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SUB-GROUP ON THE WMO INTEGRATED OBSERVING
SYSTEMS (SG-WIGOS)

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**PROPOSALS FOR UPDATE OF CONCEPT OF OPERATIONS (CONOPS) AND WIGOS
DEVELOPMENT AND IMPLEMENTATION PLAN (WDIP)**

(Submitted by the WMO Secretariat)

Summary and Purpose of Document

This document contains Concept of Operations (CONOPS) and the WIGOS Development and Implementation Plan (WDIP), adopted by EC-LX.

ACTION PROPOSED

The meeting is invited to formulate the proposals for update of CONOPS and WDIP to be submitted to the second session of the EC WG on WIGOS and WIS, December 2008 for the consideration.

References: 1. Abridged final report of the EC-LX (WMO-No. 1032)
2. Final report of the first session of the EC WG WIGOS-WIS

Annexes: 1. Draft Demonstration Project of Morocco (RA I)
2. Draft Demonstration Project of the Republic of Korea (RA II)
3. Draft Demonstration Project of Brazil (RA III)
4. Draft Demonstration Project of the United States (RA IV)

PROPOSALS FOR UPDATE OF CONCEPT OF OPERATIONS (CONOPS) AND WIGOS DEVELOPMENT AND IMPLEMENTATION PLAN (WDIP)

Background

1. The sixtieth session of the Executive Council agreed with recommendations from the first session of the Executive Council Working Group on WIGOS and WIS including an overarching WIGOS Development and Implementation Plan (WDIP) that comprises also the Planning and Implementation Phases - the Strategic Roadmap towards enhanced integration between WMO observing systems through annual phases timed according to sessions of the Executive Council.
 2. Taking into account that integration is a complex and evolving process, the EC-LX agreed that there was also a need to have in detail conceptual aspects of WIGOS operations and expected benefits of integration to make them more clear and transparent for all NMHSs, partner organizations and also for policy makers. In this connection the Council agreed with the WIGOS Concept of Operations (CONOPS) developed by the EC Working Group on the WMO Integrated Global Observing System and the WMO Information System. The EC-LX adopted the draft WIGOS Development and Implementation Plan V.1.1 elaborated by EC WG on WIGOS and WIS.
 3. The Council agreed that the principal WIGOS documents, that is, the WIGOS Concept of Operations and the WIGOS Development and Implementation Plan, should be updated on a regular basis at least annually as the planning proceeds and experiences are gained from the WIGOS Demonstration and Pilot Projects and inputs from the technical commissions and regional associations and the advisory/steering bodies of WMO co-sponsored programmes are received.
 4. The versions of the WIGOS Concept of Operations and the WIGOS Development and Implementation Plan adopted by EC-LX are reproduced in the Annexes I and II respectively, with proposals of some editorial changes (in track changes) submitted by the Secretariat.
 5. Based on the discussion during the session, the meeting is invited to formulate the proposals for the updated CONOPS and the WDIP to be submitted to the second session of the EC WG on WIGOS and WIS, December 2008 for the consideration.
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CONCEPT OF OPERATIONS (CONOPS)

(ANNEX III, Annex to paragraph 3.4.44 of the general summary, Abridged Final Report of the Sixtieth Session of the Executive Council, WMO-No. 1032)

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 into 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 other WMO 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:

- 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;
- 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:

- 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.) including emphasis on information generated by satellite, ~~radar~~, windprofilers, ~~airborne systems~~, ~~in situ ocean platforms~~, and other next generation observing systems; Deleted: RADAR
- 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;

- (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 centres.
- 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 are shown schematically in Figure 1:

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

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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 ~~representation~~ in compliance with WIS information exchange requirements for all WMO Programmes. This would be “**WIS level of integration**”.

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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 integration**” with the following goals:

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- 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.

