface measurements, as well as the integration of chemical data and numerical models. GAW observations are archived and made available by World Data Centres. The purpose of these is to collect and archive processed GAW data, to make them publicly available, and to provide support in the quality assurance, analysis and interpretation of these data for scientific advances and policy decisions. There is a growing need for the near real time data delivery, which GAW is addressing.

The services for operational, time-critical applications in atmospheric chemistry need to be defined and coordinated so that GAW and other environmental observational data are available to users online and when possible, in near real time. It is expected that integrated weather/climate-chemistry modelling systems will provide new classes of products and also improve the quality of conventional weather forecasting. Such systems require enhancement of global near real time transmission of chemical observations to support the assimilation component of the forecasting systems.

**Pilot project 2.1** Improve the dissemination of ozone (total column, profiles and surface) and aerosol observations on the GTS/WIS.

Motivation: Ozone and aerosol observations from the GAW network are needed for ingestion into atmospheric models, via data assimilation techniques, in support of improved forecasts of weather, surface UV and air quality. To be useful, the data must be disseminated in near real time, which will benefit in addition such products as the Ozone Bulletins. This project will contribute to the design of activities that enhance the transfer of GAW data in near real time through GTS/WIS in partnership with the GAW Expert Team on

Near Real Time Data Transfer (ET-NRT CDT). This project supports Task 6.1 of the GAW Strategic Plan and Recommendation G6 of the EGOS-IP. The project will be carried out in collaboration with GEMS.

Goal: To expand significantly the number of stations submitting ozone and aerosol observations to operational users in near real time via GTS/WIS.

**Pilot project 2.2** Map the current situation of GAW data providers and review the existing services and tools.

Motivation. Considering the increasing number of stations reporting data, and an increasing number of parameters on which data are reported, the burden on both data submitters and the data centres needs to be reduced. This needs to be reconciled with the need to extend the amount of metadata. In addition data providers are often submitting data to many different data centres that may require different formats. This project will provide a quantitative understanding of the different databases/formats the data providers need to support. The information will be used for simplification of data submission procedures.

A review of provided services and tools is also necessary. The assessment performed within the GSE PROMOTE project on ozone, UV, greenhouse gases, and air quality services can be used as background information for developing services.

The users of data will benefit as they will have access to more data and better services as a result of simplified submission procedures.

This project supports the GAW Strategic Plan. It will be carried out in collaboration with PROMOTE (ESA) and DLR.

Goal: To simplify the data submission processes of data providers in order to increase the submission of data, preferably in near real time, for better access by data users.

**Pilot project 2.3** Develop a Vision for a satellite constellation for atmospheric composition

Motivation. Space based observations are an important component of an integrated global atmospheric chemistry observing system. They are especially beneficial in providing information in remote areas, particularly over oceans and continental areas where there are gaps in GAW's surface-based monitoring network. Satellite observations of atmospheric composition are expensive. It is beyond the resources of any one Member or agency to provide the observations needed to meet stated user requirements; requirements will only be met through coordinated planning of an international constellation of satellite missions/instruments.

This need was identified at the Workshop on the Re-design and optimization of the space-based GOS (OPT-2, Geneva, June 2007) and supports the IGACO strategy and Tasks 3.13 and 3.16 of the GAW Strategic Plan.

Goal: To create a high-level Vision of the constellation of satellite missions/instruments for atmospheric composition, through collaboration between GAW, WMO Space Programme and CEOS.

### **3. Improved access to marine observations**

**Pilot project 3.1** Promote the interoperability of ocean data systems with the WMO Information System (WIS) in close cooperation with the ocean community.

Motivation. This should eventually permit access to meteorological and oceanographic data to serve a number of applications, including climate in an integrated way via the WIS, hence facilitating access to properly documented and standardized data-sets.

The case will have to be made with the oceanographic community in order to show the benefit of such an integration to ocean data users. Some of the existing observing systems that are not currently reporting onto the GTS will also be encouraged to submit their data in real time through the WIS. (This should be easier to realize than with the current GTS because of a more variety of available formats and the possibility of the WIS to consider specific data exchange policies).

**Pilot project 3.2** Establish a pilot project for the data collection of ocean observations using new satellite data telecommunication systems (e.g. Iridium).

Motivation. Such technological innovation will address identified deficiencies of the current observing system better to meet the requirements of a number of applications in a cost effective way by (i) permitting the distribution of high temporal and/or vertical resolution data, and (ii) improving data timeliness.

