

J1.3 PROGRESS TOWARDS THE WMO INTEGRATED GLOBAL OBSERVATION SYSTEMS (WIGOS) AND WMO INFORMATION SYSTEM (WIS)

Donald E. Hinsman⁽¹⁾, J. Hayes⁽²⁾, D. Schiessl⁽¹⁾, J. Rasmussen⁽⁴⁾

1. INTRODUCTION

Over the years, WMO (and its predecessor the IMO) has organized and fostered the creation of global observing networks and systems supporting a wide range of applications such as weather prediction, climatology and climate, environmental science, aeronautical and marine applications, agrometeorology, and hydrology and water resources, among others. Many of these observing networks have developed rather independently with considerable duplication and potential redundancy in system standards, management and in support mechanisms such as facilities and programs for calibration and inter-comparison. The increasing contribution from space-based observing systems to virtually all observing programs is a relatively new and important component of every application.

The Fifteenth WMO Congress (May 2007) agreed that enhanced integration between WMO observation systems should be pursued as a WMO strategic objective and would generate important benefits for WMO Members, their National Meteorological and Hydrological Services (NMHSs) and for the Organization as a whole.

The fifty-ninth session of the WMO Executive Council (May 2007) responded to Congress's request and established an Executive Council Working Group on WIGOS-WIS to provide advice and guidance in the preparation of an over-arching

⁽¹⁾ World Meteorological Organization, Geneva, Switzerland

⁽²⁾ National Weather Service, NOAA, Silver Springs, Maryland

⁽³⁾ Frederick, Maryland

WIGOS Development and Implementation Plan and monitor the development and implementation of WIGOS and WIS through a "rolling review" mechanism including five "Pilot Projects".

The EC Working Group on WIGOS-WIS (December 2007) developed an initial draft of the WIGOS Concept of Operations (CONOPS) and a WIGOS Development and Implementation Plan. It reviewed the status of five Pilot Projects, namely, "Integration of WWW/GOS and GAW", "Initiation of a Global Hydrologic network addressing a GCOS requirement", "Elaborating the underpinning/crosscutting role and responsibilities of the Instruments and Methods of Observation Programme", "Integration of AMDAR into the WMO global observing systems" and "Integration of marine meteorological and other appropriate oceanic observations into the WMO global observing systems".

2. WIGOS CONCEPT OF OPERATIONS OVERVIEW

There is a broadly recognized need for a comprehensive, coordinated and sustainable system of global observing systems. 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 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) has been 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.

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 the Global Climate Observing System (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 utilise international agreed-upon standards for protocols, hardware and software.

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.

The integration process should encompass four broad objectives:

- Improving WMO management and governance (use of resources, planning, institutional and

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

WIGOS aims to:

- 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;
- 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;
- 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;
- Ensure required data quality standards are met and sustained for all programme requirements;

- Facilitate improved data management including archival and data retrieval capabilities;
- Facilitate technological innovation opportunities;
- Continue on-going coordination with instrument manufacturers and scientific institutes in the development and testing of next generation observation instruments;
- Develop appropriate regulatory documentation including organization and recommended practices and procedures;
- Link existing technologies in an integrated manner to provide societal benefits.

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.

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 direct relationship to national programmes and activities as well as on coordination through the international organization.

As a system of observing systems, integration will be accomplished at three levels.

- 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).

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.

The WIGOS components are:

- The Global Observing System (GOS) of the World Weather Watch;
- Regional, river basin and global hydrological networks;
- The Global Atmosphere Watch (GAW) networks and systems for observations of atmospheric chemical composition and related environmental parameters;
- The various radiation networks both observing solar and net radiation (e.g. the BSRN);
- Marine meteorological and oceanographic observations from ships including the Ship Observations Team (SOT);
- 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;
- The climate component of atmospheric, oceanographic and terrestrial observing systems contributing to GCOS observing requirements (e.g. Argo floats, sea level observations etc.);
- 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;
- 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;
- The observing component of the Cryosphere Watch approved by the fifteenth WMO Congress;

- Other possible components yet to be defined.

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.