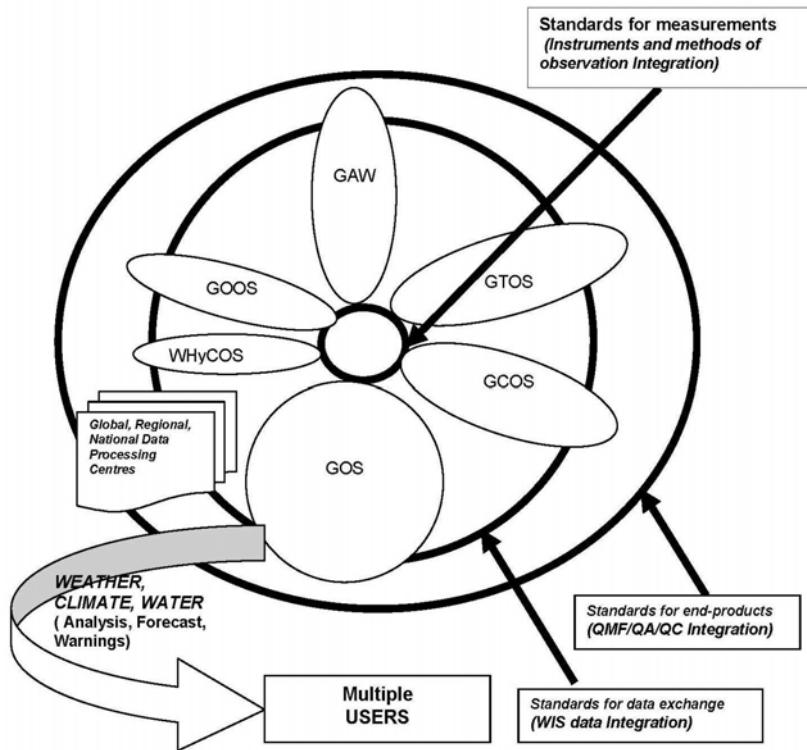


Figure 1: The three levels of integration among the WMO-sponsored and co-sponsored observing systems contributing to WIGOS: standardization of instruments and methods of observation, WIS information infrastructure; and end product quality assurance. In particular, within the first level of integration (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 second level of integration (middle circle): Data and information generated by all WIGOS constituent networks should meet a comprehensive, standardized set of WIS data representation and exchange requirements for all WMO Programmes. In the third 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.

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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);
- Regional Associations and Technical Commissions.

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 WMO component of atmospheric, oceanographic and terrestrial observing systems contributing to GCOS observing requirements;
- (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 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 efficiency by reducing as far as possible redundancies and overlaps of systems and the management activities supporting them; Deleted: ies
- 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, consistency and access to multi disciplinary observations; Deleted: and
- 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).

WIGOS DEVELOPMENT AND IMPLEMENTATION PLAN (WDIP)

(Version 1.1)

I. Introduction

The top-level and detailed description ~~of~~ WMO Integrated Global Observing System (WIGOS) ~~is a~~ foundational document identifying the urgent need for WIGOS implementation. The following document describes an initial WIGOS Development and Implementation Plan as mandated by the Fifteenth WMO Congress (Cg-XV).

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II. Strategic Roadmap for Integration

2.1 Cg-XV agreed that planning and implementation of the WIGOS integration process should proceed in phases defined by the annual meetings of the WMO Executive Council in order to assure oversight, review and direction. To that end, Cg-XV requested EC-LIX to appoint a Working Group to oversee WIGOS and WIS. The process foreseen was one where planning and implementation of WIGOS and of 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.

2.2 EC-LIX, in its Resolution 2/4 (EC-LIX), established the EC Working Group on WMO Integrated Global Observing System and WMO Information System (EC-WG WIGOS/WIS) with the following TOR:

- (1) Provide advice and guidance in the preparation of an over-arching WIGOS Development and Implementation Plan;
- (2) Refine the WIS Development and Implementation Plan and ensure coordination between WIGOS and WIS plans to allow for an integrated WMO end-to-end system of systems;
- (3) Monitor the development and implementation of WIGOS and WIS through a “rolling review” mechanism; and
- | (4) Monitor WIGOS/WIS “Pilot Projects”, as identified by Cg-XV, to test concept, identify problem areas, and to help in elaborating the Development and Implementation Plan.

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2.3 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. A draft Version 1.0 of this document was reviewed and updated at the first session of the EC-WG WIGOS/WIS. 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

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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.

2.4 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, GOOS and 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.

III. Preparatory Phase - December 2006 – Cg-XV (May 2007)

- (1) Document prepared for the EC Task Team on the WMO Integrated Global Observing Systems (EC-TT/WIGOS) Feb. 2007;
- (2) Report of EC-TT/WIGOS submitted to Cg-XV. This report to address the decision of EC-LVIII as contained in Resolution 13 (EC-LVIII);
- (3) Formation of an internal Interim WMO Secretariat WIGOS Team under the chairmanship of a Director with participation from all relevant WMO Programmes. The Interim Secretariat WIGOS Task Team to address follow-up actions as required according to proposals by the EC-TT/WIGOS in preparation for presentation to Cg-XV.