Initiatives have already started with the JCOMM Data Buoy Cooperation Panel and the Ship Observations Team, but integration with other ocean or land based observing systems can be promoted (e.g. OceanSITES, Argo).

**Pilot project 3.3** Establish a pilot project for in situ wave observations to meet the requirements maritime safety services and develop a costed justification for the users of marine services products for increasing such measurements globally.

Motivation. In situ wave observations are particularly needed for (i) assimilation into offshore wave forecast models, (ii) validation of wave forecast models, (iii) calibration/validation of satellite wave sensors, (iv) description of the ocean wave climate and its variability on seasonal to decadal time scales, and (v) understanding the role of waves in the coupled ocean-atmosphere system, and their inclusion in weather and climate models.

This will involve new technology developments for making cost-effective wave observations from drifting and moored buoys.

**Pilot project 3.4** Promote the documentation and integration of best practices and standards being used amongst the meteorological and oceanographic communities.

Motivation. Common standards for instruments and methods of observations will better serve the applications thanks to consistent and better quality data being fed into the models.

#### 4. Improved access to aircraft observations

The existing ADMAR programme is delivering operational data on the GTS on a regular basis. These data are currently being used beneficially by global and regional NWP and in subjective nowcasting and VSRF. The programme is managed by the AMDAR Panel in cooperation with the WMO Secretariat.

Following decisions by Cg-XIV and Cg-XV as well as EC-LVII and EC-LVIII, CAeM is ready to hand over responsibility for the programme to CBS, where it logically belongs being an operational observing programme. The full integration of AMDAR into a composite observing system will permit optimization of the ground based upper air observing system. In order to ensure the continued success of the programme, a stable management and funding base are required, as the current funding arrangements through the AMDAR Trust Fund is not considered a reliable long-term solution. To this effect, the following steps are proposed:

**Pilot project 4.1** Develop a costed justification for the inclusion of water vapour sensors (after successful completion of tests) with a generic software solution for all major aircraft types and models, with special emphasis on short-haul and commuter planes.

This case will compare the cost of the generic software development, hardware and certification for sensor installation and the cost of installing, maintaining, monitoring and calibrating the sensors to the cost of conventional profile data, the impact of a widespread availability of such profile data on VSRF and Nowcasting, and the potential savings by reducing or not having to install conventional radiosondes near participating airports.

**Pilot project 4.2** Develop a costed justification for the aviation industry for cost sharing on the development of a generic AMDAR software solution able to run on all major aircraft types, models and avionics systems.

This study will analyze the improvements to terminal aerodrome forecast, winds around aerodromes for optimization of arrival managers, and frequent updates of upper-level wind forecasts based on increased, universal availability of AMDAR data. This study would be presented to IATA, ICAO and projects such as NGATS and SESAR, who are currently in the process of designing the ATM concepts for the 2025 time frame, with a further presentation to regional airline associations in Asia.

## **5. Improved information for the hydrological user community**

**Pilot project 5.1** Improve the international exchange of rainfall radar and in situ precipitation observations through WIS.

Motivation: Over many populated land areas, weather radar represents the best source of information on precipitation, particularly when combined with in situ observations. However, the distribution of these data is often restricted within national boundaries. Great benefit could be derived for hydrological and other applications if observations made by weather radars currently in place were made available to a wider community in a timely manner and using convenient formats and data exchange mechanisms.

The project would respond to identified gaps in the observations available to meet the needs of a number of user applications, including hydrology. It responds to Recommendation G1(b) in the EGOS-IP.

**Pilot project 5.2** Improve the dissemination of global and regional snow analyses.

Motivation: Snow plays a crucial role in the hydrological cycle in many countries and regions. Analyses of snow cover, derived from various satellite and in situ data sources are available from some centres, but their dissemination is not widespread, and hence their quality is not well understood and their utility is not well developed.

The project would seek (1) to advertise and promote the availability of global and regional snow cover products, (2) to promote their assessment and comparison and (3) to foster their enhanced operational use for a range of applications including hydrology.

**Pilot project 5.3** Promote the use of satellite-based systems and products for the estimation of soil moisture.

Motivation: Uncertainties in estimates of soil moisture, at regional and national scale, represent a major weakness in the observational data available to hydrological users. Planned satellite soil moisture products (e.g. from ASCAT on MetOp, from AMSR on Aqua, from SMOS and from Aquarius) offer substantial improvements.

The project would respond to identified gaps in the observations available to meet the needs of a number of user applications, including hydrology. It responds to Recommendation S14 in the EGOS-IP.

**Pilot project 5.4** Harmonize standards for establishment, operation and maintenance of WHYCOS stations.