

Annex to paragraph 3.4.33 of the general summary
WMO INTEGRATED GLOBAL OBSERVING SYSTEMS (WIGOS)
CONCEPT OF OPERATIONS (CONOPS)

Foreword

There is a broadly recognized need for a comprehensive, coordinated and sustainable global observing system. Many international agencies have to administer systematically these diverse sets of observations and have developed data policies to meet their needs. WIGOS is the organizational response of WMO to this need and therefore is committed to the very strong cooperation that is needed among all partners to accomplish the broad objectives.

The following Concept of Operations describes the end state for a fully operational WIGOS; it establishes the overall goals for WIGOS. In order to achieve the goals, a detailed WIGOS Development and Implementation Plan (WDIP) will be developed in order to provide for a logical transition from initial to full operational capabilities. To fully understand WIGOS, the Concept of Operations must be considered in the context of the WDIP.

The WMO Integrated Global Observing System (WIGOS) is a comprehensive, coordinated and sustainable system of observing systems. WIGOS is based on all WMO Programmes' observational requirements. It ensures availability of required data and information and facilitates access through the WMO Information System (WIS) according to identified temporal, geographical and organizational requirements, including those for real, near-real time and delayed modes to all required information and in doing so it respects data sharing policies. Additionally, it helps ensure high data quality standards and benefits from archival and technological innovations.

The components of WIGOS (surface and space-based) include: weather observing networks (e.g. WWW/GOS, AMDAR, ASAP etc.); atmospheric composition observing networks (e.g. GAW); radiation observing networks (e.g. BSRN); marine meteorological networks and arrays (e.g. VOS, drifting and moored buoy arrays etc.); hydrological observing networks (e.g. observing components of WHYCOS etc.); and the various atmospheric, hydrologic, oceanographic and terrestrial observing systems contributing to GCOS. Improved monitoring through the integration of surface- and space-based observations is essential in understanding global climate change, including all sub-systems of the global climate system: atmosphere, hydrology, ocean, land surface and cryosphere.

WIGOS development and implementation will proceed in parallel with the planning and implementation of the WMO Information System (WIS). The combination of both efforts will allow for an integrated WMO end-to-end system of systems designed to improve Member's capability to effectively provide a wide range of services and to better serve research programme requirements.

WMO INFORMATION SYSTEM (WIS)

- Will be used in the collection and sharing of information for all WMO and related international programmes;
- Will provide a flexible and extensible structure that will allow participating centres to enhance their capabilities as their national and international responsibilities grow;

- Implementation will build upon the most successful components of existing WMO information systems in an evolutionary process;
- Development will pay special attention to a smooth and coordinated transition;
- Communication network will be based on communication links used within the World Weather Watch (WWW) for distribution of high priority real-time data;
- Will utilize international agreed-upon standards for protocols, hardware and software.

1. INTRODUCTION

1.1 Purpose

The purpose of WIGOS is to create an organizational, programmatic, procedural and governance structure that will significantly improve the availability of observational data and products and which will provide a single focus for the operational and management functions of all WMO observing systems as well as a mechanism for interactions with WMO co-sponsored observing systems. Integration will lead to efficiencies and cost savings that can be reinvested to overcome known deficiencies and gaps in the present structure and working arrangements.

1.2 Objectives

The integration process should encompass four broad objectives:

- (a) Improving WMO management and governance (use of resources, planning, institutional and programme structures, and monitoring);
- (b) Increasing interoperability between systems with particular attention given to space-based and *in-situ* components of the systems;
- (c) Addressing the needs of the atmospheric, hydrologic, oceanographic, cryospheric and terrestrial domains within the operational scope of a comprehensive integrated system;
- (d) Ensuring that broader governance frameworks (e.g. inter-agency co-sponsorship of systems) and relationships with other international entities are sustained and strengthened.

2. OVERVIEW

2.1 Aim

WIGOS is aiming to:

- (a) Address in the most cost-effective approach to meet WMO Programme requirements with a view toward reducing the financial burden on Members; while maximizing administrative and operational efficiencies;
- (b) Ensure the availability of all required information produced within the various WMO observing systems (e.g. GOS, GAW, WHYCOS, etc.), and WMO components of co-sponsored systems (e.g. GCOS, GOOS, GTOS, etc.) with particular emphasis on information generated by satellite, RADAR, wind-profilers, airborne systems, in situ ocean platforms, and other next generation observing systems;
- (c) Facilitate the access, in real/near-real time and delayed mode, of observations required for WMO and WMO co-sponsored programmes as well as relevant international conventions 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 improved data management including archival and data retrieval capabilities;
- (f) Facilitate technological innovation opportunities;
- (g) Continue on-going coordination with instrument manufacturers and scientific institutes in the development and testing of next generation observation instruments;
- (h) Develop appropriate regulatory documentation including organization and recommended practices and procedures;
- (i) Link existing technologies in an integrated manner to provide societal benefits.