3. INITIAL WIGOS DEVELOPMENT AND IMPLEMENTATION PLAN OVERVIEW

The top-level and detailed descriptions for WMO Integrated Global Observing Systems (WIGOS) are foundational documents and identify the urgent need for WIGOS implementation and are a strategic roadmap for integration.

Preparation of the overarching WIGOS Development and Implementation Plan (WDIP) closely coordinated with the WIS Development and Implementation Plan will be a critical ongoing activity during the four-year period 2008-2011. WDIP will be a "living" document. Subsequent reviews and updates will be done at least annually as the planning proceeds and experience is gained from the various Pilot Projects and inputs from the Technical Commissions, Regional Associations and the advisory/steering bodies of WMO co-sponsored programmes are received. Meetings of EC-WG WIGOS/WIS will provide oversight and guidance regarding the evolution of the plan, which subsequently would be considered at each session of EC. While further evolution of the plan will occur, it is anticipated that it should include an assessment of all

observational requirements for all WMO Programmes and co-sponsored programmes and identify those (including characteristics such as observational accuracy and resolution) that are needed to service all programmes or applications. It would also include implementation details for the various Pilot Projects and their results, details of actions required to address revisions of the Terms of Reference (TOR) of the Technical Commissions, the WMO Programme structure, and WMO Secretariat budgetary, personnel and organizational implications. Many observation systems are outside of the remit of Member NMHSs however their data provides a valuable contribution to WMO Programmes and Member NMHSs. Additionally observational data from WMO Programmes and co-sponsored programmes is of value to organizations outside of WMO. The WIGOS plan needs to address this from the aspect of improving data access across these boundaries. Data dissemination practices must be capable of respecting the data policies as designated by the "owners of the observation systems including authorization of users.

The "Roadmap" or schedule below is broken into annual "Phases" timed according to sessions of EC. The items listed under each Phase required further elaboration since the dates of various events (e.g. Commission Meetings) are not yet confirmed, but they should be incorporated as the information becomes available. For historical purposes as well as further elaboration of the plan, a description is provided of the Preparatory Phase that occurred prior to Cg-XV. The preparation of Version 1.0 of WDIP (WDIP V-1.0) that can be endorsed by the EC in June 2008 will be a crucial first step. WDIP V-1.0, and its subsequent revisions, will be important for informing the Technical Commissions, Regional Associations and the steering committees of GCOS, the Global Ocean Observing

System (GOOS) and the World Climate Research Programme (WCRP) of WIGOS and WIS planning activities and to encourage their input into the process. Scheduling of as many regular sessions as possible of Technical Commissions and Regional Associations before 2010 would be most useful in obtaining their input in the planning process. EC-LXII (2010) marks the end of the active planning period since during its session the basic proposals to Cg-XVI will be prepared.

A preparatory WIGOS phase has already been completed. The following describes the next four implementation phases.

Phase I. May 2007 - June 2008

- Establish and update as appropriate the WIGOS Concepts of Operations;
- Cg-XV through the EC-LIX establishes the EC-WG/WIGOS-WIS to oversee the development of WIGOS and WIS;
- Full time WIGOS Planning Unit organized in the WMO Secretariat (June 2007);
- Coordinate with IOC regarding the WIGOS-WIS initiatives;
- Initiate the preparation of the draft WDIP v.1.0 (completion by Dec. 2007). Present the draft WDIP v.1.0 to EC-WG/WIGOS-WIS;
- Adjust draft WDIP v.1.0 as guided by EC-WG/WIGOS-WIS and present draft WDIP v.1.1 to EC-LX;
- The agendas of Technical Commissions and Regional Associations should include an item relating to the Integration of WMO Observing Systems and should seek their “consensus inputs” to the WDIP to which the EC WG WIGOS-WIS would provide an input;
- At meetings of Presidents of Technical Commissions a major agenda item should be the WDIP to which the EC WG WIGOS-WIS would provide input.