IV. Implementation Phase I. Cg-XV (May 2007) – EC-LX (June 2008)

- (1) Establish and update as appropriate the WIGOS Concept of Operations;
- (2) Cg-XV through the EC-LIX establishes the EC-WG/WIGOS-WIS to oversee the development of WIGOS and WIS;
- (3) Full time WIGOS Planning Unit organized in the WMO Secretariat (June 2007);
- (4) Coordinate with IOC regarding the WIGOS-WIS initiatives;
- (5) 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;
- (6) Initiate first Pilot Projects (see paragraphs below):
 - (a) Integration of WWW/GOS and GAW into WIGOS;
 - (b) Initiation of Global Hydrological Network in context of WIGOS;
 - (c) Integration of AMDAR into WIGOS;
 - (d) Elaborating the underpinning/crosscutting role and responsibilities of the Instruments and Methods of Observation Programme in the context of WIGOS;
 - (e) Integration of marine meteorological and other appropriate oceanic observations into WIGOS.

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- (7) Adjust draft WDIP v.1.0 as guided by EC-WG/WIGOS-WIS and present draft WDIP v.1.1 to EC-LX;
- (8) 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;
- (9) 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.

V. Implementation Phase II. EC-LX (June 2008) - EC-LXI (June 2009)

- (1) Review and update as appropriate the WIGOS Concept of Operations; Deleted: s
- (2) EC-LX reviews draft WDIP v.1.1 and provides guidance to issue the WDIP v1.2; Deleted: 1
- (3) The Pilot Projects begun in Phase I implemented and evaluated; adjustments to the WDIP may arise from the evaluations;
- (4) Initiate planning for the Pilot Project concerning the integration of marine meteorological and oceanographic observations with WIGOS-WIS (see paragraph below);
- (5) Additional Pilot Projects may be identified;
- (6) 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);
- (7) Initiate work on the proposed revisions to the WMO Technical Regulations;
- (8) 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;
- (9) 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.

VI. Implementation Phase III. EC-LXI (June 2009) - EC-LXII (June 2010)

- (1) Review and update as appropriate WIGOS Concept of Operations; Deleted: s
- (2) 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); Deleted: G
- (3) Pilot Projects begun in Phase I and II should be completed and evaluated. Results to be appropriately incorporated into the WDIP V.2.0;
- (4) EC-WG/WIGOS-WIS meets to review in detail the WDIP that is nearing completion at this stage;
- (5) 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;
- (6) 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;
- (7) 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.

VII. Implementation Phase IV. EC-LXII (June 2010) - Cg-XVI (May 2011)

- (1) Review and update as appropriate WIGOS Concept of Operations;
- (2) WDIP (final version) is completed;
- (3) 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;
- (4) EC-WG/WIGOS-WIS submits its final report and recommendations to Cg-XVI.

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While the preparation of an over-arching WDIP will be the crucial centrepiece 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:

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

IX. Demonstration Projects on the Development and Implementation of WIGOS at NMHSs

9.1 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.

9.2 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).

X. Develop and maintain WIGOS web page

It would be essential to have an effective website containing current information about WIGOS roles and tasks, related upcoming events and background information. The WMO Secretariat, in coordination with Members concerned, relevant focal points for WIGOS in RAs and Technical Commissions, should establish and update of a WIGOS web page on the WMO Web site by publishing information about WIGOS, including general information on the current status of implementation of Pilot and Demonstration Projects, providing condensed information to various WIGOS user communities.

XI. Policy and Governance Aspects

To accomplish the goals above regarding the development of a truly integrated WMO global observing systems, adjustments must be made in the WMO Technical Regulations, the WMO Programme structure, the working structure and function of the Technical Commission, and of the WMO Secretariat. The motivations for WIGOS are focused; i.e. to the objective of instituting a truly integrated end-to-end system - comprised principally of the WIGOS and WIS. The development of an effective and efficient system of governance to guide and implement it, arrangements for effective scientific and technical advisory mechanisms to develop, monitor and evaluate it, and an appropriate WMO Programme and WMO Secretariat structure to support it, will all be important and essential components of the systems into system integration.

XII. WMO Technical Regulations (TR)

12.1 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.

12.2 The present structure of the Technical Regulations Volume I ~~centres~~ 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.

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12.3 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.

12.4 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 (atmospheric, 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.

12.5 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.

12.6 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.

XIII. WMO Programmes and Technical Commissions

13.1 One single WMO Programme should be assigned the responsibility to lead the planning of WIGOS and WIS and with its ultimate implementation and operation. Participation during the integration by the other Programmes which currently have responsibility for components of the total WMO observation system will be crucial in this transition.