2.2 Characteristics

2.2.1 The concept of WIGOS is based on the premise that the general standards and recommended practices, as agreed-upon for WIGOS, will apply to all WMO and sponsored observing systems and Programmes. WIGOS characteristics include:

- All WIGOS observational data and metadata and processed observational products which will:
 - Be exchanged via WIS using agreed upon data and metadata representation forms and formats;
 - Use WIGOS compatible hardware and software;
 - Adhere to WIGOS standards for instruments and methods of observation as well as standard observing network practices and procedures; and
 - Be archived in WIGOS approved forms and resolutions at WMO agreed upon archival centers.
- WIGOS will:
 - Develop strategies to satisfy observational requirements from WMO Programmes and international partners through the WMO Rolling Requirements Review Process;
 - Develop strategies to guarantee system interoperability, including data quality of observing systems and instruments;
 - Evaluate existing WIGOS capabilities before developing, acquiring, and or deploying new observing systems or sensors;
 - Exploit existing platforms and employ multi-sensor platform concepts to the maximum possible extent;
 - Coordinate requirements, plans and activities with all appropriate technical commissions, regional associations and Programmes;
 - Be built upon existing observing systems/networks as a system of observing systems.

2.2.2 It must be emphasized that observing programmes of the WMO are actually carried out by WMO Member States, either individually, or in some instances (notably for some satellite systems) cooperatively with consortia of countries operating a system jointly. Integration therefore has a direct relationship to national programmes and activities as well as on coordination through the international organization.

3. ASSUMPTIONS

3.1 General

This Concept of Operations provides a framework for the improvement of operations towards an integrated approach in support of WMO Members national mandates including response to natural hazards, environmental monitoring, adaptation to climate change and man-made environmental impacts. It is consistent with the decision of the Fifteenth WMO Congress concerning enhanced integration between WMO Observing Systems and the WMO Strategic Plan.

3.2 Levels of integration

As a system of observing systems, integration will be accomplished at three levels. The three levels of integration for WIGOS are shown schematically in Figure 1:

- Standardization of instruments and methods of observations (instruments and methods of observation level);
- Common information infrastructure, (WIS data level);
- End-product quality assurance (QM/QA/QC product level).

3.2.1 Coordination of WIGOS development and implementation through standardization at the observation level

A sustained, optimized, end-to-end WMO Integrated Global Observing System should encompass homogeneity, interoperability, compatibility of observations from all WIGOS constituent observing systems. This should be based on guidance and studies and achieved through implementation of recommendations on methods of observations by IMOP within WIGOS constituent networks including tests, calibration and intercomparisons. This would be an **“instruments and methods of observation level of integration.”**

3.2.2 Coordination of WIGOS development and implementation with WIS

3.2.2.1 The planning and implementation of WIGOS should proceed in parallel to the planning and implementation of WIS. It is therefore crucial that, as from its early planning stages, the WIGOS activities be coordinated with WIS. This will be accomplished through:

- Activities of the EC WG on WIGOS&WIS;
- EC WG on WIGOS&WIS Sub-Group on WIGOS (SG-WIGOS);
- Participation of representatives of RAs and technical commissions concerned;
- Coordination role of the Secretariat.

3.2.2.2 Technologically, the key action leading to the desired integrated networks will be the generation of data and information from WIGOS constituent networks using a comprehensive, standardized data presentation in compliance with WIS information exchange requirements for all WMO Programmes. This would be **“WIS data level of integration”**.

3.2.3 Coordination of WIGOS development and implementation with end-product quality assurance

The third level of standardization for a sustained, optimized, end-to-end WMO Integrated Global Observing System should embrace a quality management framework to ensure the best possible products to be delivered to end users. This should be based on agreed-upon quality assurance and control standards. This would be **“Quality Management/Quality**

Assurance/Quality Control end-product quality assurance of integration” with the following goals:

- To ensure integrated/coordinated data acquisition efforts among NMHSs and other operators to minimize duplication;
- To reduce costs and maximize data and products availability and quality;
- To develop an integrated management system which delivers reliable and timely data streams with adequate quality control.