Phase II. June 2008 - June 2009

- Review and update as appropriate the WIGOS Concepts of Operation;
- EC-LX reviews draft WDIP v.1.1 and provides guidance to issue the WDIP v1.1;
- The Pilot Projects begun in Phase I implemented and evaluated; adjustments to the WDIP may arise from the evaluations;
- Initiate planning for Pilot Project concerning the integration of marine meteorological and oceanographic observations with WIGOS-WIS (see paragraph below);
- Additional Pilot Projects may be identified;
- Schedule possible concurrent sessions of CAS and CBS with joint agenda items regarding WIGOS-WIS and the integration of GAW and GOS into WIGOS (see paragraph below);
- Initiate work on the proposed revisions to the WMO Technical Regulations;
- Revise the WDIP v.1.1 as appropriate with guidance from EC-WG/WIGOS-WIS – issue WDIP v. 1.2 and submit to EC – LXI for review and guidance;
- The agendas of Technical Commissions and Regional Associations should include an item relating to the Integration of WMO Observing Systems and should seek their “consensus inputs” to the WDIP to which the EC WG WIGOS-WIS would provide input.

Phase III. June 2009 - June 2010

- Review and update as appropriate WIGOS Concepts of Operation;
- EC-LXI provides guidance for this year (note this is the last period for active planning before specific proposals are prepared to submit to CG-XVI);
- Pilot Projects begun in Phase I and II should be completed and evaluated. Results to be

appropriately incorporated into the WDIP V.2.0;

- EC-WG/WIGOS-WIS meets to review in detail the WDIP that is nearing completion at this stage;
- The agendas of Technical Commissions and Regional Associations should include an item relating to the WIGOS-WIS and should seek their “consensus inputs” to the WDIP;
- Matters relating to the revision of the Technical Regulations, the TORs of Technical Commissions, and proposals regarding WMO Programme structure and content and Secretariat structure will be addressed in this Phase;
- The final preparations for the presentation of the overall WMO structure and function that reflects the WIGOS-WIS should be prepared for EC–LXII. The action of EC at this time will consist of the details that will be presented to Cg-XVI to which the EC WG WIGOS-WIS would provide input.

Phase IV. June 2010 - May 2011

- Review and update as appropriate WIGOS Concepts of Operation;
- WDIP (final version) is completed;
- EC-LXII to agree on the content of the submission to Congress regarding the implementation of WIGOS-WIS. This will include the proposed changes to the Technical Regulations, the revised roles and TORs of the various Technical Commissions, the adjustments to the WMO Programme structure, and the impact on Secretariat budgets and personnel. Proposed actions of Cg-XVI to implement the programme;
- EC-WG/WIGOS-WIS submits its final report and recommendations to Cg-XVI.

While the preparation of an overarching WDIP will be the crucial centre piece of the planning and implementation of WIGOS, Cg-XV felt that undertaking at the earliest possible stage several WIGOS Pilot

Projects would be useful to address major issues in the integration process and would help in elaborating the WDIP. Pilot Projects will emphasize the role and contributions to be made by the Technical Commissions. In accordance with recommendations by Cg-XV, Technical Commissions had identified the following Pilot Projects in the context of WIGOS:

- I: Joint GOS-GAW Pilot Project to accelerate implementation of WIGOS/WIS;
- II: Initiation of Global Hydrological Network addressing a GCOS Requirement;
- III: Integration of AMDAR into WIGOS;
- IV: Elaboration of the underpinning/crosscutting role and responsibilities of the Instruments and Methods of Observation Programme in the context of WIGOS;
- V: Integration of Marine Meteorological and other appropriate Oceanic Observations into the WMO Global Observing Systems.

Cg-XV emphasized that support and involvement of NMHSs and Regional Associations in the implementation of WIGOS concept was a crucial factor for ensuring important benefits for all Members. Helping Members to more fully understand WIGOS and keeping them current on its practical development should be considered as an essential component in WIGOS implementation. This can be achieved through launching Demonstration Projects in selected NMHSs. These NMHSs will be at the operational end of the WIGOS implementation demonstrating to all concerned how to initiate and keep WIGOS together with WIS components running at the required levels of performance. Feedback and lessons learnt from these NMHSs will be extremely beneficial in understanding others' expectations of WIGOS/WIS concept implementation. These projects will also have a high profile impact since

they would include all observing systems, i.e. in addition to WWW/GOS, the Demonstration Projects would involve functions of other observing networks that provide the delivery of time critical data and products, as well as other information, underlying the basic operations of NMHS. The Secretariat working with appropriate working bodies of Regional Associations and Technical Commissions would ensure regular coordination and communication between Members involved in Demonstration Projects. The Demonstration Projects would complement the already agreed-upon Pilot Projects. The Pilot Projects focus on Technical Commission involvement while the Demonstration Projects focus on NMHSs in Regional Associations.