13.2 Likewise WIGOS and WIS should fall under a revised Commission for Basic Systems. The revised CBS TOR would be designed to reinforce its 'basic systems' responsibilities while building in stronger mechanisms for assessing and meeting the needs of the different applications sectors and programmes. The revised CBS would be focused on operational systems issues including planning and implementation across the full spectrum of observing domains and disciplines. Scientific research, system requirements, service provision etc would be the prerogatives of other Commissions, WMO Programmes or the various Advisory/Steering bodies.

13.3 As recognized in Resolution 7.4/1 (Cg-XV), the process leading to WIGOS and WIS would have a wide ranging impact on the structure and functions of WMO including the WMO Technical Regulations, data policy, roles, terms of reference, and working arrangements of the technical commissions, the WMO Programme structure and the WMO Secretariat. Initially what is needed to effectively proceed is the decision to focus the WIGOS and WIS within a single Programme and associated Commission. Given that decision, proposals with regard to how to organize and adjust the rest of the WMO Programme structure and Technical Commission TOR can be developed as an early step in the planning and implementation process.

13.4 Cg-XV agreed further that the integration process would centre initially upon the preparation of an over-arching WIGOS Development and Implementation Plan (WDIP). 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 WMO Members and in particular developing countries. Several "Pilot Projects", as approved by Cg-XV, should be designed to test the concept, identify problem areas, and to help in elaborating WDIP. The possible candidate Pilot Projects approved by Cg-XV include those mentioned above under "*Phase I. Cg-XV (May 2007) – EC-LX (June 2008)*".

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XIV. Jointly Sponsored Observing Systems

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).

XV. Integration levels within WIGOS

15.1 As a system of observing systems, integration will be accomplished at three levels: observation standardization; WIS information infrastructure, i.e. WIS; and end-product quality assurance.

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

15.2 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 implementation of guidance and studies on methods of observations by IMOP within WIGOS constituent networks including tests, calibration and comparisons. Schematically, it could be defined as an "instruments" level of integration.

Coordination of WIGOS development and implementation with WIS

15.3 Cg XV emphasised that 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, with active participation of representatives of RAs and Technical Commissions concerned and coordination role of the Secretariat. 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 representation in compliance with WIS information exchange requirements for all WMO Programmes. This may be considered as "WIS" integration.

Development of WMO Regulatory material related to WIGOS, including QMF aspects

15.4 To ensure integrated/coordinated data acquisition efforts among NMHSs and other operators to minimize duplication, reduce costs and maximize data and products availability and quality, the development of an integrated management system to secure sustained, timeliness data streams and adequate quality control, there is the need for appropriate regulatory documentation including organization and recommended practices and procedures so that Members can proceed adequately with WIGOS development and implementation taking into account QMF aspects. This will constitute an "end-products" integration.

LIST OF ACRONYMS

4DVAR	Four-Dimensional Variational Assimilation
ADM	Atmospheric Dynamics Mission (ESA)
AES	Atmospheric Environment Service (Canada)
AFIRS	Automated Flight Information Reporting System
AIRS	Advanced Infra-red Sounder
AMDAR	Aircraft Meteorological Data Delay
AMSU	Advanced Microwave Sounding Unit
AMV	Atmospheric Motion Vector
AOPC	Atmospheric Observation Panel for Climate
Argo	Array for Real-time Geostrophic Oceanography
ASCAT	Advanced Scatterometer
ASAP	Automated Shipboard Aerological Programme
ATOVS	Advanced TIROS Operational Vertical Sounder
AVHRR	Advanced Very High Resolution Radiometer
AWS	Automatic Weather Station
BUFR	Binary Universal Form for the Representation of Meteorological Data
CALIOP	Cloud Aerosol LIDAR with Orthogonal Polarization
CAS	Commission for Atmospheric Sciences
CBS	Commission for Basic Systems
CGMS	Coordination Group for Meteorological Satellites
CHAMP	Challenging Minisatellite Payload
CIMO	Commission for Instruments and Methods of Observation
CMA	China Meteorological Administration
COSMIC	Constellation Observing System for Meteorology, Ionosphere and Climate
COSNA	Composite Observing System for the North Atlantic
CREX	Character Form for the Representation and Exchange of Data
DIAL	Differential Absorption LIDAR
E-AMDAR	EUMETNET-AMDAR
EARS	EUMETSAT ATOVS (now Advanced) Retransmission Service
ECMWF	European Centre for Medium-Range Weather Forecasts
EGPM	European (contribution to) Global Precipitation Measurement
ERB	Earth Radiation Budget
ESA	European Space Agency
ET-EGOS	Expert Team on the Evolution of the Global Observing System
ET-SUP	Expert Team on Satellite Utilization and Products
EUCOS	EUMETNET Composite Observing System
EUMETNET	European Meteorological Services Network
FASTEX	Fronts and Atlantic Storm Track Experiment
FY-4	Feng Yun-4 (Chinese geostationary satellite series)
GAW	Global Atmosphere Watch
GCOS	Global Climate Observing System
GEF	Global Environment Facility
GEO	Geostationary Orbit Satellite
GIFTS	Geosynchronous Imaging Fourier Transform Spectrometer
GLAS	Geoscience Laser Altimeter System
GMES	Global Monitoring of Environment and Security
GNSS	Global Navigation Satellite System