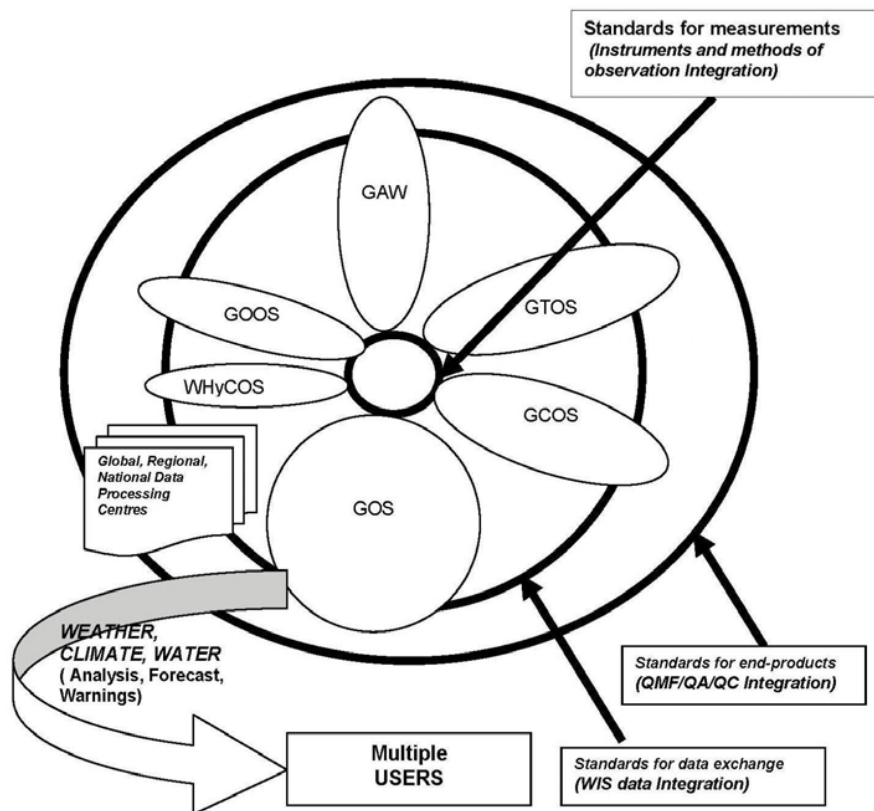


Figure 1: The three WMO Integrated Global Observing Systems (WIGOS) levels of integration are: standardization of instruments and methods of observation, common information infrastructure; and end product quality assurance. In particular, within the 1st level of integration (*inner circle*): a sustained, optimized, end-to-end WMO Integrated Global Observing System should encompass homogeneity, interoperability, compatibility of observations from all WIGOS constituent observing systems. This should be achieved through meeting the requirements on instruments and methods of observations established by CIMO/networks including tests, calibration and intercomparisons. In the 2nd level of integration (*middle circle*): Data and information generated by all WIGOS constituent networks should meet a comprehensive, standardized set of WIS data presentation and exchange requirements for all WMO Programmes. In the 3rd level of integration (*outer circle*): Various end-products generated on the basis of observations/measurements by all WIGOS constituent observing systems and exchanged through WIS should meet quality management framework requirements to ensure the best possible products to be delivered to end users.

4. RESPONSIBILITIES

4.1 In order to commence efforts towards achieving full WIGOS operations, the following entities are considered to have essential responsibilities:

- Observing and information systems sponsors;
- EC WG on WIGOS and WIS;
- SG WIGOS;
- Inter-Commission Coordination Group on WIS (ICG WIS).

4.2 It is expected in the transition phase (2008-2011) towards full operational capabilities that additional participants will commit appropriate resources, efforts and activities.

5. OPERATIONAL FRAMEWORK

5.1 Overall approach

This concept of operations covers the full spectrum of management and integration for WIGOS. In order for WIGOS to effectively and efficiently respond to user data needs, WIGOS will employ WIS as the data transmission and exchange mechanism.