Candidates for "test-bed" Demonstration Projects include the following NMHSs: Kenya, Namibia (RA I), Republic of Korea (RA II), Brazil (RA III), United States of America (RA-IV), Australia (RA V) and the Russian Federation (RA VI).

4. ORGANIZATIONAL IMPACTS

One of the principal strengths of WMO is the organizational and operational backbone provided by the WMO Basic Document Series No. 2, Technical Regulations (WMO- No.49). The three volumes of the WMO Basic Document Series are supplemented by Annexes called Manuals, which have the same status as the Basic Documents and are aimed at facilitating cooperation between WMO Members, specifying their obligations and ensuring adequate uniformity and standardization in the practices and procedures employed. In addition to the Manuals, there is a class of WMO documentation, not part of the technical regulations, usually called Guides (e.g. the Guide to the Global Observing System, WMO No. 488). The purpose of the Guides is to provide practical information on the development, organization, implementation and operation of the

system, subsystem(s) or service in order to enhance both the participation of individual WMO Members in the activity and the benefits they may obtain from it. The Guides often supplement the regulatory material contained in the TR and their Annexes.

The present structure of the Technical Regulations (TR) Volume I centers around the WWW/GOS, GDPFS, and GTS with other components of the overall WMO programmes or systems distributed within the GOS or simply added on as they evolved. In order to effectively approach the integration of WMO Global Observing Systems (WIGOS), and to incorporate WIS, a fundamental reorganization and approach to the WMO TR is required. Undertaking this task early in the WIGOS and WIS planning activity will provide structure and organization to the overall effort, and will help in organizing the work programme required to implement WIGOS and WIS. In this regard, CBS-Ext(06) (Seoul, Republic of Korea, November 2006) has already noted that the implementation of the WIGOS and WIS will ultimately require a major revision of the TR.

Space based observing and communications systems are becoming more and more central to the over-all WMO system operations. In fact, many future applications will often rely on space-based sensors as the primary source of data, and require surface based or in situ observations for calibration or "ground truth" purposes, thus changing the operational requirements placed on the integrated system substantially. The present set of TR often treats the satellite systems as entities separate from the surface based networks and systems.

The revised structure of the TR should provide a foundation for WIGOS. It should document the structure of a system of systems based on interoperability and compatibility among all its elements and with the

user community. The revised TR would need to be comprehensive and reflect all of the component systems. It would allow room to address, the wide ranging multi-discipline issues and requirements for observational resources from all domains (atmosphere, ocean, and terrestrial) facing WMO today (weather monitoring and prediction, atmospheric composition monitoring, climate monitoring and change, disaster risk reduction and mitigation, water resources etc.); it should also build on and amplify the integration across surface-based and space-based sources of observations.

In undertaking such a revision, a clearer vision for the purpose, scope, content and a process for continuous review and updating of the various elements that make up the TR, including the Guides, should be developed.

There is also an opportunity to make the TR easier to access, update and use. The application of electronic access through the Internet or similar technology for technical regulatory information should be considered as part of the integration activity. The role of WIS as the vehicle for this function may be a viable option.

In progressing toward enhanced integration of, and interoperability amongst, WMO observing systems, it will be especially important that this be carried out in close consultation with WMO's partner organizations that co-sponsor some of those systems. This will apply particularly to:

- the joint WMO-IOC-UNEP-ICSU Global Climate Observing System (GCOS);
- the WMO contribution to the joint IOC-UNEP-WMO-ICSU Global Ocean Observing System (GOOS); and
- those terrestrial/hydrological observing systems which serve as part of the FAO-UNEP-WMO-ICSU Global Terrestrial Observing System (GTOS).