GOES	Geostationary Operational Environmental Satellite
GOME	Global Ozone Monitoring Experiment
GOS	Global Observing System
GPM	Global Precipitation Measurement
GRAS	GNSS Receiver for Atmospheric Sounding
GSICS	Global Space-based Inter-Calibration System
GSN	GCOS Surface Network
GTS	Global Telecommunication System
GUAN	GCOS Upper-Air Network
HIRDLS	High Resolution Dynamic Limb Sounder
HIRS	High Resolution Infra-red Sounder
IASI	Infra-red Atmospheric Sounding Interferometer
IGDDS	Integrated Global Data Dissemination Service
IGEOLab	International Geostationary Laboratory for demonstration missions
IGOSS	Integrated Global Ocean Services System
IMD	India Meteorological Department
IOC	Intergovernmental Oceanographic Commission
IOS	IGOSS Observing System
IP	Implementation Plan
ISRO	Indian Space Research Organization
JASON	Ocean Surface Topography Mission (OSTM)
JAXA	Japan Aerospace Exploration Agency
JCOMM	Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology
JMA	Japan Meteorological Agency
LEO	Low Earth Orbit
LIS	Lightning Imaging Sensor
MDS	Meteorological Data System
MERIS	Medium Resolution Imaging Spectrometer
METOP	Meteorological Operational Satellite (EUMETSAT)
MIPAS	Michelson Interferometer for Passive Instrument Sounding
MLS	Microwave Limb Sounder
MODIS	Moderate Resolution Imaging Spectroradiometer
MTG	Meteosat Third Generation
MTSAT-FO	Multi-purpose Transport Satellite Follow-On
NAOS	North Atlantic Ocean Stations
NASA	National Aeronautics and Space Administration
NESDIS	National Environmental Satellite, Data and Information Service
NMHSs	National Meteorological and Hydrological Service(s)
NOAA	National Oceanic and Atmospheric Administration
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NPP	NPOESS Preparatory Program
NRT	Near-Real Time
NWP	Numerical Weather Prediction
OPAG	Open Programme Area Group
OSE	Observing System Experiment(s)
OSSE	Observing System Simulation Experiment(s)
PUMA	Preparation for the Use of Meteosat Second Generation (MSG) in Africa

R&D	Research and Development (satellite)
RAOB	Radiosonde Observations
RBCN	Regional Basic Climatological Network
RBSN	Regional Basic Synoptic Network
RRR	Rolling Review of Requirements
SAC	Satelite de Aplicaciones Cientificas (CONAE, Argentina) <i>Earth-observation satellite</i>
SAR	Synthetic Aperture Radar
SCIAMACHY	Scanning Imaging Absorption spectrometer for Instrumental Cartography
SEG	Scientific Evaluation Group of COSNA
SEVIRI	Spinning Enhanced Visible and Infrared Imager
SMOS	Soil Moisture and Ocean Salinity satellite
SVPB	Surface Velocity Program Barometer drifter
TAMDAR	Tropospheric Airborne Meteorological Data Reporting
THORPEX	The Observing System Research and Predictability Experiment
TRMM	Tropical Rainfall Measuring Mission
UAV	Unmanned Aerial Vehicle
VCP	Voluntary Co-operation Programme
VIIRS	Visible Infrared Imager Radiometer Suite
WIGOS	WMO Integrated Global Observing System
WMO	World Meteorological Organization
WOTAN	Wind Observation through Ambient Noise
WVSS	Water Vapour Sensing System
WWWW	World Weather Watch
XBT	Expendable Bathythermograph
ZTD	Zenith Tropospheric Delay

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