5.2 WIGOS components

The WIGOS components are:

- (a) The Global Observing System (GOS) of the World Weather Watch;
- (b) Regional, river basin and global hydrological networks;
- (c) The Global Atmosphere Watch (GAW) networks and systems for observations of atmospheric chemical composition and related environmental parameters;
- (d) The various radiation networks both observing solar and net radiation (e.g. the BSRN);
- (e) Marine meteorological and oceanographic observations from ships including the Ship Observations Team (SOT);
- (f) Moored and drifting buoy arrays developed as research arrays during GARP and WCRP related research projects, and which are now operational networks and arrays supporting weather and climate as well as oceanographic objectives;
- (g) The climate component of atmospheric, oceanographic and terrestrial observing systems contributing to GCOS observing requirements (e.g. Argo floats, sea level observations etc.);
- (h) Aircraft Meteorological Data Relay (AMDAR) systems initially developed and implemented under the GARP project and subsequently expanded to an operational status including expansions of aircraft measurement capabilities for atmospheric composition constituents;
- (i) Space-based observing systems that are currently a major component of virtually all WMO observing programmes including the geostationary meteorological satellite constellation, the core polar-orbiting meteorological constellation, and the other components of the space-based observing system serving the needs of operational and research applications;

- (j) The observing component of the Cryosphere Watch approved by the fifteenth WMO Congress;
- (k) Other possible components yet to be defined.

5.3 Purposes and goals of the integration

It is envisioned that the integration process will bring about architectural and governance structures as well as a processes for WIGOS development, implementation and sustainability. Standardization and interoperability, including data compatibility, are primary factors for enabling integration. WIGOS will meet several sub-goals as follows:

- Improve the production, use and application of data and information from across all WMO and sponsored observing systems, in a seamless way, to satisfy user requirements;
- Be designed to accommodate the diversity among Members with respect to their capabilities and needs;
- Strengthen the ability of all Members to access and utilize observations and analysis products from all WMO and sponsored observing systems;
- Ensure compatibility, connectivity and interoperability including interface arrangements within and among all WMO and sponsored observing systems components and externally with other users;
- Allow for the continuous review of the requirements placed on the integrated system and have the capability to effectively adjust and respond to changing requirements;
- Ensure the continuing sense of ownership by the various groups that have initiated and developed the individual observing system components through directly involving these groups in the planning and implementation of the WIGOS;
- Promote the development, testing and comparison of new observing capabilities and provide mechanisms to easily integrate them into WMO and sponsored operational observing systems;
- Ensure the optimum integration of the various components of all observing programmes;
- Increase efficiencies by reducing as far as possible redundancies and overlaps of systems and the management activities supporting them;
- Facilitate more rapid and efficient assimilation of technological advances and apply them as far as possible across all observing programmes;
- Foster co-location of observing sites of complementary systems as far as practical thereby reducing redundancies; and
- Ensure the involvement of the various scientific and user communities in the activities of setting requirements, and monitoring and assessing system performance.

6. DATA POLICY

6.1 WIGOS will respect the data policies of partner organizations and will adhere to the decisions of the Twelfth and Thirteenth World Meteorological Congresses (1995, 1999) that adopted **Resolution 40 (Cg-XII)** "WMO Policy and Practice for the Exchange of Meteorological and Related Data and Products including Guidelines on Relationships in Commercial

Meteorological Activities", and **Resolution 25** (Cg-XIII) "Exchange of Hydrological Data and Products", respectively.

6.2 WIGOS will strive to ensure that the conditions placed by the originator on the additional data and products are respected and made known to initial and subsequent recipients for the exchange of meteorological and related data and products including guidelines on relationships in commercial meteorological and hydrological activities.

7. BENEFITS

Benefits of WIGOS to Members and partner organizations of WIGOS include the following:

- Improved services including those in support of disaster preparedness and adaptation to climate change;
- Increased quality and consistency and access to multi disciplinary observations;
- More efficient use of resources; and
- Better preparedness to incorporate new observing systems.

8. CHALLENGES

Challenges associated with embarking upon integration of WMO observing systems include:

- The cross cutting nature of WIGOS will require significant cooperation and coordination efforts by all concerned;
- 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;
- Effective and constructive coordination and collaboration with co-sponsoring and cooperating Organizations is a sensitive issue that must be carefully undertaken to avoid misunderstandings; and
- Differences in levels of development of national and regional systems and services among Members and partner organizations.

9. RESOURCES

Implementation of the concept of operations for WIGOS will require significant resources on the national, regional and global levels as well as within the WMO Secretariat during the transition phase (2008-2011).
